Digital Geologic Map of the Redding 1º x 2º Quadrangle, Shasta, Tehama, Humboldt, and Trinity Counties, California

By Luis A. Fraticelli, John P. Albers, William P. Irwin, Milton C. Blake, Jr, and Carl M. Wentworth

Pamphlet to accompany

Open-File Report 2012-1228

2012

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Contents

Figures

Digital Geologic Map of the Redding 1° x 2° Quadrangle, Shasta, Tehama, Humboldt, and Trinity Counties, California

By Luis A. Fraticelli, John P. Albers, William P. Irwin, Milton C. Blake, Jr, and Carl M. Wentworth

Digital Compilation

The original map compiled by Fraticelli and others (1987; Open-File Report 87–257) was prepared with ink on mylar and released in 1987 as a black-line map on a screened (gray) base. Here, we (Porter Irwin and Carl Wentworth) have converted that original map into a colored digital map supported by GIS files. The GIS process involved scanning a paper copy of the original map, vectorizing the line work in ArcGIS, and then editing that line work in workstation ArcInfo (v. 8.1) under the control of the menu interface ALACARTE (Fitzgibbon and Wentworth, 1991; Wentworth and Fitzgibbon, 1991). Label points were then added to identify the geologic units.

The original map contained many unlabelled polygons and various polygons containing conflicting labels, incomplete unit boundaries (hanging lines), and mislabeled areas. We resolved many of these problems, in part by consulting more detailed maps of the area. The 543 remaining unlabelled polygons (uncolored on the map) are mostly small and probably mostly surficial deposits, but some larger unlabelled areas are included, particularly in the southeastern part of the map. Dashed contacts and faults in the original are shown as solid on this map.

The southern half of the map area is covered by two geologic maps at scales of 1:100,000: McLaughlin and others (2000) and Blake and others (1999). These, together with five 15-minute quadrangles by Irwin (2009; 2010a,b), Irwin and others (2011), and Albers and others (1964), were consulted to help identify unlabelled polygons and resolve apparent geologic conflicts. Units Qbt (Basalt near Tuscan Buttes, Holocene and (or) Pleistocene), Qeb (Olivine basalt of Eagle Canyon, Pleistocene), and Qra (Rockland Ash, Pleistocene), unlabelled on the original map, have been identified from Blake and others (1999).

Map figures 1–3 of the original report (Fraticelli and others, 1987) are not reproduced here.

DESCRIPTION OF MAP UNITS

[This Description of Map Units was taken from Fraticellli and others (1987), with additions as noted and other, largely minor, additions and changes]

SUPERJACENT ROCKS

SURFICIAL DEPOSITS

t **Man-made materials (Holocene)**—Dredge tailings and other disturbed ground

Qsc **Stream channel deposits (Holocene)**—Light tan and gray, unweathered deposits of open, active stream channels. Deposits are transported under modern hydrologic conditions, usually in contact with modern surface waters

Qa **Alluvium and colluvium (Holocene)**—Unconsolidated silt, sand, and gravel in modern stream channels and on associated low terraces

Qo **Overbank deposits (Holocene)**—Sand, silt, and minor lenses of gravel deposited by floods and during high water stages

Qao **Alluvial and overbank deposits, undivided (Holocene)**

Qt **Terrace deposits (Holocene)**—Unconsolidated sand and gravel; closely associated with modern stream channels but generally higher than normal modern high-water level; also may include remnants of high-level terraces not necessarily related to present streams

Qls **Landslide deposits (Holocene)**—Slumped, rotated chaotic mixtures of underlying bedrock units and colluvium. Many landslides in areas of the Rattlesnake Creek terrane, Pickett Peak terrane, and in the Franciscan rocks of the Coastal and Central terranes are not shown although these areas are exceptionally unstable, and downslope movement is widespread

Qg **Glacial deposits (Pleistocene and (or) Holocene)**—Numerous moraines and debris flows that extend down glacial valleys, primarily in the Trinity Alps, north central part of the quadrangle

Qm **Modesto formation of Davis and Hall (1959) (Pleistocene)**—Consists of tan and light-gray gravely sand, silt, and clay, except where derived from volcanic rocks of the Tuscan Formation. It then is distinctly red and black with minor brown clasts. The Modesto Formation is the youngest unit comprising the Pleistocene alluvium. It borders existing stream channels in the southeast quarter of the quadrangle

Qr **Riverbank Formation (Pleistocene)**—Weathered reddish gravel, sand, and silt, forming alluvial terraces and fans. Differentiated from the younger Modesto Formation by (1) its geomorphic position in terraces topographically above the terraces of Modesto age and (2) the degree of post-depositional soil-profile development

Qrb **Red Bluff formation of Diller (1894) (Pleistocene)**—Thin veneer of distinctive, highly weathered bright-red gravels overlying the Tehama, Tuscan, and Laguna Formations. Interpreted as a sedimentary cover on a pediment surface

QTog **Older gravel deposits (Pliocene and (or) Pleistocene)**—Moderately well indurated, coarse to very coarse gravel with minor sand resting unconformably on a truncated soil profile developed on the Tuscan Formation in the southeast part of the quadrangle. In the Rattlesnake Creek and the Hayfork terrane, it consists of unconsolidated gravels in patches as much as 700 ft higher than modern stream levels

VOLCANIC ROCKS

Qip **Basalt flows of Paynes Creek (Pleistocene)—**Thin, black to dark-gray basalt flows with scattered yellowish-brown phenocrysts of olivine and glassy-green phenocrysts of clinopyroxene, in a matrix of fine-grained plagioclase, clinopyroxene, and glass. Age uncertain but less than 26,000 yr and possibly less than 12,000 yr because it overlies upper member of the Modesto formation of Davis and Hall (1959)

Qiu **Undifferentiated basalt flows of Inskip Hill (Pleistocene)**

Qbbb **Cinder blanket deposits (Pleistocene)—**Black, well-bedded basaltic cinder deposits forming a dissected ejecta blanket ranging in thickness from 10 m to 1.5 m. Remaining volume of cinder blanket and cone deposit is estimated at about 6 $x 10^6 m^3$

Qbbf **Basalt flow of Black Butte (Holocene)—**Dark-gray to black basalt, similar in texture and mineralogy to the Paynes Creek flows; olivine and clinopyroxene phenocrysts scattered in a diktytaxitic matrix of clinopyroxene and plagioclase. Holocene age from Blake and others (1999); Fraticelli and others (1987) showed it as Pleistocene

Qbt **Basalt near Tuscan Buttes (Pleistocene and (or) Holocene)**—Local extrusions of gray to black, glomeroporphyritic to highly vesicular, high-alumina basalt and minor amounts of scoria (unlabeled unit identified and described from Blake and others, 1999)

Qvu **Volcanic rocks of the Millville quadrangle (Pleistocene)—**Dark-gray, moderately diktytaxitic, high-alumina basalt (Al_2O_3, 18.4 to 19.1 %), composed of openwork plagioclase laths, fine-grained clinopyroxene, and magnetite with small scattered phenocrysts of brownish-green olivine

Qbs **Basalt of Shingletown Ridge (Pleistocene)—**Composed of three subunits (not differentiated on map) of dark-gray, fine-grained, diktytaxitic, and locally porphyritic basalt with rounded phenocrysts of brownish-green olivine scattered in an openwork mesh matrix of plagioclase and clinopyroxene. High-alumina basalts containing about 47.6 % SiO_2, 18.09 % Al_20_3, and 0.19 % K_20

Qeb **Olivine basalt of Eagle Canyon (Pleistocene)**—Dark-gray, diktytaxitic, vesicular olivine basalt (unlabeled unit identified and described from Blake and others, 1999)

Qba **Olivine basalt of Devils Half-Acre (Pleistocene)—**Gray, glomeroporphyritic, vesicular olivine basalt. Maximum thickness 15 m, source unknown. Pleistocene age from Blake and others (1999); Fraticelli and others (1987) showed the age as a query (?)

Qab **Andesite of Brokeoff Mountain (Pleistocene)—**Porphyritic hypersthene andesite with abundant white plagioclase phenocrysts, minor amounts of hypersthene, and sparse augite phenocrysts in a fine-grained matrix of plagioclase microlites and brown glass

Qra **Rockland ash bed of Sarna-Wojcicki and others (1982) (Pleistocene)**—Loosely aggregated, dacitic pumice lapilli ash that contains scattered, coarse, white pumice fragments as large as 20 cm in diameter (unlabeled unit identified and described from Blake and others, 1999)

Qcb **Basalt of Coleman Forebay (PIeistocene)—**Dark-gray olivine basalt with pronounced diktytaxitic texture and scattered large vesicles and voids. Weathers light-rusty gray. The unit is undated but is older than the Red Bluff formation of Diller (1894) and has a maximum thickness of 10 m

Ta **Andesite (Pliocene)—**Undivided flows of predominantly two-pyroxene andesite; commonly platy, medium to light gray, rarely dark gray, locally pink, greenish gray, or mottled; locally overlies hornblende-bearing pyroxene andesite containing abundant plagioclase phenocrysts and less abundant, smaller hornblende phenocrysts

Tva **Andesitic breccia (Pliocene)—**Breccias and tuff breccia in area east of Shasta Lake; may be correlative with the Tuscan Formation. Fraticelli and others (1987) called the unit andesite, here renamed andesitic breccia to contrast with unit Ta

Tvb **Basalt (Pliocene)—**Undivided basaltic flows east of Shasta Lake

SEDIMENTARY ROCKS

Tte **Tehama Formation (Pliocene)—**Pale-green, gray, and tan sandstone and siltstone with lenses of cross-bedded pebble and cobble conglomerate. Interfingers with the Tuscan Formation north of Red Bluff. Clastic debris is more andesitic in composition and Tuscan-like in appearance eastward in area of interfingering. The Tehama and Tuscan Formations are considered coeval because both contain the Nomlaki Tuff Member at or near their stratigraphic bases. Maximum thickness is about 600 m

Ttn **Nomlaki Tuff (Pliocene)—**White, light-gray, locally reddish-tan to salmon dacitic pumice tuff and pumice lapilli tuff exposed in widely separated areas at or very near the bases of the Tuscan and Tehama Formations. Varies from massive non-layered ash flow at Tuscan Springs, Gas Pointe, and Antelope Creek to bedded and cross-bedded, reworked pumiceous sediment at Richardson Springs. Thickness varies from 1 to 30 m. Evernden and others (1964) obtained a K-Ar date of 3.4 Ma on a welded ash-flow tuff at Bear Creek Falls, which Anderson and Russell (1939) correlated with the type Nomlaki Tuff

Tt **Tuscan Formation, undivided (Pliocene)—**Includes interbedded lahars, volcanic conglomerate, volcanic sandstone, siltstone, and pumiceous tuff. The Tuscan Formation is divided into four subunits:

Ttd **Fragmental deposits—**Characterized by large monolithologic masses of gray hornblende andesite, augite-olivine basaltic andesite, black pumice, and smaller fragments of black obsidian and white and gray hornblende-bearing pumice in a grayish-tan pumiceous mudstone matrix. Thickness ranges from 10 to 50 m

Tth **Tuff of Hogback Road—**Discontinuous thin lapilli tuff, pumiceous sandstone, and conglomerate composed of rounded white hornblende-bearing dacitic pumice fragments up to 3 cm in diameter and smaller gray and black pumice fragments admixed with varying amounts of andesitic tuff about 2.5 m thick at the hogback on Hogback Road

Ttc **Lahars with minor interbedded volcanic conglomerate and sandstone**—North of Antelope Creek, separated from overlying units by partially stripped soil horizons. This unit is about 80 m thick near Tuscan Springs

Tti **Ishi Tuff Member—**White to light-gray, fine-grained, pumiceous air-fall tuff commonly reworked with variable amounts of volcanic sandstone and silt, distinguished by abundant black to bronze biotite flakes about 1 mm in diameter. A fission-track age of 2.7 Ma obtained from zircons separated from the pumice clasts is the best current estimate age of the Ishi Tuff member (Blake and others, 1984)

Twg **Wildcat Group (Upper Miocene-Pliocene)—**Weakly consolidated mudstone, siltstone, sandstone, and conglomerate and minor interbeds of limestone, tuff, and lignite. Abundant fossils of a molluscan and foraminiferal fauna indicate a Pliocene age, but the oldest part (not differentiated on the map) may be as old as late Miocene (Irwin, 1960). Includes the Falor Formation in the northwest corner of the quadrangle

Tw **Weaverville Formation (Oligocene and (or) Miocene)—**Nonmarine sedimentary rocks including conglomerate, sandstone, and thinly laminated, light-colored clay and tuff; lignitic coal beds present locally. Fossil plants previously indicated Oligocene age (MacGinitie, 1937), but more recent study of pollen and spores indicates late Oligocene and (or) Miocene age (Barnett, 1982)

Tmc **Montgomery Creek Formation (Eocene)—**Gray, yellowish-orange-weathering, arkosic sandstone with conglomerate and shale; commonly massive to thick-bedded nonmarine sandstone with scattered lenses of pebble conglomerate and shale. The unit is about 80 m thick at its southern limit and thickens to the north to about 200 m (Anderson and Russell, 1939) in Montgomery Creek

Kc **Chico Formation (Upper Cretaceous)—**Tan, yellowish-brown to light-gray, fossiliferous marine sandstone with lenticular beds of pebble to fine cobble conglomerate and minor siltstone. Clasts in conglomerate include rounded to well-rounded, red, green, and black chert, white vein quartz, quartzite, granite, and greenstone

Ks **Sedimentary rocks (Lower Cretaceous)—**Mostly marine sedimentary rocks; well indurated, buff-weathering sandstone, mudstone, and conglomerate. Contains ammonites and other marine fossils; rocks are similar to those of equivalent age in the Great Valley sequence. Includes some minor nonmarine rocks in western part of quadrangle near Glade Creek and Big Bar

ELDER CREEK TERRANE

ecms **Mudstone (Upper Jurassic-Lower Cretaceous)—**Dark gray, mainly hackly fractured, with minor tan siltstones and sandstones. Limestone nodules, lenses, and thin beds locally abundant eco **Coast Range ophiolite (Upper Jurassic)—**Dismembered ophiolite consisting of sheared serpentinite and small blocks of gabbro and diabase

PLUTONIC ROCKS

Kqd **Shasta Bally Batholith (Lower Cretaceous)—**Quartz diorite and granodiorite of Shasta Bally is dated by K-Ar analysis at 135 Ma by Lanphere and others (1978). Unit includes other small plutonic bodies of similar composition and age. In the extreme northeast part of the quadrangle, small bodies of coarse-grained quartz diorite yielded radiometric ages of 123 Ma (Paul René, oral commun., May 1986)

SUBJACENT ROCKS

KING RANGE TERRANE

krt **Turbidites and pillow lava (Eocene(?)-Miocene)—**Pillow lava overlain by thin-bedded turbidites thought to range in age from early Cenozoic to middle Miocene (McLaughlin and others, 1982). Turbidites are characterized by closely spaced folds of three generations. Represents youngest known terrane within the Franciscan Complex in California. Present only in extreme southwest corner of map

YAGER SUBTERRANE

ymt **Chiefly marine mudstone and sandstone (Paleocene-upper Eocene)**

yst **Chiefly marine sandstone, locally conglomerate (Paleocene-upper Eocene)**

COASTAL TERRANE

Broken formation consisting largely of arkosic sandstone. Fossils range in age from Late Cretaceous to Eocene. Characterized by abundant laumontite veins. Locally isoclinally folded and (or) stratally disrupted

cosa **Chiefly broken to coherent, well-bedded sandstone and argillite (Upper Cretaceous-Eocene)**

cosas **Chiefly sheared argillite and sandstone (Upper Cretaceous-Eocene)**

cov **Basalt flows, tuff, breccia, and diabase intrusives (Upper Cretaceous-Eocene)—**Locally contain manganese, pink pelagic limestone, or minor cherty partings

CENTRAL TERRANE

Tectonic melange consisting of resistant blocks in a highly sheared argillaceous matrix. The matrix, where well exposed and less sheared, is commonly made up of interbedded fine-grain mudstone, lithic sandstone, and radiolarian tuff. Pillow lava is probably also part of the matrix but is usually detached by faulting. Fossils from the matrix and interbedded chert range in age from Late Jurassic (Tithonian) to Early Cretaceous (Valanginian)

ctmm **Melange matrix (Upper Jurassic-Lower Cretaceous)—**Chiefly sheared argillite and lithic sandstone or graywacke with some interbedded green tuff. Includes scattered high-grade blueschist, eclogite, and amphibolite blocks (not shown)

ctsp **Serpentinite (Upper Jurassic-Lower Cretaceous)—**Possibly includes some Coast Range ophiolite ctcr **Coast Range ophiolite (Upper Jurassic-Lower Cretaceous)—**Includes peridotite, diabase, gabbro, basalt; may include other rocks derived from the Coast Range ophiolite

ctls **Pelagic limestone(?)—**(only two localities on map)

ctgs **Greenstone(?)**

ctch **Chert(?)**

ctss **Sandstones(?)**

YOLLA BOLLY TERRANE

Intercalated graywacke, shale, conglomerate, and radiolarian chert, all intruded by diabase-gabbro and quartz keratophyre and subsequently metamorphosed to blueschist facies. Cherts contain radiolarians of Middle(?) Jurassic to Middle Cretaceous age (Blake and others, 1981)

ybt **Taliaferro metamorphic complex (Lower Cretaceous(?) metamorphic age)**—Includes schistose metagraywacke, crumpled phyllite, metagreenstone, and metachert

ybtmm **Melange (Upper Jurassic to Lower Cretaceous)—**Mostly sheared argillite, graywacke, and conglomerate with abundant blocks of fine-grained greenstone, chert, plus scarce serpentinite, and rare blueschist and amphibolite knockers. Radiolarians extracted from chert are Tithonian-Valanginian in age (Blake and others, 1984)

ybh **Metagraywacke of Hammerhorn Ridge (Upper Jurassic-Lower Cretaceous)—**Dominantly graywacke with lesser amounts of argillite and conglomerate and abundant interbeds of chert which yield fossils of Upper Jurassic-Lower Cretaceous (Tithonian-Valanginian) age (Blake and others, 1984)

ybtch **Chert (Middle(?) Jurassic-Middle Cretaceous)**

PICKETT PEAK TERRANE

Strongly deformed quartz-mica schist, metagraywacke, metabasalt, and metachert. Contains high-pressure blueschist-facies minerals. Includes South Fork Mountain Schist, Colebrooke Schist of southwest Oregon, and Valentine Springs Formation. No fossils are known; radiometric ages on metamorphic minerals suggest an Early Cretaceous (125 Ma) metamorphic age (Lanphere and others, 1978)

sfm **South Fork Mountain Schist (Lower Cretaceous(?))—**Consists chiefly of fine-grained quartz-albite-muscovite-chlorite schist and commonly contains microscopic lawsonite. Most of the South Fork Mountain Schist is poorly exposed owing to a thick cover of slope debris

sfmmb **Chinquapin Metabasalt Member (Lower Cretaceous(?))—**A fine-grained, albite-chlorite- actinolite-epidote gneiss with local crossite-rich layers; also includes sparse metachert

vsmv **Metavolcanic rocks within the Valentine Springs Formation (Lower Cretaceous(?))**

WESTERN JURASSIC TERRANE

wJg **Galice Formation(?) (Upper Jurassic)—**Interbedded mudstone, graywacke, and conglomerate ranging in texture from weakly slaty to semischist. Fossils have not been found in the Galice Formation(?) in this mapped area, but it is presumed to correlate with similar rocks in southern Oregon containing fossils that indicate a Late Jurassic (late Oxfordian and middle Kimmeridgian) age (Imlay, 1959). Age of metamorphism is Late Jurassic based on K-Ar analysis (148±1.8 Ma,151±4.4 Ma, and 153±4.5 Ma; Lanphere and others, 1978)

wJr **Rogue Formation(?) (Middle to Upper Jurassic(?))—**Mafic to intermediate volcanic flows(?), breccia, and tuff; includes volcanic conglomerate in upper part

wJsp **Serpentinite (Upper Jurassic(?))**—Occurs as tectonic slices along South Fork Fault; may be related to Josephine ophiolite of Harper (1980), which is more completely exposed in the Western Jurassic terrane farther north in the Klamath Mountains province

wJd **Diorite-Ammon Ridge Pluton (Upper Jurassic(?))**

wJgb **Gabbro (Upper Jurassic(?))**

wJgn **Friday Camp gneiss (Upper Jurassic(?))—**Weakly foliated hornblende-diorite gneiss

wJgm **Meta-Galice (Upper Jurassic(?))—**Hornfels and fine-grained chiastolite-biotite-chlorite schist adjacent to the Ammon Ridge Pluton (wJd)

RATTLESNAKE CREEK TERRANE

rcv **Volcanic broken formation and melange (Middle(?) Triassic to Middle Jurassic)—**Consists of sheared and dislocated mafic volcanic rocks, including pillow basalt, flows(?), tuff, volcanic breccia, and volcaniclastic rocks that contain locally interbedded red and gray to black, thin-bedded radiolarian chert; includes minor intermediate and silicic volcanic rocks, lenses, and tectonic blocks of limestone, amphibolite, plutonic rocks, and serpentinite. Microfossils in various bodies of chert and limestone have yielded ages ranging from Permian to Jurassic. A K-Ar age on blueschist-facies chert is 185±8.8 Ma (Irwin, 1985). Continuity of lithic units is disrupted by faults and obscured by landslides

rcs **Detrital sedimentary rocks (Triassic or Jurassic)—**Well-bedded, somewhat slaty rocks ranging from mudstone to pebble conglomerate; may be inliers or fault slices of Western Jurassic terrane (Irwin, 1985)

rcp **Plutonic rocks (Triassic to Jurassic)—**Medium- to coarse-grained rocks that range from diorite to granite; includes Eltapom and Grassy Mountain Plutons, Bear Wallow diorite, and Tule Creek granite complex. Some are isotopically dated as Early Jurassic (207-193 Ma; Wright, 1982) in Chanchelulla Peak and Dubakella Mountain quadrangles. May include some intermediate and silicic volcanic rocks

rcsp **Serpentinite (age unknown)—**Dominantly serpentinized peridotite, but includes associated metasomatized mafic rocks of uncertain origin, as well as minor sheared-in volcanic rocks and chert. Continuity of serpentinite zone is disrupted by faults and obscured by landslides

rcgb **Gabbro (Triassic(?) to Jurassic)**

HAYFORK TERRANE

Western Hayfork Subterrane

hhvc **Chert and argillite (Middle Jurassic)—**Dominantly thin-bedded radiolarian chert locally interlayered with argillite and meta-andesite. Generally overlies (conformably(?)) and locally interfingers with the Hayfork Bally Meta-andesite (hhb)

hhb **Hayfork Bally Meta-andesite (Middle Jurassic)—**Layered mafic volcanogenic rocks ranging in texture from coarse agglomerate to crystal tuff, probably representing an island-arc deposit. Commonly characterized by euhedral augite and plagioclase crystals in a light-to dark-green groundmass. Locally includes interlayered thin-bedded radiolarian chert and dark argillite. Age of meta-andesite is thought to be Middle Jurassic on basis of a probable cogenetic relation with the Ironside Mountain Batholith (him; 170 Ma, revised constant) and on K-Ar isotopic ages of 159 Ma (Fahan and Wright, 1983) measured on hornblende from meta-andesite

him **Ironside Mountain batholith (Middle Jurassic)—**Mostly medium grained monzodiorite, but includes quartz diorite and minor gabbro and pyroxenite. Fine-grained and hybrid(?) varieties are common along much of the boundary between the batholith and the Hayfork Bally Meta-andesite. Age of batholith is Middle Jurassic based on isotopic ages of about 170 Ma determined by K-Ar analysis (Lanphere and others, 1968, revised constant) and by U-Pb analysis (Wright, 1982)

hgb **Gabbro (Middle Jurassic(?))—**Includes the Goods Creek Pluton and some small unnamed intrusives bodies in both the Eastern and Western Hayfork subterrane

hpx **Pyroxenites (Middle Jurassic(?))—**Includes the Chanchelulla Peak zoned ultramafic complex

Eastern Hayfork Subterrane

hm **Melange (Middle(?) Jurassic)—**Slaty argillite and other clastic sedimentary rocks, thin-bedded chert, volcaniclastic rocks, sparse recrystallized limestone (ls), minor mica schist, amphibolite (ha), and serpentinite (hsp). Unit structurally overlies unit hhb

ha **Amphibolite tectonic blocks (age unknown)—**Rare occurrences within the Eastern Hayfork subterrane

hsp **Serpentinite (age unknown)**

hgd **Granodiorite (Middle Jurassic(?))—**Unnamed small intrusive body in the northern part of the Hayfork terrane

hd **Diorite (Middle Jurassic(?))—**Small intrusive bodies mostly in the northern part of the Hayfork terrane

NORTH FORK TERRANE

nf **Tectonically dismembered ophiolite (Upper Triassic-Middle(?) Jurassic)—**Includes overlying siliceous tuff, chert, sandstone, and limestone. Locally a mélange containing blocks and slabs of Permian limestone having Tethyan faunal affinities and blueschist knockers. Radiolarians from chert range from Late Triassic to Middle(?) Jurassic (Irwin and others, 1982)

nfsp **Serpentinite of the North Fork terrane(?)**

nfgb **Gabbro(?)**

nfd **Diorite(?)—**Small isolated intrusives bodies in the North Fork terrane

nfdb **Diabase**

nfs **Metasedimentary rocks of the Stuart Fork Formation (pre-Upper Jurassic(?))—** Includes phyllitic quartzites and dark quartz-mica phyllites, commonly graphitic (Davis and others, 1965)

nfv **Metavolcanic rocks of the Stuart Fork Formation (pre-Upper Jurassic(?))—** Fine-grained greenstones and associated schistose metavolcanic rocks interfingering with siliceous Stuart Fork rocks in upper part of formation. Schistose rocks include mainly actinolite schists and phyllonites (Davis and others, 1965)

CENTRAL METAMORPHIC TERRANE

cms **Salmon Hornblende Schist (Devonian)—**Amphibolite-grade hornblende schist and gneiss, probably represents mafic volcanic rocks of an island arc; locally includes lenses of micaceous schist. Lower part of unit in the Weaver Bally area may be a metagabbro; co-metamorphic with Abrams Mica Schist; K-Ar isotopic ages of 390 and 399 Ma (Hotz, 1977) of possibly correlative amphibolites in the Yreka-Callahan area, north of the Redding map area, suggests a Devonian age of metamorphism

cma **Abrams Mica Schist (Devonian)—**Schistose metasedimentary rocks; generally micaceous and quartzitic; discontinuous lenses of micaceous marble near base (m, where distinguished); Rb-Sr isotopic ages of about 380 Ma indicate Devonian age of metamorphism (Lanphere and others, 1968); unit equivalent to the Grouse Ridge Formation of Davis and Lipman (1962)

cmsa **Undifferentiated Salmon Hornblende and Abrams Mica Schist (Devonian)**

EASTERN KLAMATH TERRANE

Island-arc volcanic rocks plus intercalated sedimentary rocks of Devonian through Middle Jurassic age. Forms a younging-eastward, homoclinal but internally deformed sequence that is faulted against the Trinity terrane to the west. Overlain to the south and east, with great angular unconformity, by Cretaceous sedimentary strata of the Great Valley sequence

Jp **Potem Formation (Jurassic)—**Sandstones, shales, and tuffs; thin-bedded sandstones and gray, sometimes slaty, shales predominate in lower part and comprise the greater part of the unit. Subordinate lentils of limestone are contained in lower part. Tuffaceous conglomerate predominates in upper half of the formation

mi **Mafic intrusive rocks (Jurassic)—**Mainly two-pyroxene diorite formerly mapped as Bagley Andesite in northeast part of the quadrangle; radiometric age is 160 Ma (Paul Renne, oral commun., 1986)

Ja **Arvison Formation (Jurassic)—**Volcanic breccia, tuff, agglomerate, and volcanic conglomerate, named by Sanborn (1960) for exposures in the Big Bend area

Ʀm **Modin Formation (Upper Triassic)—**Extensive succession of andesitic tuffaceous beds, overlain by shaley sandstone and shale; volcanic conglomerate at the base locally contains limestone fragments with Hosselkus-type (ꝶh) fossils; unit here includes underlying Brock Shale of Diller (1906)

ꝶh **Hosselkus Limestone (Upper Triassic)—**Medium- to light-gray, lenticular limestone as much as 60 m thick

ꝶp **Pit Formation (Permian(?) or Triassic)—**Predominantly gray and black shale with interbedded layers of tuff in lower part and limestone lenses in upper part. Also contains local mafic flows and dome-like bodies of silicic volcanic rock. Contains lenses of massive sulfide in lowermost part in local areas. Some cherty layers at the base in two localities have yielded radiolarians of Permian age (Silberling and Jones, 1982; Fraticelli, 1984)

Pbh **Bully Hill Rhyolite (Permian(?)-Middle Triassic(?))—**Dominantly porphyritic and non-porphyritic quartz keratophyre; locally includes much volcanic breccia. Contains lenticular bodies of massive sulfide in uppermost part. Formation is of small areal extent, highly variable in thickness, and extensively altered. Age is uncertain, but possibly late Permian based on radiolarians of Permian age in chert bed above the Bully Hill Rhyolite in the Shasta Lake area (Fraticelli, 1984)

Ppr **Pit River stock (Permian)—**Coarse-grained quartz diorite, granodiorite, and albite granite, with associated aplite dikes. Isotopic age as determined by U/Pb ratios on zircon is 261 Ma (Fraticelli and others, 1985)

aqd **Augite-quartz diorite (Permian(?))—**Includes medium-grained augite quartz diorite, fine-grained diorite, and minor granodiorite that intrude and surround the McCloud Limestone

md **Mafic rocks (Permian(?))—**Includes mafic diorites and diabasic rocks that intrude Bragdon, Baird, and Nosoni Formations

Pd **Dekkas Andesite (Permian)—**Predominantly albitized andesite (keratophyre) and subordinate albitized basalt (spilite); forms massive flows and volcanic breccia; commonly porphyritic and (or) amygdaloidal. Contains lenses of mudstone and tuffaceous mudstone

Pn **Nosoni Formation (Permian)—**Predominantly mafic volcanic tuffs and subordinate mudstone, tuffaceous sandstone, mafic flows, volcanic conglomerate, and breccia. Some mudstone is calcareous and contains abundant fusulinids of Permian age (Fraticelli, 1984). Formation thickens from south to north but is absent in some areas. Contact with overlying Dekkas Andesite (Pd) is locally difficult to ascertain

Pm **McCloud Limestone (Pennsylvanian(?) and Permian)—**Light-gray massive limestone; locally contains abundant Permian fusulinids; forms individual large blocks in many areas owing to disruption by faults and (or) engulfment by mafic quartz diorite or other dark fine-grained intrusive rock; may be in part Pennsylvanian but fossil evidence is controversial (Skinner and Wilde, 1965)

Mb **Baird Formation (Mississippian and Pennsylvanian(?))—**Predominantly volcaniclastic sandstone composed of clasts of intermediate volcanic rocks; subordinate interbedded purple-weathering tuff, mudstone, shale, and blue-gray bioclastic limestone. Some shale and limestone lenses are highly fossiliferous; lowest part of Baird Formation in southern part of its exposed area is massive albitized porphyritic andesite flows

Mbd **Bragdon Formation (Mississippian)—**Dark-gray to black shale, mudstone, and siltstone in lower part; siliceous sandstone, grits, and chert conglomerate prominently interlayered with dark pelitic rocks in middle and upper parts; some tuffaceous beds near top of formation seem to be comformable with and gradational into the overlying Baird Formation. The abundant chert in the conglomerate is of unknown source

Dk **Kennett Formation (Devonian)—**Lowest part in southern exposure of Kennett Formation is silicic volcaniclastic debris derived largely from erosion of Balaklala Rhyolite. This is overlain by interlayered black carbonaceous and cherty shales containing local volcaniclastic interbeds. Shales typically weather medium to light gray. Uppermost part contains massive gray limestone lenses, locally with abundant fossils. Contact with overlying Bragdon Formation is unconformable and may be a thrust fault of regional extent

Dmm **Mule Mountain stock (Devonian)—**Highly altered phaneritic igneous body consisting of trondhjemite, albite granite, and quartz diorite; U/Pb isotopic age is 400 Ma (Albers and others, 1981)

Dbr **Balaklala Rhyolite (Devonian(?))—**Silicic flows, breccias, and tuffs; subordinate dikes and mafic flows; all rocks are intensely albitized, and protolith was probably dacite. Most of the rocks are quartz keratophyres, but through long informal usage are usually referred to as hyalite. The unit is divided into three informal units (not differentiated on this map); a nonporphyritic rhyolite consisting of flows and breccias, with subordinate tuffs and mafic flows; a medium-grained porphyritic rhyolite consisting of flows; and a coarse-grained porphyritic rhyolite consisting of flows and breccias in the upper part. The Balaklala is considered to be a cogenetic extrusive equivalent of the Mule Mountain Stock. The lower and middle units are intruded by the stock

Dcg **Copley Greenstone (Devonian(?))—**Chiefly keratophyre and subordinate spilite pillow lavas and volcanic breccias; includes some metaandesite and metabasalt, as well as boninite and shaly tuff lenses in lower part. Pillow lavas conspicuously dominate the upper part where it is locally interlayered with, and also intruded by, middle facies of Balaklala Rhyolite (Dbr). Probably coeval with Balaklala Rhyolite

TRINITY TERRANE

tum **Trinity ultramafic complex (Ordovician(?))—**Strongly deformed and recrystallized peridotite, minor layered and intrusive gabbro (tgb, where distinguished), diabase dike-sill-complex, plus rare volcanic rocks. Has yielded early Paleozoic radiometric ages. May represent an Ordovician ophiolite (Lindsley-Griffin, 1977) or a mantle diapir, intrusive into an island-arc or back-arc basin environment (Quick, 1981)

tgb **Gabbro (Ordovician(?))**—Layered intrusive, minor component, locally distinguished

References Cited

Albers, J.P., Kinkel, A.R., Jr., Drake, A.A., and Irwin, W.P., 1964, Geology of the French Gulch quadrangle: U.S. Geological Survey Geologic Quadrangle Map GQ-336, scale 1:62,500.

Albers, J.P., Kistler, R.W., and Kwak, L., 1981, The Mule Mountain stock, an early Middle Devonian pluton in northern California: Isochron/West, v. 31, p. 17.

Albers, J.P., and Robertson, J.F., 1961, Geology and ore deposits of East Shasta copper-zinc district, Shasta County, California: U.S. Geologica1 Survey Professional Paper 338, 107 p.

Anderson, C.A., and Russell, R.D., 1939, Tertiary formations of the northern Sacramento Valley, California: California Journal of Mines and Geology, v. 35, p. 219-253.

Bailey, E.H., and Jones, D.L., 1973, Preliminary lithologic map, Colyear Springs quadrangle, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-516, scale 1:48,000.

Barnett, J.C., 1982, Palynology and paleoecology of the Weaverville Formation (Tertiary), northwestern California: Seattle, Wash., University of Washington, M.S. thesis, 118 p.

Blake, M.C., Jr., 1965, Structure and petrology of low-grade metamorphic rocks, blueschist facies, Yolla Bolly area, northern California: Stanford, Stanford University, Ph.D dissertation, 91 p.

Blake, M.C., Jr., Harwood, D.S., Helley, E.J., Irwin, W.P., Jayko, A.S., and Jones, D.L., 1984, Preliminary geologic map of the Red Bluff 1:100,000 quadrangle: U.S. Geological Survey Open-File Report 84-105.

Blake, M.C. Jr., Harwood, D.S., Helley, E.J., Irwin, W.P., Jayko, A.S., and Jones, D.L., 1999, Geologic map of the Red Bluff 30' x 60' quadrangle, California: U.S. Geological Survey Geologic Investigations Map I-2542, scale 1:100,000.

Blake, M. C., Jr., Jayko, A. S., and Howell, D. G., 1981, Geology of a subduction complex in the Franciscan assemblage of northern California: Proceedings, 26th International Geological Congress,
Geology of Continental margins symposium, Paris, July 7-17, p. 267-272.

Charlton, D.W., 1979, Geology of part of the Ironside Mountain quadrangle, northern California, Klamath Mountains: Santa Barbara, University of California, Ph.D dissertation, 542 p.

Cox, D.P., 1967, Reconnaissance geology of the Helena quadrangle, Trinity County, California, *in* Short Contributions to California Geology: California Division of Mines and Geology Special Report 92, p 43-55.

Davis, G.A., Holdaway, M.J., Lipman, P.W., and Romey, W.D., 1965, Structure, metamorphism, and plutonism in the south-central Klamath Mountains, California: Geological Society of America Bulletin, v. 76, p. 933-966.

Davis, G.A., and Lipman, P.W., 1962, Revised structural sequence of pre-Cretaceous metamorphic rocks in the southern Klamath Mountains, California: Geological Society of America Bulletin, v. 73, p. 1547-1552.

Davis, S.N., and Hall, F.R., 1959, Water quality of eastern Stanislaus and northern Merced Counties, California: Stanford University Publications, Geological Sciences, v. 6, no. 1, 112 p.

Diller, J.S., 1894, The Tertiary revolution in the topography of the Pacific coast: U.S. Geological Survey Fourteenth Annual Report, part II, p. 397-434.

Diller, J.S., 1906, Description of the Redding quadrangle, California: U.S. Geological Survey Atlas Folio 138, l4 p.

Evernden, J.F., Savage, D.E., Curtis, G.H., and James, G.J., 1964, Potassium-argon dates and the Cenozoic mammalian chronology of North America: American Journal of Science, v. 262, p. 145-198.

Fahan, M.R., 1982, Geology and geochronology of a part of the Hayfork terrane, Klamath Mountains, northern California: Berkeley, University of California, M.S. thesis, 127 p.

Fahan, M.R., and Wright, J.E., 1983, Plutonism, volcanism, folding, regional metamorphism, and thrust faulting—Contemporaneous aspects of a major Middle Jurassic organic event within the Klamath Mountains, northern California: Geological Society of America Abstracts with Programs, v. 15, no. 5, p. 272-273.

Fitzgibbon, T.T., and Wentworth, C.M., 1991, ALACARTE user interface—AML code and demonstration maps (version 1.0): U.S. Geological Survey, Open-File Report 91-587A.

Fraticelli, L.A., 1984, Geology of portions of the Project City and Bella Vista quadrangles, Shasta County, California: San Jose, Calif., San Jose State University, M.S. thesis, 110 p.

Fraticelli, L.A., Albers, J.P., Irwin, W.P., and Blake, M.C., Jr., 1987, Geologic map of the Redding 1x2 degree quadrangle, Shasta, Tehama, Humboldt and Trinity Counties, California: U.S. Geological Survey Open-File Report 87-257, scale 1:250,000.

Fraticelli, L.A., Albers, J.P., and Zartman, R.E., 1985, The Permian Pit River stock of the McCloud plutonic belt, Eastern Klamath terrane, northern California: Isocron/West, no. 44, p. 6-8.

Harper, G.D, 1980, The Josephine ophiolite—Remains of a Late Jurassic marginal basin in northwestern California: Geology, v. 8, p. 333-337.

Harwood, D.S., Helley, E.J., Barker, J.A., and Griffen, E.A., 1980, Preliminary geologic map of the Battle Creek fault zone, Shasta and Tehama Counties, California: U.S. Geological Survey Open-File Report 80-474, scale 1:24,000.

Helley, E.J., and Harwood, D.S., 1985, Geologic map of late Cenozoic deposits of the Sacramento Valley and northern Sierra foothills, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1790, scale 1:62,500.

Helley, E.J., Harwood, D.S., Barker, J.A., and Griffen, E.A., 1981, Geologic map of the Battle Creek fault zone, northern Sacramento Valley, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1298, scale 1:62,500.

Hilton, R.P., 1975, The Geology of the Ingot-Round Mountain area, Shasta County, California: Chico, California State University, M.S. thesis, 83 p.

Hollister, V.F., and Evans, J.R., 1965, Geology of the Redding quadrangle, Shasta County, California: California Division of Mines and Geology Map Sheet Series 4, scale 1:24,000.

Hotz, P.E., 1977, Geology of the Yreka quadrangle, Siskiyou County, California: U.S. Geological Survey Bulletin 1436, 72 p.

Hotz, P.E., Greene, R.C., Close, T.J., and Evans, R.K., 1974, Mineral resources of proposed additions to the Salmon-Trinity Alps primitive area, California (supplement to U.S. Geological Survey Bulletin 137 1–B): U.S. Geological Survey Open-File Report 74-71, 70 p.

Huber, D.F., Nelson, S.C., Fraticelli, L.A., and Stebbins, S.A., 1983, Mineral resource potential map of the Chanchelulla Roadless Area, Trinity County, California: U.S. Geological Survey Open-File Report 83–0506, 14 p.

Imlay, R.W., 1959, Succession and speciation of the pelecypod *Aucella*, *in* Short contributions to general geology: U.S. Geological Survey Professional Paper 314-G, p. 441-454.

Irwin, W.P., 1960, Geologic reconnaissance of the northern Coast Ranges and Klamath Mountains, California: California Division of Mines and Geology Bulletin 179, 80 p.

Irwin, W.P., 1963, Preliminary geologic map of the Weaverville quadrangle, California: U.S. Geological Survey Mineral Investigations Field Studies Map MF-275, scale 1:62,500.

Irwin, W.P., 1974, Reconnaissance geologic map of the Hayfork quadrangle, Trinity County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-576, scale 1:62,500.

Irwin, W.P., 1985, Reconnaissance geologic map of the Hyampom quadrangle, Trinity County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1809, scale 1:62,500.

Irwin, W.P., 2009, Geologic map of the Weaverville 15' quadrangle, Trinity County, California: U.S. Geological Survey Scientific Investigations Map 3095, scale 1:50,000. (Available at http://pubs.usgs.gov/sim/3095/.)

Irwin, W.P., 2010a, Reconnaissance geologic map of the Hayfork 15' quadrangle, Trinity County, California: U.S. Geological Survey Scientific Investigations Map 3119, scale 1:50,000. (Available at http://pubs.usgs.gov/sim/3119/.)

Irwin, W.P., 2010b, Reconnaissance geologic map of the Hyampom 15' quadrangle, Trinity County, California: U.S. Geological Survey Scientific Investigations Map 3129, scale 1:50,000. (Available at http://pubs.usgs.gov/sim/3129/.)

Irwin, W.P., Jones, D.L., and Blome, C.D., 1982, Map showing sampled radiolarian localities in the Klamath Mountains, California and Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-1399, scale 1:250,000.

Irwin, W.P., Wolfe, E.W., Blake, M.C., Jr., and Cunningham, C.G., Jr., 1974, Geologic map of the Pickett Peak quadrangle, Trinity County, California: U.S. Geological Survey Geological Quadrangle Map GQ-1111, scale 1:62,500.

Irwin, W.P., Yule, J.D., Court, B.L., Snoke, A.W., Stem, L.A., and Copeland, W.B., 1985, Reconnaissance geologic map of the Dubakella Mountain quadrangle, Trinity, Shasta, and Tehama Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1808, scale 1:62,500.

Irwin, W.P., Yule, J.D., Court, B.L., Snoke, A.W., Stern, L.A., and Copeland, W.B., 2011, Reconnaissance Geologic Map of the Dubakella Mountain 15' Quadrangle, Trinity, Shasta, and Tehama Counties, California: U.S. Geological Survey Scientific Investigations Map 3149, scale 1:50,000. (Available at http://pubs.usgs.gov/sim/3149/.)

Kelsey, H.M., and Allwardt, A.O., 1974, Geologic map of the Van Duzen River basin environmental atlas: California Department of Water Resources, Plates 8A thru 81, scale 1:36,000.

Kingston, J.D., 1985, Geology of the northern Lamoine quadrangle, Shasta County, California: Berkeley, University of California, M.S. thesis, 146 p.

Kinkel, A.R., Jr., Hall, W.E., and Albers, J.P., 1956, Geology and base metal deposits of West Shasta copper-zinc district, Shasta County, California: U.S. Geological Survey Professional Paper 285, 156 p.

Lanphere, M.A., Blake, M.C., Jr., and Irwin, W.P., 1978, Early Cretaceous metamorphic age of the South Fork Mountain Schist in the northern Coast Ranges of California: America Journal of Science, v. 278, no. 6, p. 798-515.

Lanphere, M.A., Irwin, W.P., and Hotz, P.E., 1968, Isotopic age of the Nevadan orogeny and older plutonic and metamorphic events in the Klamath Mountains, California: Geological Society of America Bulletin, v. 79, no. 8, p. 1027-1052.

Lawson, W.A., 1986, Geology and structure of the Covington Mill 7.5-minute quadrangle, Trinity County, California: San Jose State University, M.S. thesis, l0l p.

Lindsley-Griffin, Nancy, 1977, Paleogeographic implications of ophiolites—The Ordovician Trinity complex, Klamath Mountains, California, *in* Stewart, J.H., Stevens, C.H., and Fritsche, eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologist and Mineralogist, Pacific Coast Paleogeography Symposium 1, p. 409-420.

Lipman, P.W., 1962, Geology of the southeastern Trinity Alps, northern California: Stanford, California, Stanford University, Ph.D. dissertation, 101 p.

Lydon, P.A., and Klein, I.E., 1969, Geology of the southeast quarter of Trinity Lake quadrangle, Trinity County, California: California Division of Mines and Geology Map Sheet 12.

MacGinitie, H.D., 1937, The flora of the Weaverville beds of Trinity County, California: *in* Eocene flora of western America: Contributions to Paleontology, Publication 465, p. 83-15l.

Maytum, J.R., 1967, Areal geology of southeast portion Chanchelulla Peak quadrangle, California: San Diego, California State University, M.S. thesis, 1l3 p.

McLaughlin, R.J., Ellen, S.D., Blake, M.C. Jr., Jayko, A.S., Irwin, W.P., Aalto, K.R., Carver, G.A., and Clarke, S.H., Jr., 2000, Geology of the Cape Mendocino, Eureka, Garberville, and southwestern part of the Hayfork 30- x 60-minute quadrangles and adjacent offshore area, northern California: U.S. Geological Survey Miscellaneous Field Studies Map MF–2336, scale 1:100,000.

McLaughlin, R.I., Kling, S.A., Poore, R.Z., McDougall, Kristin, and Beutner, E.C., 1982, Post-middle Miocene accretion of Franciscan rocks, northwestern California: Geological Society of America Bulletin, v. 93, p. 595-605.

Murphy, M.A., Redda, P.U., and Morton, D.M., 1969, Geology of the Ono quadrangle, Shasta and Tehama Counties, California: California Division of Mines and Geology Bulletin 192, 28 p.

Quick, J.E., 1981, Petrology and petrogenesis of the Trinity peridotite, an upper mantle diapir in the eastern Klamath Mountains, northern California: Journal of Geophysical Research, v. 86, p. 11,837-11,863.

Peterson, G.L., 1969, Chanchelulla Peak quadrangle, *in* Murphy, M.A., Redda, P.U., and Morton, D.M., Geology of the Ono quadrangle, Shasta and Tehama Counties, California: California Division of Mines and Geology Bulletin 192, 28 p.

Rowland, R.E., 1966, Geology of the Grouse Creek area, South Fork Mountains, California: Los Angeles, University of California, M.A. thesis, 106 p.

Sanborn, A.F., 1960, Geology and paleontology of the southwest quarter of the Big Bend quadrangle, Shasta County, California: California Division of Mines Special Report 63, 26 p.

Sarna-Wojcicki, A.M., Meyer, C.E., Bowman, H.R., Hall, N.T., Russell, P.C., Woodward, M.J., and Slate, J.L., 1985, Correlation of the Rockland ash bed, a 400,000-year-old stratigraphic marker in northern California and western Nevada, and implications for middle Pleistocene paleogeography of central California: Quaternary Research, v. 23, p. 236-257.

Silberling, N.I., and Jones, D.L., 1982, Tectonic significance of Permian-Triassic strata in northwest Nevada and northern California: Geological Society of America Abstracts with Programs, v. 4, p. 234.

Skinner, Law, and Wilde, G.L., 1965, Permian biostratigraphy and fusulinid faunas of the Lake Shasta area, northern California: University of Kansas Paleontological Contribution, Protozoa article 6, v. 39, 98 p.

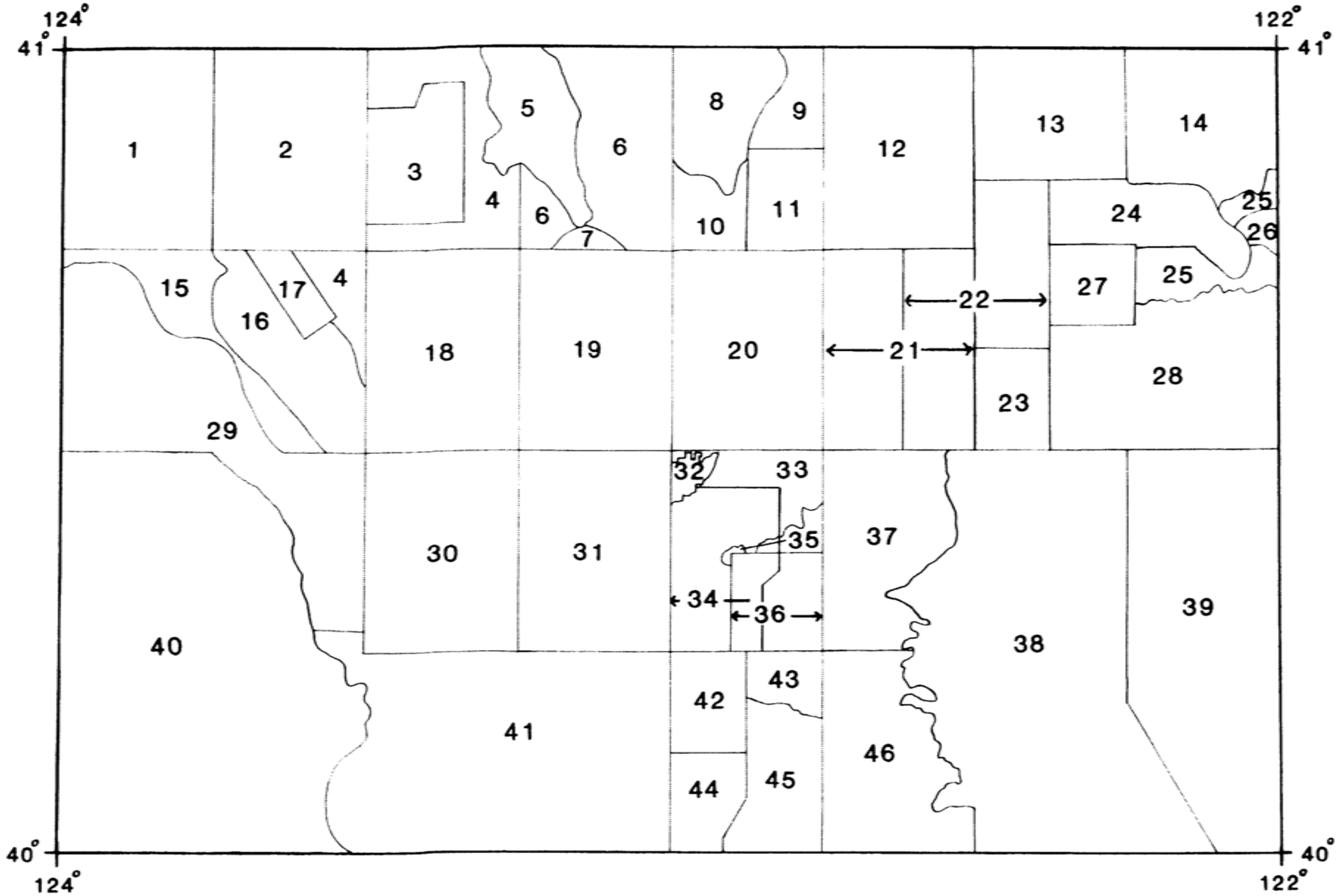
Wentworth, C.M., and Fitzgibbon, T.T., 1991, ALACARTE user manual (version 1.0): U.S. Geological Survey Open-File Report 91-587B.

Worrall, D.M., 1981, Imbricate low-angle faulting in uppermost Franciscan rocks, south Yolla Bolly area, northern California: Geological Society of America Bulletin, v. 92, p. 703-729.

Wright, J.E., 1981, Geology and U-Pb geochronology of the western Paleozoic and Triassic Subprovince, Klamath Mountains, northern California: Santa Barbara, University of California, Ph.D. dissertation, 300 p.

Wright, J.E., 1982, Permo-Triassic accretionary subduction complex, southwestern Klamath Mountains, northern California: Journal of Geophysical Research, v. 87, p. 3805-3818.

Young, J.C., 1978, Geology of the Willow Creek quadrangle, Humboldt and Trinity County, California: California Division of Mines and Geology map sheet 31, scale 1:62,500, 16 p.



INDEX TO GEOLOGIC MAPPING

1. Carver, G.A., Cashman, S.M., Kelsey, H.M., and Stephens, T.A., 1985, Geologic map of the Blue Lake 15-minute quadrangle, California (unpublished)
2 Young (1978)
3. Charlton (1979)
4. Irwin, W.P., and Court, B.L., 1985, Reconnaissance map of portions of the Ironside Mountain 15-minute quadrangle (unpublished)
5. Hotz and others (1974)
6. Cox (1967)
7. Fahan (1982)
8. Lipman (1962)
9. Lawson (1986)
10. Fraticelli, L.A., 1985, Reconnaissance map of portions of the Rush Creeks 7.5-minute quadrangle, Trinity County, California (unpublished)
11. Lydon and Klein (1969)
12. Sorensen, M.L., 1985, Reconnaissance map of the Schell Mountain quadrangle, Trinity and Shasta County, California (unpublished)
13. Kingston (1985)
14. Renne, P.R., 1985, Reconnaissance map of the northern Bollibokka Mountain, Shasta County, California, scale 1:62,500 (unpublished)
15. unmapped area
16. Aalto, K.R., 1984, Reconnaissance geologic map of portions of the Pilot Creek quadrangle, Humboldt County, California (unpublished)
17. Rowland (1966)
18. Irwin (1985)
19. Irwin (1974)
20. Irwin (1963)
21. Albers and others (1964)
22. Kinkel and others (1956)
23. Hollister and Evans (1965)
24. Albers and Robertson (1961)
25. Fraticelli, L.A., 1985, Reconnaissance mapping in parts of the Millville 15-minute quadrangle, Shasta County, California (unpublished)
26. Hilton (1975)
27. Fraticelli (1984)
28. Helley and Harwood (1985)
29. Kelsey and Allwardt (1974)
30. Irwin and others (1974)
31. Irwin and others (1985)
32. Huber and others (1983)
33. Irwin, W.P., Unpublished reconnaissance mapping, *in* Blake and others (1984)
34. Wright (1981)
35. Peterson (1969)
36. Maytum (1967)
37. Murphy and others (1969)
38. Helley and others (1981)
39. Harwood and others (1980)
40. McLaughlin, R.J., 1986, Reconnaissance geologic mapping in the western half of the Garberville 1:100,000 quadrangle (unpublished)
41. Blake, M.C., Jr., 1986, Reconnaissance geologic mapping in the eastern half of the Garberville 30- x 60-minute quadrangle, scale 1:100,000 (unpublished)
42. Blake (1965)
43. Worrall (1981)
44. Blake, M.C., Jr., and Jayko, A.S., 1984, Reconnaissance geologic map, southern half of Yolla Bolly 15-minute quadrangle (unpublished)
45. Worrall, D.M. (#44), and Blake, M.C., Jr., and Jayko, A.S. (#45)
46. Bailey and Jones (1973)