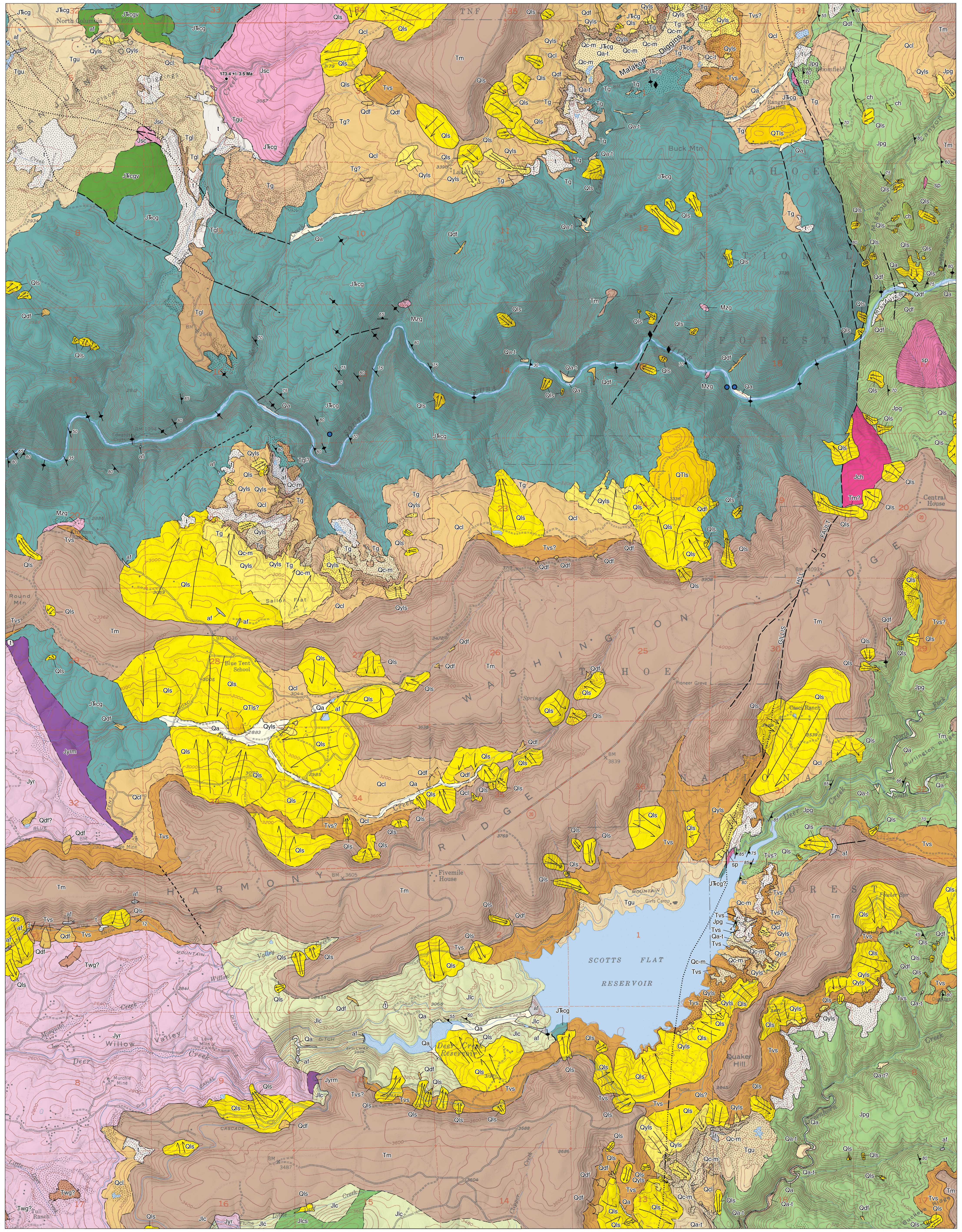

Coordinate System:
Universal Transverse Mercator, Zone 10N
North American Datum 1927

Topographic base from U.S. Geological Survey
North Bloomfield 7.5-minute Quadrangle, 1949, photo revised 1979.
Shaded relief image derived from 1 m Digital Elevation Models (DEMs) (USGS, 2019).

Scale 1:24,000

Contour Interval 40 Feet
National Geodetic Vertical Datum of 1929

Approximate Mean Declination, 2024

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Professional License and Certification:
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PRELIMINARY GEOLOGIC MAP OF THE NORTH BLOOMFIELD 7.5' QUADRANGLE, NEVADA COUNTY, CALIFORNIA

VERSION 1.0

By

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2024

Preliminary Geologic Maps available from:
https://www.conservation.ca.gov/cgs/rgm/preliminary

California Department of Conservation
California Geological Survey

DESCRIPTION OF MAP UNITS

SURFICIAL UNITS

af — **Artificial fill (historic)—**Anthropogenic deposits of earth materials that may be engineered or non-engineered.

t — **Tailings (historic)—** Primarily rounded, quartz-rich gravels and cobbles that are a byproduct of the hydraulic mining process. Tailings mapped adjacent to underground mine adits are usually spoils piles derived from both bedrock and Tertiary gravels.

Qc-m — **Modern colluvium (historic)—**Unconsolidated deposits of clay, silt, sand, gravel, cobbles and boulders that have been deposited at the base of cliffs created by historic hydraulic mining activities.

Qa — **Alluvial deposits (historic to late Holocene)—**Unconsolidated and poorly sorted silt, sand, gravel, and cobble deposits adjacent to rivers and streams. Variable in color but often pale yellow to light reddish brown.

Qa-t — **Modern alluvium with hydraulic mining debris (historic)—**Hydraulic mining debris deposited by alluvial processes within modern drainages. Composed dominantly of siliceous sand, gravel, and cobbles; gravel and cobbles are well rounded and derived from Tertiary gravels and Valley Springs Formation. Occurs often as terraces above modern stream elevations marking peak aggradation of hydraulic tailings before subsequent erosion. Where mapped within Malakoff Diggins, the alluvium was deposited during historic time and can be over 30 m thick (Peterson, 1980).

Qyls — **Young landslide deposits (late Holocene)—**Unconsolidated and jumbled deposits of clay, silt, sand, gravel, cobbles, and boulders that are undissected; commonly adjacent to, and sliding towards, hydraulic mining pits during historic time; variable in color but often reddish brown to reddish yellow and distinct from other landslide deposits by their youthful geomorphic features. Head scarps and internal hummocky or bench and swale topography are apparent. Landslide toe deposits are commonly absent because the debris has fallen into the hydraulic mine pits.

Qcl — **Colluvium and landslide deposits (Holocene to Pleistocene)—**Unconsolidated cobbles and gravel in a reddish-brown clay matrix that commonly form aprons flanking the margins of Mehrten Formation outcrops; cobble and gravel content is variable and sometimes lacking; clasts derived primarily from the Mehrten Formation. Recognized by geomorphic expression of generally uniform, gentle slope gradients, and a lack of outcrops and distinct landslide geomorphology and boundaries. Includes a combination of thick colluvial deposits, surficial failures, or thin, older landslide deposits that are either too small to map individually or are questionable.

Qls — **Landslide deposits (Holocene to Pleistocene)—**Mostly unconsolidated, jumbled, and chaotic fragments of bedrock material sourced from varying geologic units and forming deposits of varying thickness; commonly reddish brown to yellow brown. The largest landslides are usually derived from the Mehrten Formation and contain abundant andesite debris. Recognized by geomorphic expression and jumbled appearance of debris. Queried where existence is questionable.

Qdf — **Debris fan deposits (Holocene to Pleistocene)—**Unconsolidated and poorly sorted clay, silt, sand, gravel, and boulders forming relatively steep, fan-shaped deposits at the mouths of small drainages and along steep hillsides where deposits include undifferentiated colluvium. Deposits are primarily derived from small, recurring debris slide and debris flow events rather than from fluvial processes.

QTls — **Very old landslide deposits (Pleistocene to Pliocene)—**Unconsolidated and poorly sorted clay, silt, sand, gravel, and boulders that occur on isolated hills spatially separated from the source area. Most material is composed of debris derived from the Mehrten Formation but deposits occur at lower elevations than intact Mehrten Formation suggesting down-slope displacement.

TERTIARY UNITS

Tm — **Mehrten Formation (early Pliocene to Miocene)—**Volcanic debris flow (lahar) deposits interbedded with sandstone and conglomerate; debris flow deposits consist primarily of matrix-supported breccia. Weathered surfaces are reddish brown with fresh surfaces light gray to dark gray. Sandstone and conglomerate facies are moderately to well sorted and breccia facies are poorly sorted. Compositionally distinct and dominated by intermediate volcanic rock types, especially andesite. Andesite clasts are often angular to subrounded and can be up to 5 meters in diameter, as noted on top of Quaker Hill. The volcanic material is sourced from the ancestral Cascade Arc located to the east (e.g., Cousens and others, 2008). Within the arc, possible source rocks range from ~16 to ~3 Ma, but within the map area, the age of individual Mehrten strata is very poorly constrained within this range. Within the North Bloomfield Quadrangle, the thickness of the Mehrten Formation is variable but reaches a maximum thickness of approximately 160 meters.

Tvs — **Valley Springs Formation (early Miocene to Oligocene)—**Tuffaceous sandstone, siltstone, conglomerate, and interbedded rhyolitic tuff; often flat laying or very gently dipping; light bluish gray to light greenish gray in color. The tuffs were erupted from calderas to the east in central Nevada. Within the Truckee 30' x 60' Quadrangle $^{40}Ar/^{39}Ar$ ages of interbedded tuffs within the Valley Springs Formation range from 24.9 to 31.7 Ma (Chris Henry, oral commun.). The Valley Springs Formation is distinguishable from other Cenozoic deposits based on the presence of rhyolitic ash and tuff clasts within the conglomerate facies. In places where the Valley Springs Formation overlies Tertiary gravels, the contact is not always clearly distinguishable as both units contain similar interbedded sandstone and conglomerate beds in terms of thickness, texture, induration, and color. During fieldwork we noted several occurrences of petrified wood and leaf fossils near Scotts Flat Reservoir.

Tg — **Tertiary gravels (early Oligocene to Eocene)—**Quartz-rich conglomerate ("gravels"), sandstone, and siltstone deposits that are generally flat lying to gently west dipping. Fluvial deposits that filled paleovalleys during Eocene and early Oligocene time when the drainages extended far to the east, well beyond the modern crest of the Sierra Nevada (Cassel and Graham, 2011). The gravels contain variable but often significant amounts of placer gold, which were heavily mined during the 19th and 20th centuries. The gravels are well exposed in the walls of former hydraulic mining pits. These deposits have been the focus of several previous studies (e.g., Lindgren, 1911; Yeend, 1974; Cassel and others, 2022). Lindgren (1911) popularized the term "Tertiary gravels," and divided the Tertiary gravels into two informal units, consisting of lower channel deposits (which he considered narrow Eocene paleovalleys) and upper gravel deposits (which filled in much broader and wider parts of the paleovalleys); this nomenclature has been adopted where the units are distinguishable. Pease (1992) mapped three separate units of the Tertiary gravels within the North Columbia area (lower, middle, upper); the middle gravel unit of Pease (1992) is relatively thin and represents the transition between the heterogeneous clast size and composition of the lower unit and the finer-grained, better sorted, overwhelmingly silicious clast composition of the upper unit. We grouped Pease's middle gravel into the upper gravel unit on this map. Where mapped in areas without surface mining, the Tertiary gravels may be thin and restricted to ferricrete and silcrete paleosols overlying bedrock. At Malakoff Diggins, Cassel and Graham (2011) report several sets of alternating fine-grained and coarse-grained units within the pit walls, with the sandstones being resistant cliff-forming units and the fine-grained intervals forming gentler slopes. Zones of hard, well-cemented conglomerate and sandstone occur as ferricrete and silcrete. These zones often occur near the basal contact with the underlying bedrock units but can also occur higher up in the section. We noted the occurrence of petrified wood in this unit throughout the quadrangle.

Tgu — **Upper unit (early Oligocene to late Eocene)—**Interbedded sandstone, siltstone, and conglomerate. The conglomerate is generally composed of fine- to coarse-grained, well-rounded siliceous clasts (e.g., vein quartz, quartzite). The fresh surfaces are generally light gray in color with some layers more reddish yellow or light brown.

Tgl — **Lower unit (Eocene?)—**Predominantly conglomerate with interbedded sandstone. Clasts are coarser than the upper unit, often boulder sized. Clast composition is predominantly siliceous, like the upper unit, but is noticeably more heterogeneous with additional metamorphic and plutonic clast types. The color is reddish yellow. This unit is most easily observed at the South Yuba River Campground (which Lindgren (1911) refers to as Grizzly Hill).

Twg — **Weathered granitic rocks (Oligocene to Eocene?)—**Distinct weathered zone developed on the Yuba Rivers Pluton (unit described below) at least 10 m thick but likely much thicker, which is well exposed just west of the quadrangle around the Nevada County Madelyn Helling Library. The granitic parent rock has been weathered almost entirely to a clayey sand consistency. The weathered color is a distinctive pale yellow-brown to pale yellow-red.

INTRUSIVE ROCK UNITS

Jyr — **Yuba Rivers Pluton (Jurassic)—**Coarse-grained granodiorite, tonalite, and quartz diorite that intrudes the Clipper Gap Formation and Lake Combie Complex. Day and Bickford (2004) provide a U-Pb age of 157 +/- 1 Ma. This unit is variably weathered in the quadrangle and can occur as hard, fresh corestones in a matrix of decomposed rock. In areas underlain by the Yuba Rivers pluton, the topography is gentle with rolling hills. Outcrops are often large and rounded. In the eastern margin of the pluton, Bobbitt (1982) mapped mafic intrusive rocks separately as pyroxenite-gabbro.

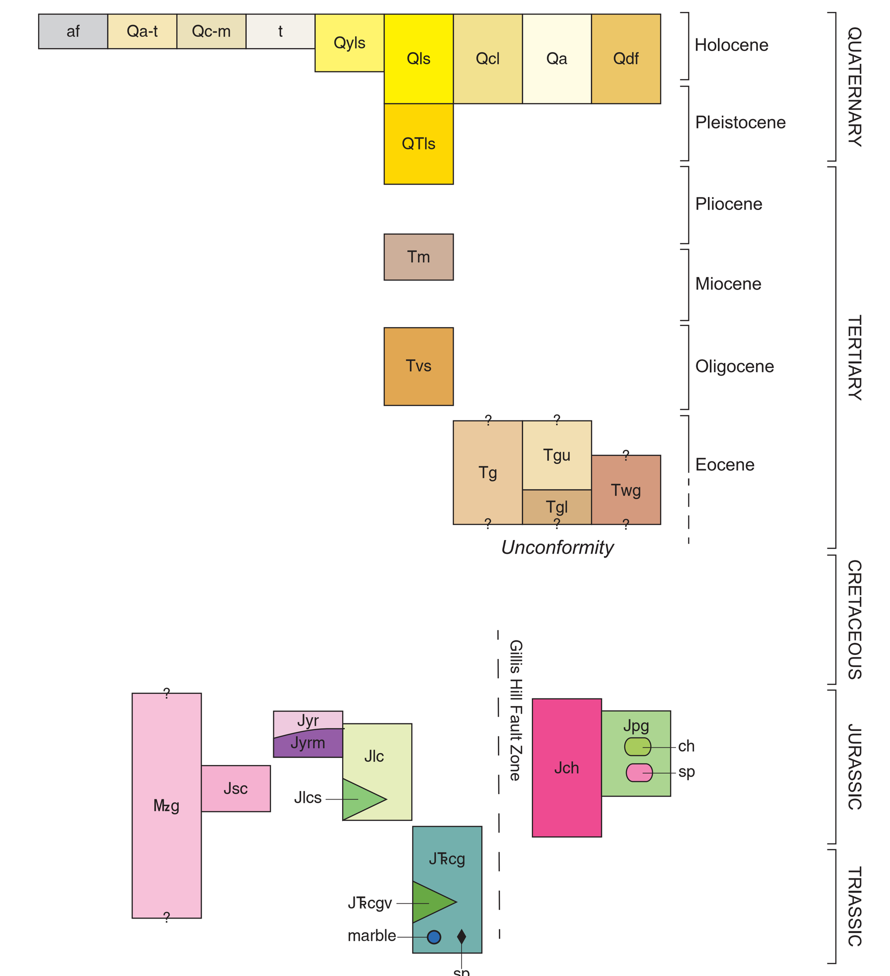
Jyrm — **Pyroxenite-gabbro (Jurassic)—**Mafic facies of the Yuba River Pluton that consists of hornblende-clinopyroxene tonalite, metatonalite, and clinopyroxene-hornblende gabbro/diorite, with xenoliths of quartz gabbro/diorite and rocks from the Clipper Gap Formation. Fine grained to very coarse grained and typically massive. Hacker (1984) reports some outcrops have centimeter- to millimeter-thick layers of mafic crystals, or a weak magmatic foliation defined by oriented plagioclase laths. Weathers to form reddish-brown soils. Considered slightly older than the main Yuba Rivers pluton unit as field relationships indicate the main pluton body intruded into this mafic border; however, there are no radiometric dates for this unit.

Jsc — **Spring Creek pluton (Jurassic)—**Biotite-hornblende quartz gabbro/diorite mapped in detail both on the surface and in the subsurface beneath the Tertiary gravels by Pease (1992). Informally named and described by Hacker (1984) as massive and medium grained. We submitted a sample for zircon U-Pb dating and received a preliminary age of 173.4 +/- 3.5 Ma (age +/- 2% total uncertainty); analysis conducted on zircons at UCSB Laser Ablation Laboratory (J. Schwartz, written commun., 2024). Pease (1992) maps the western contact of the pluton to be a fault within the Clipper Gap Formation.

Jch — **Central House pluton (Jurassic)—**Mapped and named by Hacker (1984) as the Central House tonalite. Orthopyroxene-clinopyroxene-hornblende tonalite with poor outcrops, often extensively altered to a green color (Hacker, 1984).

Mzg — **Undifferentiated granitic rocks (Mesozoic)—**Several small bodies of granitic rock previously reported by Hacker (1984) or observed during this mapping. Bodies occur in small areas where the contact relationship with the surrounding rocks is unclear and it is undetermined if these outcrops are small intrusive stocks or detrital megablocks within Clipper Gap Formation.

CORRELATION OF MAP UNITS



METAMORPHIC UNITS

Jlc — **Lake Combie Complex (Jurassic)—**Metavolcanic and metasedimentary rocks that were previously studied by Tuminas (1983) and Day and others (1985). The color is generally yellow-brown to red-brown when weathered and grayish green to light gray when fresh. Lindgren (1900) previously mapped this as part of the Calaveras Formation. Generally considered Jurassic in age but may in part be as old as Triassic (Rack and others, 2024) based on U-Pb dates south of the quadrangle. Near Dear Creek Reservoir and Banner Mountain, the rocks are siliceous and cherty with interbedded sandstone and mafic volcanic rocks. Lindgren (1896, 1900) mapped the siliceous rocks separately in the southern part of the quadrangle near Banner Mountain, which we map as an informal siliceous member:

Jlcs — **Siliceous member—**Siliceous, well-cemented, light blue-gray to yellow-brown sandstone and conglomerate. Thickly bedded with relict bedding apparent. Conglomerate clasts are subrounded to subangular and composed primarily of chert and other highly siliceous rock types typically smaller than 2-cm in diameter. Originally mapped by Lindgren (1896, 1900) as a cherty unit within the Calaveras Formation.

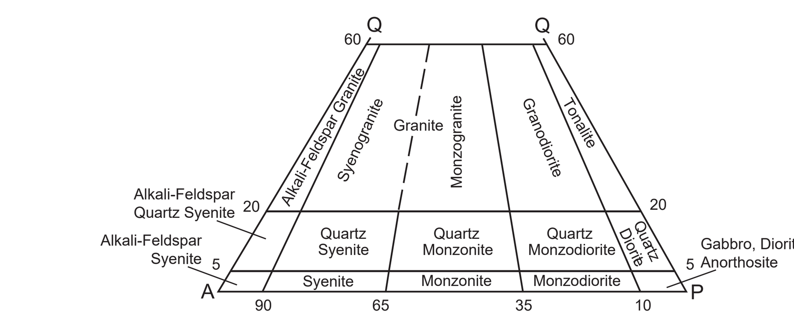
Jpg — **Phyllite-Greenschist Belt (Jurassic)—**Strongly deformed phyllitic metasedimentary and schistose metavolcanic rocks that occur east of the Gillis Hill fault. Mapped and described by Hacker (1984) within the North Bloomfield Quadrangle as part of the Cape Horn Formation and later termed the "High-Strain Phyllite-Greenschist Belt" by Schweickert (2015). These rocks often have well developed slaty cleavage that helps differentiate them from other Mesozoic units in the quadrangle. Schweickert (2015) interprets these rocks as Jurassic in age based on correlation to similar rocks to the south. Hacker (1984) and Peterson (1980) mapped several rock types within this unit, including serpentinite and chert.

sp — **Serpentinite—**Primarily blue-gray serpentinite with less altered ultramafic rocks. Often pervasively sheared and foliated. Weathers to a yellowish-brown color.

ch — **Chert—**Massive, yellowish- to bluish-gray chert that is generally hard and lacks bedding. Forms large, rounded outcrops.

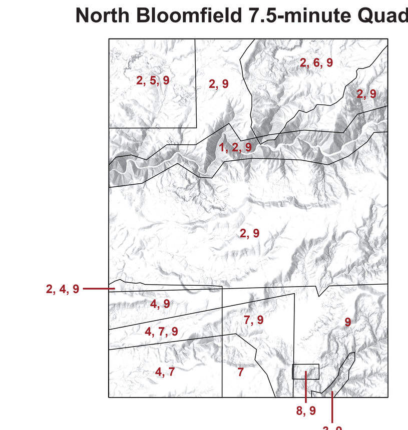
JTRcg — **Clipper Gap Formation (Jurassic to Triassic)—**Mélange unit incorporating multiple, mostly sedimentary, rock types occurring west of the Gillis Hill fault. Includes abundant chert and siliceous argillite that commonly exhibits a distinctive light-yellowish-gray color. Also contains sandstone, siltstone, conglomerate, pillow lava, and blocks of limestone, serpentinite, and granitic rocks. This unit has been referred to as the Oregon City formation (Hacker, 1984) and as part of the Fiddle Creek Complex (Edelman and others, 1989). Schweickert (2015) refers to this unit simply as "mélange." The rocks are moderately foliated and weakly metamorphosed; primary sedimentary features are often preserved. Clark and Huber report crinoid fossils in the area of Edwards Crossing. Hacker (1984,1993) reports that these rocks vary from being relatively undeformed, where bedding is preserved and lithologies are slightly intermixed, to strongly deformed where bedding is no longer discernible and exotic rock types are juxtaposed. The western mapped extent of this unit (within approximately 2 to 3 km of the Yuba Rivers pluton) exhibits contact metamorphism caused by intrusion of pluton; this western zone appears more recrystallized and indurated than the rest of the unit. Along the South Yuba River from Edwards Crossing to the west edge of the quadrangle, the unit is cut by many non-foliated granitic dikes. These dikes are oriented subparallel to the general foliation of the Clipper Gap Formation and are up to 3 m in diameter. The Clipper Gap Formation has been reported as Late Triassic to Early Jurassic in age based on radiolarian chert fossils and an $^{40}Ar/^{39}Ar$ hornblende date of 174.3 +/- 1.9 Ma from a volcanic clast in a lahar deposit (Hacker, 1993). Locations of marble (blue circles) and serpentinite (black diamonds) blocks within the mélange are mapped based on Hacker (1984), Clark and Huber (1975), and new field observations.

JTRcgv — **Metavolcanic unit (Jurassic to Triassic)—**Pease (1992) mapped a separate metavolcanic member of the Clipper Gap Formation in the northwest section of the quadrangle. Pease (1992) describes this unit as greenish- to bluish-gray, slightly metamorphosed andesite and basalt that generally have an aphanitic groundmass surrounding very fine-grained plagioclase phenocrysts. These rocks are massive, dense, hard, and weather into subangular blocks.



Classification of plutonic rock types (from Streckeisen, 1973; 1976).
A, alkali feldspar; P, plagioclase feldspar; Q, quartz.

North Bloomfield 7.5-minute Quadrangle



SOURCES OF MAP DATA
1. Clark and Huber, 1976
2. Hacker, 1984
3. James and others, 2007
4. Lindgren, 1896
5. Pease, 1992
6. Peterson, 1980
7. Tuminas, 1983
8. Vieira, 2019
9. Yeend, 1974

Data sources that cover entire quadrangle
Lindgren, 1900
Holland and others, 2024

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IMAGERY

Google Earth Pro, 2024, Color and black-and-white imagery dated between June 1993 to May 2023.

Lidar 1 meter DEM Mosaic: USGS LPC CA NoCAL Wildfires B1 lidar dataset, 2018. ftp://rockyftp.cr.usgs.gov/vdelivery/Datasets/Staged/Elevation/1m/Projects/CA_SoCal_Wildfires_B1_2018/ . Accessed 2020-09-01

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MAP SYMBOLS

Contact between map units—Solid where accurately located; long dash where approximately located; queried where uncertain.

Fault—Solid where accurately located; long dash where approximately located; short dash where inferred; dotted where concealed; queried where uncertain. Dip of fault plane unknown but sense of displacement known (D = downthrown, U = upthrown)

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

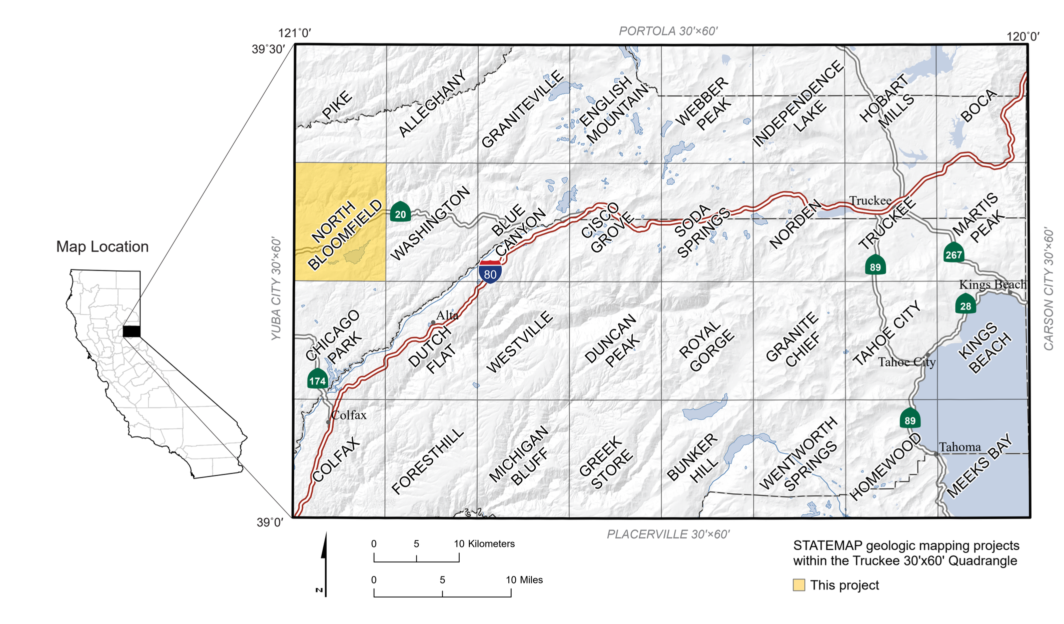
U-Pb Geochronology point (one sample)

Marble block

Sepentinite block—See description of map unit "sp" for details.

Area of mine-related ground disturbance primarily a result of previous hydraulic mining; ; locally overprinted by later landslide movement and colluvial deposition.

Strike and dip of geologic structure; number indicates dip angle in degrees.
- 25 Bedding
- 50 Metamorphic foliation
- Vertical metamorphic foliation



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Preliminary Geologic Map 24-02

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