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PRELIMINARY GEOLOGIC MAP OF THE BURBECK 7.5′ QUADRANGLE MENDOCINO COUNTY, CALIFORNIA

VERSION 1.0

By
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2026

California Department of Conservation
California Geological Survey



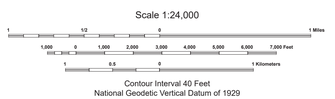
Coordinate System:
Universal Transverse Mercator, Zone 10N
North American Datum 1927

Topographic base from U.S. Geological Survey
Burbeck 7.5′ Quadrangle, 1991
Shaded relief image derived from USGS lidar DEM, 2019

Scale 1:24,000

1 0 1 Miles
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet
1 0.5 0 1 Kilometers

Contour Interval 40 Feet
National Geodetic Vertical Datum of 1929



Approximate Mean Declination, 2026

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program, STATEMAP Award no. G24AC00329

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DESCRIPTION OF MAP UNITS

QUATERNARY SURFICIAL DEPOSITS

af

Artificial fill (historical)—Consists of engineered and/or non-engineered soil materials; includes larger roadway embankments, earthen dams, levees, and other graded areas.

Qsc

Stream channel deposits (modern to latest Holocene)—Fluvial deposits within active, natural, and constructed stream channels. Composed of loose sand, gravel, and silt. Episodes of bank-full stream flow are frequent enough to inhibit growth of vegetation.

Qhay

Stream terrace deposits (late Holocene)—Unconsolidated sand, gravel, silt, and minor clay deposited in active stream settings; typically 3 m or less above the active channel. Commonly inset into adjacent, higher-level deposits of Holocene age.

Qha

Alluvial deposits (Holocene)—Unconsolidated sand, gravel, silt, and minor clay deposited in active or recently active valley fill, inter-fan areas, point bar, and stream settings. Surfaces are relatively flat or gently sloping, minimally dissected except at stream-facing margins, and widely disturbed by agricultural or other human activities. Generally less than 8 m above the active channel.

Qhf

Alluvial fan deposits (Holocene)—Unconsolidated, poorly sorted gravel, sand, and silt; deposited chiefly from distributary streamflow and debris flows forming deposits with characteristic fan-shaped morphology that emanate from mountain front drainages and from channels incised through older materials. Fan surfaces show little dissection or soil profile development.

Qdf

Debris fan deposits (Holocene)—Unconsolidated, poorly sorted gravel, sand, and silt forming relatively steep, fan-shaped deposits at the mouth of small drainages and along steep hillsides where they include undifferentiated colluvium. Sediment is derived mainly from debris slides and debris flow events rather than fluvial processes. Limited dissection, poor soil development, and/or absence of mature vegetation indicate relatively recent or ongoing depositional processes.

Qa

Alluvial deposits, undivided (Holocene to latest Pleistocene)—Unconsolidated to weakly cemented sand, gravel, silt, and minor clay, mapped in smaller valleys and where variations in age and/or depositional settings such as fans, debris fans, stream terraces, ponded alluvium, and active channels are not distinguishable or not delineated at the scale of mapping.

Qf

Alluvial fan deposits, undivided (Holocene to latest Pleistocene)—Unconsolidated to weakly cemented, poorly sorted gravel, sand, and silt; mapped where morphologic indicators such as incision and soil development suggest the fan surface appears dormant, or the fan age is not distinguishable at map scale.

Qls

Landslide deposits, undivided (Holocene)—Unconsolidated surficial failures commonly composed of a mix of soil, colluvium, and weathered bedrock; also includes moderately well-consolidated jumbled rock debris resulting from rock creep and large-scale rotational rockslides. Recognizable by topographic expression or chaotic internal structure. Only larger landslides discernable at the map scale are included. Includes deposits with ages ranging from historically active to dormant. Age not well defined; estimated based on geomorphic expression so boundary with Qols may overlap. Queried where landslide existence is questionable.

Qols

Old landslide deposits, undivided (early Holocene to late Pleistocene)—Weakly consolidated to well-consolidated jumbled sediment or rock debris consisting of ancient rock avalanches and large-scale rockslides. Distinctive geomorphic expression subdued due to post-failure erosion, but recognizable based on altered topographic expression, chaotic internal structure, pervasive fracturing, and/or out-of-sequence rock packages. Age not well defined; estimated based on geomorphic expression so boundary with Qls may overlap. Queried where landslide existence is questionable.

EARLY QUATERNARY TO LATE TERTIARY CONTINENTAL BASIN DEPOSITS

QTag

Airport gravels of Woolace (2005) (Pleistocene to Pliocene (?))—Pebble- to cobble-conglomerate with interbedded laminated siltstone and/or mudstone; well consolidated. The conglomerate typically appears matrix supported and massive or crudely stratified. Clasts are generally subrounded to well rounded, and range in size up to 25 cm. Material appears derived from the Franciscan Complex; dominated by sandstone, with lesser metamorphic rock and chert, and includes distinctive white meta-quartzite(?) of uncertain origin. The unit is generally deeply weathered with yellow to brownish-yellow colors; sandstone clasts and other fine-grained clasts are reduced to a friable condition. Bedding is gently dipping. Unit defined by Woolace (2005) for deposits exposed near Willits Municipal Airport. May be overlain locally by a very old terrace gravel weathered to yellowish-red and red colors, not differentiated on map. Age is inferred to be equivalent to the Ukiah Formation (e.g., Rubin, 2024) based on some common characteristics, including the following: similar conglomerate properties; interbedded fine-grained facies; and possible overlying very old terrace deposits. Based on stratigraphic data and tephrochronology from the Ukiah Formation near Willits, Woolace (2005) estimates the maximum age of that section is approximately 1.2 Ma. However, the extensive weathering of the Airport gravels and the occurrence at higher elevation may distinguish it from the Ukiah Formation. Woolace (2005) suggests the Airport gravels may be older than Pleistocene; however, the age of the lower boundary of the Pleistocene has since been redefined (Gibbard and others, 2010) and increased approximately one million years; therefore, the basal age of the Airport gravels could be older than the Ukiah Formation without extending beyond the Pleistocene.

FRANCISCAN COMPLEX

Tfco

Coastal Belt, undivided (Oligocene to Eocene)—Poorly to moderately sorted, fine- to medium-grained, arkosic sandstone; locally includes shale, mudstone, and pebble-rich beds. The unit is minimally overprinted by zeolite facies metamorphism (e.g., Ernst and McLaughlin, 2012); noted by the presence of laumontite in replacement of detrital plagioclase and in vein mineralization. Sandstone is commonly grayish orange in color; ranges from very pale orange to dark yellowish orange, yellowish gray and light olive gray to light olive brown; pale yellowish brown, to medium light gray where minimally weathered; shale locally has distinctive very pale-orange to yellowish-gray color. Grayish-orange and related oxidized colors can aid distinction of TFco from fcm, which is commonly light olive gray. Metamorphic laumontite grains commonly give TFco sandstones a white speckled appearance, which is also distinctive from fcm sandstones. Lithic component varies in abundance; detrital potassium feldspar, muscovite, biotite, and coarse shale chips are common. Bedding varies from massive or indistinct, to thinly interbedded sandstone and shale; where bedded, sandstone is commonly less than 30 cm thick; laminations are locally present in the sandstone units. Bedding can be deformed or discontinuous over short distances due to shearing or likely soft-sediment deformation (Kramer, 1976). Rock is commonly deeply weathered with yellowish-brown oxide stains; reduced to a friable or weak highly oxidized condition, although locally can be moderately strong where less weathered and cementation is intact. Bailey and others (1964) document widespread presence of distinctive detrital potassium feldspar in Coastal Belt sandstones, in contrast to the Central Belt, which has none, and therefore can be a factor in distinguishing the two units. Bailey and others (1964) also note that Coastal Belt sandstones have a relatively lower specific gravity than the rest of the Franciscan Complex. Coastal Belt units generally associated with relatively dense redwood and other evergreen forests (e.g., LandFire, 2022), which can aid in distinguishing it from Central Belt units (e.g., Hahm and others, 2019). Landslides are common, but generally more discrete relative to landslides in fcm bedrock. Large landslides appear concentrated near the faulted contact with the Central Belt. The degree of internal deformation varies from relatively coherent with localized zones of shearing or other deformation, to more pervasive deformation consistent with "broken formation" (e.g., Raymond, 1984). Kramer (1976) describes evidence for submarine landsliding and soft sediment deformation that likely accounts for some of the observed irregularity in bedding orientations. Detrital zircons from sandstones within the Coastal Belt near the study area suggest maximum depositional ages that range from early Oligocene to Eocene (Dumitru and others, 2015).

The nature of the contact with the Central Belt varies among previous geologic maps of the area. Regionally, the Coastal Belt is understood to have been thrust under the older Central Belt during east-directed subduction (e.g., Kramer, 1976; Langenheim and others, 2013) to depths of 5-8 km or less, resulting in extensive deformation and zeolite facies metamorphism (e.g., Ernst and McLaughlin, 2012). However, on some maps it is shown as depositionally overlying the Central Belt locally (e.g., Jennings and Strand, 1960; Irwin, 1960; Kilbourne, 1984). Kramer (1976) describes localized depositional relationships but does not depict locations on his map. In contrast again, Kilbourne (1984) primarily depicts the Coastal Belt as thrust over the older Central Belt in the Burbeck Quadrangle, whereas Kramer (1976) shows the opposite relationship in cross-section. In the current study, the Coastal Belt is considered to be structurally lower than the Central Belt.

fcm

Central Belt mélange, undivided (Tertiary (?), Cretaceous, and Jurassic (?))—Pervasively sheared, dark-gray to black, scaly argillite and sandstone (informally referred to as graywacke), which form a matrix enclosing small pods, blocks, and large slabs of more intact, structurally coherent rock of various lithologies; overprinted by low-grade (i.e., prehnite-pumpellyite facies) metamorphism associated with subduction to depths in the range of 15-18 km (e.g., Ernst and McLaughlin, 2012). The degree of recrystallization is commonly not apparent in hand sample. Blocks with higher grades of metamorphism than the surrounding matrix are widespread. The Central Belt matrix sandstone is gray to olive gray, yellowish brown where oxidized, well indurated, poorly sorted, and arkosic; commonly consisting of approximately equal proportions of quartz, plagioclase feldspar, and lithic fragments, with 5 to 20 percent of the rock being matrix (Hecht, 1970; Stanford, 1991). Coarse shale chips and detrital biotite are common lithic components visible in hand sample. The olive-gray color can be a representative characteristic to distinguish fcm from TFco. The sandstone lacks potassium feldspar grains and displays textures and metamorphic mineral assemblages consistent with Central Belt units elsewhere (Jayko and others, 1989; Stanford, 1991). Sandstone appears weakly recrystallized due to metamorphism and is commonly cut by veins. Interbedded sandstone and shale resembling turbidites are exposed locally. Due to pervasive deformation and limited exposure, bedding is variable over short distances and is not traceable across a mappable area. In the northern portion of the map, a couple of occurrences resembling volcanic stratification were observed; these may be isolated blocks, but their possible limits weren't accessible. The mélange underlies rolling, characteristically hummocky topography, particularly where isolated blocks within shale matrix are the dominant structure. Hummocky topography is also commonly associated with overprinting of the structure by extensive Quaternary landslide movement. The unit also includes large areas with landslide-like features not distinguishable as individual landslides. Vegetation associated with fcm is commonly grassland and sparse oaks (e.g., LandFire, 2022), which distinguishes it from areas underlain by Tfco (e.g., Hahm and others, 2019). Mélanges are interpreted as originating from tectonic and/or depositional mixing processes (e.g., Wakabayashi, 2015), which likely also included coeval submarine landslide/large-scale gravitational movement. Contacts are generally interpreted as faulted, but their nature is commonly unconfirmed based on the limited exposures available.

In the Redwood Valley Quadrangle (Rubin, 2021), chert blocks within the mélange range from Jurassic through Cretaceous in age (Stanford, 1991); however, dates from mélange matrix collected elsewhere in the region suggest tectonic and/or depositional assemblage of the mélange may have extended into the early Tertiary (McLaughlin and others, 2018). Detrital zircons from Central Belt sandstones in the map region indicate an approximate mid-Cretaceous maximum depositional age, with ages ranging from 107 to 85 Ma (Dumitru and others, 2015). Other units and blocks within the undifferentiated mélange may have ages extending into the Jurassic. Portions of undifferentiated mélange in this study may include additional distinctive mappable blocks and coherent slabs of lithologies described below, but large areas were largely inaccessible in the field so they couldn't be delineated on the map. Mappable units within the mélange include:

ss

Sandstone—Map unit combines isolated blocks and areally extensive occurrences of poorly to moderately sorted, fine- to medium-grained, low-grade metamorphic arkosic sandstone and rare conglomerate and breccia. Commonly light olive-gray to olive-gray in color; ranges from dusky yellow, to grayish olive, to greenish gray and medium gray where minimally weathered. Lithic component varies in abundance; detrital biotite and coarse shale chips are common. Bedding varies from massive to interbedded sandstone and shale. Rock varies widely from strong and cemented, with little oxide staining, to intensely weathered and friable with highly oxidized grayish-orange and reddish-yellow colors. Degree of internal deformation varies from relatively coherent with localized zones of shearing or other deformation, to broken formation or localized block in matrix structure. May locally include blocks of other subunits. Generally weakly recrystallized, consistent with metamorphic Textural Zone 1 of Blake and others (1967); higher grade, foliated metamorphic units found locally. Mapped where unit is large enough to meet minimum map unit size and where assignment to another map unit is uncertain. Relative to Central Belt mélange (fcm) matrix, larger mapped occurrences of this unit are generally more structurally coherent, contain fewer exotic lithologies, are less prone to large landslides, and are more resistant slopes, as expressed in the northeast corner of the quadrangle. Generally associated with denser forest vegetation relative to undifferentiated fcm.

ch

Chert—Red, green, and white chert; variably metamorphosed. Occurs mostly in rhythmically bedded packets with dark-gray shale partings and locally contorted bedding. Unit commonly includes, or is locally associated with, metavolcanics and sandstone. Locally massive or as brecciated fragments; also present as isolated mélange blocks too small to distinguish at map scale. Chert samples from various units in the Redwood Valley Quadrangle (Rubin, 2021) yielded radiolarians ranging from Tourcian (late Early Jurassic) to Albian (late Early Cretaceous) in age (Stanford, 1991).

mv

Metavolcanic rock (greenstone)—Olive-gray to greenish-black, strong-brown and yellowish-red weathering, aphanitic, variably weathered and altered, mafic volcanic rock; predominately massive and broken; variably sheared; locally stained black. Unit locally includes sandstone and other lithologies. Also present as isolated mélange blocks too small to distinguish at map scale. Weathers to a soil with distinctive red and brown colors.

High-grade metamorphic rock—Metamorphic rock with phyllitic to gneissose texture; largely blueschist but can include other highly metamorphosed Franciscan rock types such as amphibolite and eclogite. Occurs as mélange blocks. Burial depths of up to 40 km are indicated in occurrences of the highest-grade mineral assemblages; retrograde metamorphism also recorded in some cases. Protoliths include igneous and likely sedimentary rock. Unit includes occurrences compiled from Kramer (1976), which groups blocks of blueschist and greenschist.

sp

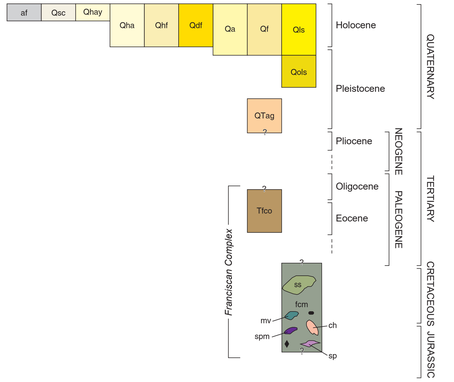
Conglomerate—Identified in two locations. Outcrop patterns suggest they are mélange blocks. The largest occurrence, on Sherwood Road near the north end of the quad, is clast-supported chiefly consisting of subangular, chert, meta-volcanics, sandstone, with lesser amounts of serpentinite. Clast size is commonly approximately 3 to 10 cm, ranging up to 30 cm. Internal deformation is not apparent. Deeply weathered to dusky brown color. The second location is a much smaller exposure near the northeast corner of the quad, where the clasts are rounded with more varied lithologies; matrix is dark greenish gray.

spm

Serpentinite—Commonly pale-green, serpentinized ultramafic rock. Commonly pervasively sheared and foliated; ultramafic protolith texture is preserved locally. Occurs as mappable units and isolated blocks within the fcm and also along some shear zones. Weathers to regolith and thin soil with distinctive blue-green or reddish colors; sometimes distinctive in color imagery. Vegetation on serpentinite is chiefly sparse shrubs.

Serpentinite matrix mélange—Pale-green to grayish-olive-green and greenish-black, serpentinized ultramafic rock. Brecciated or possibly detrital granular textures are exposed locally, and the unit appears to enclose blocks of other fcm lithologies locally, including metavolcanic, chert, sandstone, and blueschist.

CORRELATION OF MAP UNITS



MAP SYMBOLS

Contact between map units—Solid where accurately located; long dash were approximately located; short dash where inferred; dotted where concealed; queried where identity or existence is uncertain.

Fault—Solid where accurately located; long dash were approximately located; short dash where inferred; dotted where concealed; queried where identity or existence is uncertain. Arrow and number indicate direction and angle of dip of fault plane. Relative horizontal movement shown by arrows parallel to fault.

Minor fault

Landslide—Arrows indicate principal direction of movement. Where mapped as a landslide complex, adjacent defined slides have different relative ages and/or failure types.

Fossil point

Strike and dip of geologic structure; number indicates dip angle in degrees; bedding symbols that appear within Quaternary map units represent bedrock exposures too small to map.

- Inclined bedding
- Vertical bedding
- Horizontal bedding
- Contorted bedding
- Volcanic flow banding
- Vertical tectonic foliation

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Burbeck 7.5′ Quadrangle



SOURCES OF MAP DATA

1. Kramer, 1976
2. Smith, 1981
3. Woolace, 2005

Sources covering entire quadrangle
Rubin and Altringer, 2026
Bachman, 1979
Durham, 1979
Kilbourne, 1984

Acknowledgements:
CGS geologists Kevin Doherty and Patrick Brand contributed time and valuable geologic insights in the field.

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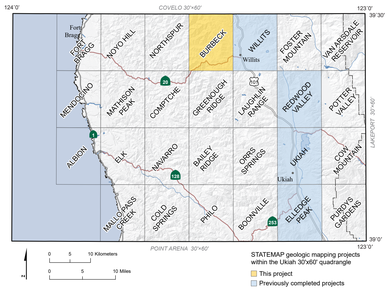

Suggested citation:
Rubin, R.S., and Altringer, J.L., 2026, Preliminary geologic map of the Burbeck 7.5′ Quadrangle, Mendocino County, California: California Geological Survey Preliminary Geologic Map 26-01, scale 1:24,000.

AUTHORSHIP DOCUMENTATION AND PRODUCT LIMITATIONS

PUBLICATION TITLE: Preliminary Geologic Map of the Burbeck 7.5’ Quadrangle, Mendocino County, California
Preliminary Geologic Map 26-01

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Date: June 30th, 2026



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This authorship document accompanies the geologic map with the following citation:

Rubin, R.S., and Altringer, J.L., 2026, Preliminary geologic map of the Burbeck 7.5’ Quadrangle, Mendocino County, California: California Geological Survey Preliminary Geologic Map 26-01, scale 1:24,000.