U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Redwood National Park

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Redwood National Park

redw_geology.pdf

Version: 3/8/2022

Geologic Resources Inventory Map Document for Redwood National Park

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Geologic Resources Inventory Map Document

Redwood National Park, California

Document to Accompany Digital Geologic-GIS Data

redw_geology.pdf

Version: 3/8/2022

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Redwood National Park, California (REDW).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) **Map Unit List** – A listing of all geologic map units present on the digital geologic-GIS map, listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

5) **Ancillary Source Map Information** – Additional source map information presented by source map.

6) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you

need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Redwood National Park, California (REDW) are presented below.

Digital Geologic-GIS Map of Redwood National Park and Vicinity, California (*GRI MapCode REDW*)

The above GRI digital geologic-GIS map was produced from the following source map. The full extent of the source map was and all geologic features within this extent were captured.

> Delattre, Marc, and Rosinski, Anee, 2012, Preliminary Geologic Map of the Onshore Portions of the Crescent City and Orick 30' x 60' Quadrangles, California: California Geological Survey, Preliminary Geologic Map, scale 1:100,000 (Crescent City and Orick 30' x 60' Quadrangle (Portions of)). (*GRI Source Map ID 75672*).

Digital Geohazard-GIS Map of Redwood National Park and Vicinity, California (2002 Mapping) (*GRI MapCode REDW_geohazard*)

The above GRI digital geohazard-GIS map was produced from the following source map. Only a portion of the full extent of the source map was, however, all geologic features within this extent were captured.

> Dell'Osso, D.R., Falls, J.N., and McGuire, D.J., 2002, Maps, GIS Data and Geologic Report for the Watershed Mapping Series, Map Set 6, Redwood Creek Watershed, Humboldt County, California: California Geological Survey, CD 2002-10, scale 1:100,000 (Redwood Creek Watershed (Geology)). (*GRI Source Map ID 74843*).

In further defining how both source maps above were used the following explanations are provided.

Source data included geology and landslide data. Geomorphic and fluvial features were not captured from these sources.

Redwood Creek Watershed landslide potential data is included in the GRI digital geohazards-GIS data. Additional information is available in the Redwood Creek Watershed section of this document. Additional landslide information for geohazard features is also included in the Landslide Information (REDWLSI) table in the GRI digital geohazard-GIS data.

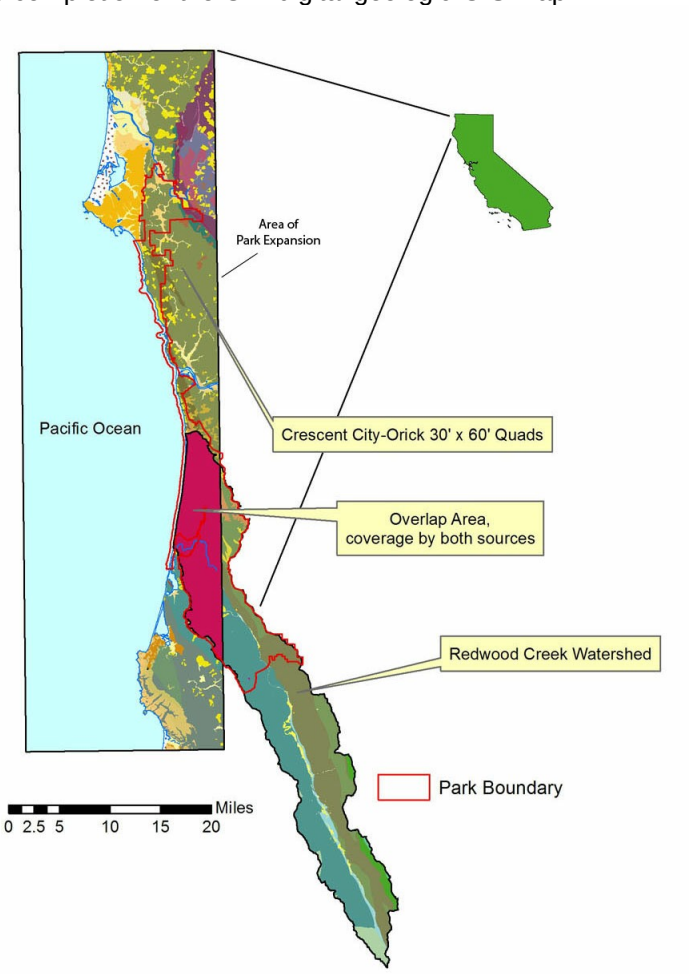
Features (from the Dell'Osso et al., 2002 source map) in the area of overlap with Crescent City-Orick quadrangles were not used (see the Source Index Map figure below). Landslide direction lines present on the Delattre and Rosinski, 2012 source map are presented in the GRI digital geologic-GIS map, and were not transferred to the GRI digital geohazards-GIS map as the map extents between the two source maps differed, and the landslide direction lines are associated with landslide deposits (Qls) units present in the GRI digital geologic-GIS data.

Geohazards features from the Dell'Osso, Falls, and McGuire (2002) map are at 1:24,000 scale, all other geology features are at 1:100,000 scale.

Additional information pertaining to each source map is also presented in the GRI Source Map Information (REDWMAP) table included with the GRI digital geologic-GIS data.

Index Map

The following index map displays the extents of the GRI digital geologic-GIS maps produced for Redwood National Park (REDW). The boundary for Redwood National Park (as of September 2013) is outlined in green. Of note, one small area of the present park boundary (not shown, but text and line denotes general area) in the northern third of the GRI digital geologic-GIS map isn't covered. No GRI digital geologic-GIS data presently exists for this small area (an area of park expansion since September 2013). The index map also displays the area of overlap between two data sources used in the completion of the GRI digital geologic-GIS map.



Index map by Greg Mack (NPS Pacific West Region). As mentioned above, the park boundary shown is from September, 2013, and doesn't therefore show the extent of the park boundary as of March, 2022. Added figure text does, however, indicate the general area not covered by the GRI digital geologic-GIS maps. See text above the index map for additional information.

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Redwood National Park, California (REDW) are listed below. Units are listed with their assigned unit symbol and unit name (e. g.,Qaf - Artificial fill). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (REDWUNIT) table included with the GRI digital geologic-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted.

Cenozoic Era

Quaternary Period

Qaf - Artificial fill
Qbs - Beach deposits
Qhc - Stream channel deposit, younger
Qscu - Stream channel deposit
- Qsc2 - Stream channel deposit, 5 to 20 years
- Qsc3 - Stream channel deposit, 20 to 50 years
- Qsc4 - Stream channel deposit, 50 to 100 years

Qscl - Stream channel deposit, between levees
Qds - Dune sand
Qal - Recent alluvium
Qha - Young alluvial deposits, undifferentiated
Qhf - Young alluvial fan deposits
Qht - Young stream terrace deposits
Qe - Estuarine deposits
Qf - Alluvial fan deposits
Qa - Alluvial deposits, undifferentiated
Ql - Lacustrine deposits
Qt - Stream terrace deposits
Qls - Landslide deposits
Qrt - Undifferentiated river terrace deposits
Qort - Undifferentiated continental and marine deposits
Qby - Battery Formation
Qmt - Marine terrace deposits
- Qmt1 - Marine terrace deposits, Patrick's Point terrace
- Qmt2 - Marine terrace deposits, Savage Creek terrace and McKinleyville terrace
- Qmt3 - Marine terrace deposits, Westhaven terrace
- Qmt4 - Marine terrace deposits and Sky Horse terrace
- Qmt5 - Marine terrace deposits, A-Line terrace
- Qmt6 - Marine terrace deposits, Maple Stump terrace

Qsc - Terrace gravels of Surpur Creek

Of note, in the overlap area between the two source maps used by the GRI to produce the digital geologic-GIS map, Qha is comprised of units Qsc3, Qscl, and Qal. Although units Qsc3 and Qal are listed these units are not actually present in the GRI digital geologic-GIS data, they simply comprise the indicated unit.

Quaternary and Tertiary Periods
QTu - Undifferentiated marine and nonmarine overlap deposits
QTpc - Prairie Creek Formation
Qtg - Undifferentiated continental and marine deposits

Tertiary Period
Twi - Wimer Formation
Tsg - St. George Formation
Ti - Coyote Peak diatreme

Mesozoic Era

Cretaceous and Jurassic Periods

Franciscan Complex
KJfm - Franciscan Complex, Central Belt, mélange of the Central Belt
  KJfmgs - Franciscan Complex, Central Belt, mélange of the Central Belt, greenstone block
KJfsc - Franciscan Complex, Central Belt, Sandstone and Mélange unit of Snow Camp Mountain
KJfmg - Franciscan Complex, Eastern Belt, metagraywacke
KJfbf - Franciscan Complex, Eastern Belt, Broken formation
KJfmc - Franciscan Complex, Eastern Belt, mélange unit of Crescent City area
  KJfmcgs - Franciscan Complex, Eastern Belt, mélange unit of Crescent City area, greenstone
  KJfmcch - Franciscan Complex, Eastern Belt, mélange unit of Crescent City area, chert
  KJfmcmg - Franciscan Complex, Eastern Belt, mélange unit of Crescent City area, metagraywacke
  KJfmcu - Franciscan Complex, Eastern Belt, mélange unit of Crescent City area, undifferentiated rock mass
KJfs - Franciscan Complex, Eastern Belt, South Fork Mountain Schist
KJfsp - Franciscan Complex, Eastern Belt, serpentinite

Franciscan units of Hardin and others (1982)
KJfl - Franciscan units of Harden and others (1982), coherent unit of Lacks Creek
KJfc - Franciscan units of Harden and others (1982), incoherent unit of Coyote Creek
KJfg - Franciscan units of Harden and others (1982), transitional rocks of the Grogan Fault Zone
KJfrc - Franciscan units of Harden and others (1982), Redwood Creek schist
  KJfrcmv - Franciscan units of Harden and others (1982), Redwood Creek schist, metatuff
  KJfrcsp - Franciscan units of Harden and others (1982), Redwood Creek schist, serpentine
KJfpp - Franciscan units of Harden and others (1982), Patrick's Point unit of Aalto and others (1981)

Jurassic Period

Josephine ophiolite of Harper (1980)
Jdc - Josephine ophiolite of Harper (1980), dike complex
Jgb - Josephine ophiolite of Harper (1980), gabbro
Juc - Josephine ophiolite of Harper (1980), cumulate ultramafic rocks
Jpd - Josephine ophiolite of Harper (1980), peridotite
Jsp - Josephine ophiolite of Harper (1980), sheared serpentinite
Jspm - Josephine ophiolite of Harper (1980), serpentinite matrix mélange
  Jspmms - Josephine ophiolite of Harper (1980), metasedimentary mélange blocks
  Jspmgs - Josephine ophiolite of Harper (1980), greenstone mélange blocks
  Jspmgr - Josephine ophiolite of Harper (1980), granitic rock mélange blocks
Jk - Klamath Mountain rocks, undifferentiated

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Qaf - Artificial fill (Historical)

af - Artificial fill (historical)
Includes earth and rock fill for dam, levee, jetty, and roadway embankments; may be engineered and/or non-engineered. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

af - Artificial fill (Holocene)
Heterogeneous mixture of artificially deposited material ranging from well compacted, gravel, sand, silt and clay to poorly compacted sediment high in organic content, locally delineated. Description from source map: Redwood Creek Watershed (Geology)

Qbs - Beach deposits (Holocene)

Qbs - Beach sand (latest Holocene)
Well-sorted fine- to coarse-grained sand with some fine gravel; may locally include dune sand. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qbs - Beach sand (Holocene)
Unconsolidated marine-laid deposits of fine to coarse grained sand with lesser amounts of silt clay, shell fragments and Franciscan cobbles and gravel, may migrate seasonally. Description from source map: Redwood Creek Watershed (Geology)

Qhc - Stream channel deposit, younger (latest Holocene)

Fluvial deposits within active stream channels composed of loose sand, silt and gravel. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qscu - Stream channel deposit (Holocene)

Interbedded boulders, cobbles, gravel, sand, silt and day within active stream channels and flood plains. May include some silt and clay estuarine deposits near the mouth of creeks. Description from source map: Redwood Creek Watershed (Geology)

Qsc2 - Stream channel deposit, 5 to 20 years (Holocene)

Same as Qscu except, deposited during flood stage return periods of 5 to 20 years. Description from source map: Redwood Creek Watershed (Geology)

Qsc3 - Stream channel deposit, 20 to 50 years (Holocene)

Same as Qscu except, deposited during flood stage return periods of 20 to 50 years. Description from source map: Redwood Creek Watershed (Geology)

Of note, unit Qsc3 doesn't appear in the GRI digital geologic-GIS data, however, as noted in the Map Unit Listing, as well as with the map unit description for unit Qha, this unit comprises unit Qha (along with units Qscl and Qal) in the area of overlap between the two source maps used to produce the GRI digital geologic-GIS map.

Qsc4 - Stream channel deposit, 50 to 100 years (Holocene)

Same as Qscu except, deposited during flood stage return periods of 50 to 100 years. Description from source map: Redwood Creek Watershed (Geology)

Qscl - Stream channel deposit, between levees (Holocene)

Stream channel confined between levees containing interbedded boulders, cobbles, gravel, sand, silt and clay within active stream channels and flood plains. May include some silt and clay estuarine deposits near the mouth of creeks. Description from source map: Redwood Creek Watershed (Geology)

Of note, unit Qscl doesn't appear in the GRI digital geologic-GIS data, however, as noted in the Map Unit Listing, as well as with the map unit description for unit Qha, this unit comprises unit Qha (along with units Qsc3 and Qal) in the area of overlap between the two source maps used to produce the GRI digital geologic-GIS map.

Qds - Dune sand (Holocene)

Active dunes and older eolian deposits near the coast; typically very well sorted fine- to medium-grained sand; includes both vegetated and unvegetated dunes. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qal - Recent alluvium (Holocene)

Clay, silt, sand, gavel, and boulders, deposited in stream beds, alluvial fans, terraces, flood plains and ponds; and soils formed on these deposits. Includes largely Holocene deposits in modem stream channels and on flood plains. Description from source map: Redwood Creek Watershed (Geology)

Of note, unit Qal doesn't appear in the GRI digital geologic-GIS data, however, as noted in the Map Unit Listing, as well as with the map unit description for unit Qha, this unit comprises unit Qha (along with units Qsc3 and Qscll) in the area of overlap between the two source maps used to produce the GRI digital geologic-GIS map.

Qha - Young alluvial deposits, undifferentiated (Holocene)

Alluvium deposited in fan, terrace, or basin environments that could not be readily separated at scale of mapping. Typically, consist of unconsolidated, poorly to moderately sorted sand, silt, and gravel that form smooth geomorphic surfaces with little to no dissection. Description from source map: Crescent

City and Orick 30' x 60' Quadrangle (Portions of)

Of note, in the area of overlap between the two source maps used to produce the GRI digital geologic-GIS map, unit Qha is comprised of the following units, Qsc3, Qscl and Qal. See these individual unit descriptions for a "collective description" of unit Qha in the area of source map overlap (see the Index Map for this depiction and discussion).

Qhf - Young alluvial fan deposits (Holocene)

Sediment emanating from canyons to produce relatively undissected, fan-shaped deposits along mountain fronts and on alluvial valley floors. Typically consists of unconsolidated, moderately to poorly sorted and composed of sand, gravel, silt, and clay. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qht - Young stream terrace deposits (Holocene)

Sand, gravel, silt, and minor clay deposited in recent flood plain settings along rivers; form relatively flat surface with little or no dissecting. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qe - Estuarine deposits (Holocene)

Qe - Estuarine deposits (Holocene)
Unconsolidated clay, silt, and fine sand deposited in estuary and tidal flat settings near the coast. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qe - Estuarine deposits (Holocene-Pleistocene)
Undifferentiated and unconsolidated day, silt and fine sand. Description from source map: Redwood Creek Watershed (Geology)

Qf - Alluvial fan deposits (Pleistocene to Holocene)

Qf - Alluvial fan deposits (Holocene to Pleistocene)
Poorly sorted deposits of sand, gravel, silt and clay; mapped on sloping, fan-shaped alluvial surfaces that are slightly to moderate dissected. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qf - Alluvial fans (Holocene)
Characteristic fan or cone shapes at the mouths of eroding stream canyons; includes debris fans typically consisting of poorly sorted silt, sand, gavel, cobbles and some boulders. Description from source map: Redwood Creek Watershed (Geology)

Qa - Alluvial deposits, undifferentiated (Holocene and Pleistocene)

Unconsolidated, moderately to poorly sorted sand, gravel, silt and clay mapped in small valleys and where separate fan, terrace, and active stream channel units could not be delineated at the scale of mapping. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Ql - Lacustrine deposits (Holocene and Pleistocene)

Undifferentiated and unconsolidated lake deposits of clay, silt and fine sand. Description from source map: Redwood Creek Watershed (Geology)

Qt - Stream terrace deposits (Pleistocene to early Holocene)

Erosional remnants of older alluvium forming relatively flat or gently sloping surfaces in a raised position relative to recent flood plains. Slightly to moderately weathered and dissected deposits of gravel, sand silt and clay. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qls - Landslide deposits (Pleistocene to historical)

Limited to relatively large, deep-seated landslides and slide complexes where the existence is considered definite or probable; not intended to represent an inventory of all recognized or suspected landslides in the area. Arrows indicate direction of movement. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qrt - Undifferentiated river terrace deposits (Holocene and Pleistocene)

Interbedded boulders, cobbles, gravel, sand, silt and clay, lithologically similar to modern alluvium accumulated in stream channels found on flat-lying to gently-inclined platforms where they were deposited during floods. Individual terraces with distinctly different elevations were noted separately. Description from source map: Redwood Creek Watershed (Geology)

Qort - Undifferentiated continental and marine deposits (Holocene and Pleistocene)

Undifferentiated older river terrace deposits: Holocene-Pleistocene. Weakly consolidated, moderately to poorly sorted, gravel, sand, silty sand, silt and clay deposited in a fluvial environment and subsequently uplifted. Description from source map: Redwood Creek Watershed (Geology)

Qby - Battery Formation (late Pleistocene)

Marine terrace deposits with interfingering dune sands and alluvial gravels; overlying abrasion platforms dated at approximately 80, 105, and 125+ thousand years old (Polenz and Kelsey, 1999); consists largely of tan to reddish-brown, semiconsolidate, medium-grained sands alternating with blue-gray silty clay and imbricated gravels. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qmt - Marine terrace deposits (Pleistocene)

Qmt1-Qmt6 - Marine terrace deposits (Pleistocene)

Qmt, Qmt1 - Qmt6 - Marine terrace deposits (Pleistocene)
Shallow marine deposits on elevated wave-cut platforms; also older dune deposits and interfingering non-marine deposits. North of Redwood Creek, includes massive sands with discontinuous pebble layers that unconformably rests on an erosional surface cut on both the Redwood Creek Schist and Prairie Creek Formation, and formerly referred to as the Skunk Cabbage unit of the Prairie Creek Formation (Kelsey and Trexler, 1989). May also include abrasion platforms were little or no Pleistocene deposits remain. Uplifted and faulted marine terraces at Trinidad; terrace names and approximate ages (ka=1000 years) from Woodward-Clyde Consultants (1980), and Carver (1992):

Qmt1 - Patricks Point terrace, age 64 ka
Qmt2 - Savage Creek terrace, age 83 ka, and McKinleyville terrace, age 96 ka
Qmt3 - Westhaven Terrace, 103 ka
Qmt4 - Fox Farm terrace, 120 ka, and Sky Horse terrace, age 130 ka
Qmt5 - A-Line terrace, age 176 ka and older.
Qmt6 - Maple Stump terrace, age 200+ ka

Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Qmt - Marine terrace deposits (Pleistocene)
Sand and gravel deposited in a shallow marine setting on gently-inclined uplifted wave-cut benches.
Description from source map: Redwood Creek Watershed (Geology)

Qsc - Terrace gravels of Surpur Creek (Pleistocene)

Alluvial terrace gravels with minor sand and silt facies that cap ridge tops along the lower Klamath River. Near the mouth of the river these deposits are interbedded with near-shore marine silts and sands (Aalto and others, 1981); unconformably overlies the Prairie Creek Formation to the south; thought to have been deposited by the ancient Klamath River. Informally referred to as the Surpur Creek unit of the Prairie Creek formation by Kelsey and Trexler (1989), but described as terrace deposits separate from the Prairie Creek Formation by Cashman et al. (1995).

QTu - Undifferentiated marine and nonmarine overlap deposits (late Pliocene? to Pleistocene)

Qu - Undifferentiated marine and nonmarine overlap deposits (Pleistocene to late Pliocene?)
Includes multiple stratigraphic units of tilted, unconformably bounded sequences of weekly consolidated sands, silts and gravels representing transgressive-regressive cycles of deposition in nearshore marine, beach, dune, lagoon and alluvial settings (Aalto, 1989b). Portions are considered part of, or equivalent to the upper Falor Formation (Carver, 1987) and/or Wildcat group of the Eel River basin to the southeast.

QTpc - Prairie Creek Formation (late Pliocene to early Pleistocene)

QTpc - Prairie Creek Formation (early Pleistocene to late Pliocene)
Weakly consolidated sand and gravel, grading upward from shallow marine sand in the lower part to deltaic, estuarine and coarse fluvial sand and gravel in the upper parts; appears to be a remnant of the lowermost reaches of the ancestral Klamath River (Cashman and others, 1995). Marine mollusks in the lower part of the unit are similar to those found in the Falor Formation and are thought to constrain

the lower age limit to 2-4 Ma (Kelsey and Trexler, 1989).Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

QTpc - Prairie Creek Formation (Pleistocene - Pliocene)
Weakly consolidated shallow marine and alluvial sediments. Dominantly composed of marine sands, beach, estuarine, and alluvial deposits, grading upward from medium to coarse sand, pebbles, cobbles and mixed small metamorphic and igneous boulders with minor organic-rich mud. *Protothaca hannibali* discovered at base of unit (Cashman et al., 1995). Unit is relatively stable from a mass wasting perspective. Rock slides and debris slides are the typical modes of movement.

The Prairie Creek Formation was deposited over an approximately 1 to 4 million year time period (Cashman and others, 1995). This unit consists of weakly consolidated shallow marine and alluvial sediments inferred to represent near-shore sedimentary deposits related to the ancestral mouth of the Klamath River (Figure G3) (Cashman and others, 1995). This unit is dominantly composed of marine sands, beach, estuarine and alluvial deposits, grading upward from medium to coarse sand, pebbles, cobbles and metamorphic and igneous boulders and minor organic-rich mud.

The Prairie Creek Formation is probably largely derived from Klamath Terrane rocks farther inland rather than the nearby Franciscan Complex because there is very little Franciscan debris within it. Additionally, this debris is found near the bottom of the section (Cashman and others, 1995). The best exposures are along the cliffs of Gold Bluffs Beach (the type locality), eight miles north of Orick. Total exposed section of this unit at Gold Bluffs Beach is approximately 1,500 feet thick. A single mollusk fossil (Protothaca hannibali) discovered at the base of the unit provides a general age of the formation because it has an age span from about 1 to 4 million years before the present. No other conclusive age-determinant information has been identified (Cashman and others, 1995). This unit is relatively stable from a mass wasting perspective. Occasional rock slides and debris slides are the typical modes of movement, when it occurs. Description from source map: Redwood Creek Watershed (Geology)

QTg - Undifferentiated continental and marine deposits (Pleistocene and Pliocene)

Deposits typically consist of gravel, sand! gravel, and gravelly sandy silt deposited in terrigeneous and near shore environments.

These deposits are slightly older (possibly late Pliocene) than the Prairie Creek Formation (Kelsey and Cashman, 1983) and typically consist of gravel, sandy gravel and gravelly sandy silt deposited in continental and near-shore environments. This unit is relatively stable from a mass wasting perspective because it occupies gently sloping ridge crests in the northeast portion of the watershed. Description from source map: Redwood Creek Watershed (Geology)

Twi - Wimer Formation (late Miocene)

Erosional remnants of material accumulated on the “Klamath peneplain” of Diller (1902), an elevated, westward-tilted erosion surface recognized over a large area in the highlands east of Crescent City. Consists of a western estuarine marine facies of fossiliferous mudstone, sandstone and pebble conglomerate, and an eastern fluvial facies of coarse conglomerate and subordinate sandstone (Stone, 1992). Molluscan fauna suggest late Miocene age (Watkins, 1974). Age of diatoms from the unit initially thought to be earliest Pliocene were reinterpreted as late Miocene (Aalto, 2006). Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Tsg - St. George Formation (late Miocene)

Bioturbated marine sandstone and sandy mudstone with scattered pebbles, carbonized wood, and fragmented molluscan shells. Exposed in wave cut cliffs west of Crescent City and encountered in borings beneath the coastal plain. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Ti - Coyote Peak diatreme (Tertiary)

Alkalic intrusive igneous rock composed of olivine, clinopyroxene, phlogopite, nepheline, acmite, schorlomitic garnet, titanomagnetite, perovskite, apatite and some rare sulfide minerals. Inclusions of Franciscan sedimentary rocks and aphanitic (micro-crystalline) alkalic igneous rocks are present.

Located approximately 5 miles north of Pine Ridge Summit. This rock is thought to have intruded into the Coyote Creek unit after it was emplaced against North America. Description from source map: Redwood Creek Watershed (Geology)

KJfm - Franciscan Complex, Central Belt, melange of the Central Belt (mid to Late Cretaceous and Early Jurassic)

Tectonic mixture of penetratively sheared argillite and graywacke that forms a matrix around more coherent masses of greywacke and isolated blocks of greenstone, chert, and serpentinite, as well as exotic blocks of blueschist and other high grade metamorphic rock that are notably absent from the Eastern Belt mélange units (KJfms and KJfc) north of the Grogan fault. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfmgs - Franciscan Complex, Central Belt, melange of the Central Belt, greenstone block (mid to Late Cretaceous and Early Jurassic)

gs
Large enough to be shown at map scale. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfsc - Franciscan Complex, Central Belt, Sandstone and Melange unit of Snow Camp Mountain (Cretaceous and Jurassic)

Bedded graywacke bodies intermixed with pervasively sheared shale-rich melange containing blocks of metagraywacke, metachert, volcanic breccia, metavolcanic rocks, greenstone and blueschist. Unit appears to behave in similar manner as Incoherent Unit of Coyote Creek. Geomorphology is varied with steep slopes forming in areas underlain by sandstone. More subdued, hummocky terrain in areas underlain by melange. Earthflows are the dominant mode of mass wasting.

This unit underlies the southern portion of the watershed and consists of bodies of intact sandstone intermixed with a pervasively sheared shale-rich mélange containing blocks of metagraywacke, metachert, volcanic breccia, metabasalt, metatuff, metavolcanic rocks, greenstone and glaucophane-lawsonite blueschist (Figure G3). Based on our aerial photograph interpretation and mapping, this material appears to behave in a similar manner mechanically as the incoherent unit of Coyote Creek. The geomorphology is varied with steep slopes forming in areas underlain by relatively competent sandstone and more subdued hummocky terrain in areas underlain by mélange. Earthflows are the dominant mode of mass wasting. A large earthflow complex in this unit dominates the headwaters of

Redwood Creek and appears to have deflected the channel eastward several hundred feet. Description from source map: Redwood Creek Watershed (Geology)

KJfmg - Franciscan Complex, Eastern Belt, metagraywacke (Cretaceous and Jurassic)

Foliated metagraywacke and argillite of textural zone II (Blake and others, 1976) found in a thin zone along the west side of the Coast Range Thrust fault; includes tectonic blocks of recrystallized chert and greenstone (Aalto and Harper, 1982). Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfbf - Franciscan Complex, Eastern Belt, Broken formation (Early Cretaceous and Late Jurassic)

Massive greywacke sandstone, and interbedded sandstone, mudstone, and conglomerate tectonically fragmented into blocks in a shaley matrix; appears unmetamorphosed (textural zone 1 of Blake and others, 1967). Masses of bedded chert exposed along fault in the Requa 7.5' quadrangle up to 20 meters thick and conformably overlain by sandstone and shale to the east (Aalto and Harper, 1982). Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfmc - Franciscan Complex, Eastern Belt, melange unit of Crescent City area (Cretaceous and Jurassic)

Tectonically disrupted blocks of greywacke, shale, conglomerate, chert, limestone, phyllite, greenstone, and serpentinite, in a shaley matrix; contact with KJfbf to the east is gradational, marked by the disappearance of chert and greenstone blocks (Aalto and Harper, 1982). Unlike mélange of the Central Belt (KJfm), exotic blocks of blueschist are absent. Where exposed along the shoreline west of Crescent City, some disruption of strata interpreted as due to olistostromal deposition and soft-sediment deformation of turbidite beds (Aalto, 1989a). Individual blocks large enough to be shown at this map scale are as follows: gs, mg, ch,and u. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfmcgs - Franciscan Complex, Eastern Belt, melange unit of Crescent City area, greenstone (Cretaceous and Jurassic)

gs
Individual blocks large enough to be shown at this map scale. Greenstone; mostly agglomerate, felsic tuff, and pillow basalt. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfmcch - Franciscan Complex, Eastern Belt, melange unit of Crescent City area, chert (Cretaceous and Jurassic)

ch
Individual blocks large enough to be shown at this map scale. Red and green, thin bedded, radiolarian chert. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfmcmg - Franciscan Complex, Eastern Belt, melange unit of Crescent City area, metagraywacke (Cretaceous and Jurassic)

mg
Individual blocks large enough to be shown at this map scale. Metagraywacke. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfmcu - Franciscan Complex, Eastern Belt, melange unit of Crescent City area, undifferentiated rock mass (Cretaceous and Jurassic)

u
Individual blocks large enough to be shown at this map scale. Undifferentiated rock mass mapped from a distance or aerial photos, but lithology not confirmed in the field.

KJfs - Franciscan Complex, Eastern Belt, South Fork Mountain Schist (Cretaceous and Jurassic)

Dominant rock type is quartz-albite-muscovite-chlorite schist. Mineralogically similar to Redwood Creek Schist. Appears nearly identical to Redwood Creek schist at hand-sample scale. Includes foliated greenstone and quartz-gneissic rocks. Surface expression is geomorphically variable. The dominant mode of mass wasting is large dormant earthflows.

The dominant rock is dark gray to green quartz-albite-muscovite-chlorite schist. The South Fork Mountain Schist is not as extensive as the Redwood Creek schist in the watershed (4,000 v. 77,000 acres), but has similar mineralogical characteristics (Figure G3). Includes foliated greenstone and quartz-gneissic rocks. The surface expression is geomorphically variable. It has a well-developed foliation (platy texture), is fine-grained and typically has quartz veins oriented parallel to the foliation based on our field examination of hand specimens and outcrop exposures. The dominant modes of mass wasting in this unit appear to be large, dormant landslide complexes, active earthflows and large rotational landslides as seen within the unit farther to the southeast in the upper portion of the Redwood Creek watershed. Most of these large features appear to be dormant at this time. Other modes of mass wasting in this unit account for less than 1% of the total within the unit. Description from source map: Redwood Creek Watershed (Geology)

KJfsp - Franciscan Complex, Eastern Belt, serpentinite (Cretaceous and Jurassic)

sp
Serpentine and serpentinized ultramafic rocks. Description from source map: Redwood Creek Watershed (Geology)

KJfl - Franciscan units of Harden and others (1982), coherent unit of Lacks Creek (Cretaceous and Jurassic)

KJfl - Coherent unit of Lacks Creek (Cretaceous and Jurassic)
Unmetamorphosed sandstone and mudstone assemblage mapped by Harden and others (1982) in the Redwood Creek watershed east of the Grogan fault; equivalent to broken formation (KJfbf). Sandstone occurs as massive beds up to 10 m thick, but can't be traced far laterally due to complex folding and faulting. Mudstone comprises a noticeably lower percentage of the coherent unit than KJfc and

tectonic blocks of chert and greenstone are not found. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfl - Coherent Unit of Lacks Creek (Cretaceous-Jurassic)
Sandstone and mudstone assemblage underlying the Redwood Creek basin east of the Grogan Fault. Unit appears to have two distinct facies. Type locality ("south Lacks Creek facies") consists of resistant assemblage of sandstone and mudstone. Relatively intact sections of interbedded sandstone and mudstone show sedimentary structures characteristic of turbidites (Cashman et al., 1995). Topography is steep and rugged and debris slides are common. Harden and others (1982) also map Lacks Creek Unit adjacent to Redwood Creek channel in Upper Basin. "North Lacks Creek facies" forms gentle topography compared to "south facies" and is populated with numerous dormant rotational landslides and earthflows. Eastern portion contains occasional debris slide slopes. "North facies" appears to be closely related, in rock texture, to Incoherent Unit of Coyote Creek.

This unit underlies the east side of the watershed and appears to have two distinct facies (Figures G3 - G4). The type locality of the Lacks Creek Unit ("south Lacks Creek facies" in this report) consists of a relatively resistant assemblage of sandstone and mudstone. Relatively intact sections of interbedded sandstone and mudstone show rhythmic bedding and sedimentary structures characteristic of turbidites (repeating sequences of sandstone and siltstone deposited underwater by density currents). Sandstones are composed of lithic greywacke and quartzofeldspathic greywacke (Cashman and others, 1995). Massive sandstone beds are up to 10 m thick and are typically 0.1 - 3 m thick where interbedded with mudstone. Topography is steep and rugged and debris slides slopes are common (Figure G4, Plate 1, Sheet 2). This unit is best seen along the northeast side of the watershed in the Lacks and Minor Creek drainages. Harden and others (1982) also mapped the Lacks Creek unit adjacent to the Redwood Creek channel in the Upper Basin. The "north Lacks Creek facies" forms gentle topography compared to the "south facies" and is populated with numerous dormant rotational landslides and occasional debris slide slopes (Plate 1, Sheet 1). The north facies appears to be more closely related, at least from an overall rock texture basis, to the incoherent unit of Coyote Creek (KJfc), because its topographic style and mode of mass wasting more closely resemble the incoherent unit of Coyote Creek than the south Lacks facies (Figure G4). Description from source map: Redwood Creek Watershed (Geology)

KJfc - Franciscan units of Harden and others (1982), incoherent unit of Coyote Creek (Cretaceous and Jurassic)

KJfc - Incoherent unit of Coyote Creek (Cretaceous and Jurassic)
Mélange unit in the vicinity of the Grogan fault consisting of brecciated and sheared mudstone and sandstone enclosing tectonic blocks of chert, greenstone and sandstone, as well isolated bedded sequences of sandstone and chert. Like the mélange unit of the Crescent City area (KJfmc), exotic blueschist blocks are absent and the degree of shearing is less extreme than the mélange of the Central Belt. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfc - Incoherent Unit of Coyote Creek (Cretaceous-Jurassic)
Unit consists dominantly of fine-gained sandstone and mudstone assemblage. Unit has been sheared into melange by tectonic processes. Coyote Creek: Unit is further characterized by presence of greenstone, chert and minor conglomerate. Greenstone blocks are found as "floaters" in pervasively sheared mudstone matrix. Soils developing on bedrock are highly susceptible to sliding. Areas dominated by melange generally form rounded hilltops with gentle slopes and poorly developed sidehill drainages. Several large topographic amphitheaters along the east side of the watershed appear to have formed over time from long-term episodic action of numerous earthflows. Sharp-crested ridges with moderately steep slopes and well-defined drainage systems develop where upper edges of earth flow complexes meet. Intact tectonic blocks (usually sandstone) within Coyote Creek Unit stand out from surrounding landscape as steep-sided rocky knobs. Active earthflows and composite slides are main modes of mass wasting in melange matrix of Coyote Creek Unit.

Such "earthflow amphitheaters" appear to represent what we informally call "probability surfaces" in this report. In this hypothesis, these are surfaces that have been created over time through the actions

of thousands of earthflows occurring throughout the amphitheater in much the same way as alluvial fans develop at the bottoms of hillsides. Alluvial fans develop when watercourses exit hill-fronts and migrate back and forth across valley floors, depositing sediment as they go. The eventual result is a broad cone of sediment with its apex at the base of the hill-front. “Earthflow amphitheaters” may form over time by material being removed from the system by earthflow activity (“negative probability surfaces”) whereas alluvial fans form by material being added to the system (“positive probability surfaces”).

Sharp-crested ridges with moderately steep slopes and well-defined drainage systems tend to develop where the upper edges of earthflow complexes meet. Intact tectonic blocks (usually sandstone) within the Coyote Creek Unit stand out from the surrounding landscape as steep-sided rocky knobs. Active earthflows are the main modes of mass wasting in the mélange matrix of the Coyote Creek unit. Mélange matrix typically underlies the expansive grassland and lightly wooded areas present in the southeastern portion of the watershed. Well-developed gully networks are common within the more active portions of earthflow complexes and are considered significant sediment sources because they are directly connected to the drainage system. Description from source map: Redwood Creek Watershed (Geology)

KJfg - Franciscan units of Harden and others (1982), transitional rocks of the Grogan Fault Zone (Cretaceous and Jurassic)

KJfg - Transitional rocks of the Grogan Fault Zone (Cretaceous and Jurassic)
Metamorphosed mudstone, sandstone, and lesser conglomerate of textural zone II (Blake and others, 1976) found in a thin zone along the Grogan Fault Zone. Metaconglomerate exhibits alignment and shattering of clasts. Mudstone exhibit platy cleavage and a phyllitic sheen due to the presence of metamorphic chlorite and white mica; lawsonite is common in the sandstones (Harden and others, 1982). Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfg - Transitional Rocks of the Grogan Fault Zone (Cretaceous-Jurassic)
Phyllitic sandstone and mudstone with minor greenstone, metaconglomerate and exotic blocks of blueschist. Degree of metamorphism is intermediate between unmetamorphosed rocks of the Coyote Creek and lacks Creek Units and the Redwood Creek: Schist. Metaconglomerate exhibits alignment and shattering of clasts. Most unstable unit in the watershed. The dominant modes of mass wasting are debris slides and rotational/translational landslides.

Metaconglomerates exhibit alignment, deformation and shattering of clasts. Grogan fault zone rocks are described as intermediate in texture and degree of metamorphism between the Redwood Creek schist and the sandstone and mudstone units (Harden and others, 1982). These rocks crop out along the trace of the Grogan fault and underlie much of the inner gorge of Redwood Creek (Figure G3). Most of the mapped near-channel debris slides along the mainstem of Redwood Creek are found in this unit. Debris slides are the dominant mode of mass wasting and occur 400 to 500% more often in this unit than any other in the basin. This predisposition to debris slides indicates the presence of relatively weak rock within the unit.

Earthflows are also indicated in our analyses as important modes of transport within this unit, but we suspect that this is primarily the case where the earthflows have started upslope of the Grogan fault zone rocks in weak units and have simply flowed across the fault zone on their way to Redwood Creek. Further fieldwork and statistical analyses are needed to evaluate this hypothesis. Description from source map: Redwood Creek Watershed (Geology)

KJfrc - Franciscan units of Harden and others (1982), Redwood Creek schist (Early Cretaceous and Late Jurassic)

KJfrc - Redwood Creek Schist (Cretaceous and Jurassic)
Predominately fine-grained schist, semischist, and coarse-grained metagraywacke belonging to textural zones II and III (Blake and others,1967); typical mineral assemblage consists of quartz, chlorite, white mica, and albite, and less frequently epidote, actinolite, and lawsonite (Cashman and others., 1995). Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfr - Redwood Creek Schist (Cretaceous-Jurassic)
Light green to dark gray fine-grained foliated and crenulated quartz-mica schist. Unit is distinctive because of its strongly developed platy (metamorphic) texture and high quartz/mica content. Appears nearly identical to South Fork Mountain schist at hand-sample scale. Large variations in texture, composition and degree of deformation are reportedly seen within this unit (Cashman et al., 1995). Several other types of rocks occur within the unit, including altered sandstone, greenstone, and tuff. Outcrops occasionally contain minor amounts of epidote, actinolite, lawsonite, and minor graphite. Large dormant rotational/translational landslide complexes and earthflows are common along the main channel of Redwood Creek and its western tributaries.

The unit is distinctive because of its strongly developed platy (metamorphic) textures and high quartz/mica content. The Redwood Creek schist and South Fork Mountain Schist units appear nearly identical at hand-sample scale. Several other types of rocks occur within the unit, including metasandstone, greenstone (altered basalt) and tuff. Large variations in texture, composition and degree of deformation are reportedly seen within this unit (Cashman and others, 1995). Outcrops occasionally contain minor amounts of epidote, actinolite, lawsonite and graphite.

Large dormant rotational/translational landslide complexes and earthflows are common along the main channel of Redwood Creek and its western tributaries. These features typically are seen as broad, bowl-shaped depressions in the hillsides that often extend from the Creek to the ridgetop (Figure G6). The large features do not appear to be recently active from a geomorphic perspective, but rather contain occasional areas of localized activity. Careful field reconnaissance is necessary to evaluate the relative stability of specific areas on these slopes.

Several factors appear to cause a significantly higher surface erosion rate in areas underlain by schist (KJfr, KJfs) after logging than on comparable slopes underlain by different parent material (Marron and others, 1995). The main factor appears to be how exposure of schist soils to ash leachate following a fire causes them to become less cohesive and readily erodible. Schist soils of the Sites series in the watershed are described as rich in kaolinite (a low plasticity clay) (http://www.statlab.iastate.edu/cgi-bin/osd/osdname.cgi?-P - 9/25/2013 Server not found. Attempted to locate web page but could not.) and varying from non-sticky to slightly sticky when wet (University of California, 1965).

Clay minerals have a platy form and many types of clay adhere together in tiny book-like clumps (flocculate) because of attractive charges between the particles. Such materials are known as flocculated clays and are cohesive (cling together well). Cohesive clays are relatively resistant to erosion as a result (Bell, 1998). Not all clays are cohesive, however. Kaolinite is a clay mineral that has a relatively low cohesion and is susceptible to dispersion when exposed to ash leachate (Holcomb and Durgin, 1979). Dispersed clays have an open structure because the attractive forces between particles are weak. This clay mineral is commonly found in soils developed from Redwood Creek schist bedrock as discussed earlier. Description from source map: Redwood Creek Watershed (Geology)

KJfrcmv - Franciscan units of Harden and others (1982), Redwood Creek schist, metatuff (Early Cretaceous and Late Jurassic)

mv - metatuff (Cretaceous and Jurassic)
Minor interbeds of metatuff within the Redwood Creek Schist. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfrcv - Metatuff (Cretaceous-Jurassic)
Moderately metamorphosed tuff beds interbedded in the Redwood Creek Schist. Description from source map: Redwood Creek Watershed (Geology)

KJfrcsp - Franciscan units of Harden and others (1982), Redwood Creek schist, serpentine (Early Cretaceous and Late Jurassic)

sp
Blocks of serpentinite within Redwood Creek Schist. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

KJfpp - Franciscan units of Harden and others (1982), Patrick's Point unit of Aalto and others (1981) (Early Cretaceous and Late Jurassic)

Foliated and moderately reconstituted (textural zone 2 of Blake and others, 1967) mudstone, sandstone and minor conglomerate. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jdc - Josephine ophiolite of Harper (1980), dike complex (Late Jurassic)

Dark-green to light-green aphanitic to fine-grained mafic dikes averaging approximately 60 cm in width. Chilled margins are locally well preserved. Dike cores are generally coarser-grained towards base. The upper part is commonly altered to epidosites. Most dikes are subparallel resulting in a well defined sheeting. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jgb - Josephine ophiolite of Harper (1980), gabbro (Late Jurassic)

Medium-grained non-diabasic gabbro, locally intercalated with cumulate ultramafics, and commonly intruded by diabase dikes. Gradational contact with underlying cumulate ultramafic rocks. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Juc - Josephine ophiolite of Harper (1980), cumulate ultramafic rocks (Late Jurassic)

Fine- to medium-grained, layered olivine and orthopyroxene-bearing gabbro displaying cumulate texture, cut by diabase dikes that increase in abundance in upper part of gabbro; locally cut by dikelets of hornblende-albite pegmatite and lesser biotite-bearing plagiogranite. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jpd - Josephine ophiolite of Harper (1980), peridotite (Late Jurassic)

Predominantly medium- to coarse-grained layered and foliated harzburgite tectonite, with subordinate dunite, lherzolite, and orthopyroxenite. Generally greater than 50% serpentinized; sheared and serpentinized near faults. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jsp - Josephine ophiolite of Harper (1980), sheared serpentinite (Jurassic)

Fault bounded zones of highly sheared serpentinite. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jspm - Josephine ophiolite of Harper (1980), serpentinite matrix melange (Jurassic)

Zone along the Coast Range Thrust fault of pervasively sheared serpentinite enclosing blocks of peridotite, metasedimentary rocks (ms), greenstone (gs), and granitic rocks (gr).

Jspmms - Josephine ophiolite of Harper (1980), metasedimentary melange blocks (Jurassic)

ms
Mélange blocks of metasedimentary rocks within Serpentinite matrix mélange. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jspmgs - Josephine ophiolite of Harper (1980), greenstone melange blocks (Jurassic)

gs
Greenstone Mélange blocks of metasedimentary rocks within Serpentinite matrix mélange. Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jspmgr - Josephine ophiolite of Harper (1980), granitic rock melange blocks (Jurassic)

gr
Granitic rock mélange blocks within serpentinite matrix mélange (Jspm). Description from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Jk - Klamath Mountain rocks, undifferentiated (Jurassic)

Undifferentiated rocks of the Klamath Mountain tectonic province. Commonly consist of sheared serpentinite, partially serpentinized peridotite and associated minor mafic intrusive rocks correlative with the Josephine ophiolite and a zone of tectonically mixed rocks consisting of metagraywacke, diorite, serpentinite, and foliated greenstone along the South Fork Mountain Fault zone.

These rocks are seen as a small area (<1% of the basin) of sheared serpentinite and altered peridotite with minor volcanic and sedimentary rocks along the watershed boundary approximately 2 miles southeast of Berry Summit (Figure G3) (Harden and others, 1982; Cashman and others, Description from source map: Redwood Creek Watershed (Geology)

Ancillary Source Map Information

The following sections present ancillary source map information associated with sources used for this project.

Crescent City and Orick 30' x 60' Quadrangle (Portions of)

The formal citation for this source.

> Delattre, Marc, and Rosinski, Anee, 2012, Preliminary Geologic Map of the Onshore Portions of the Crescent City and Orick 30' x 60' Quadrangles, California: California Geological Survey, Preliminary Geologic Map, scale 1:100,000 (*GRI Source Map ID 75672*).

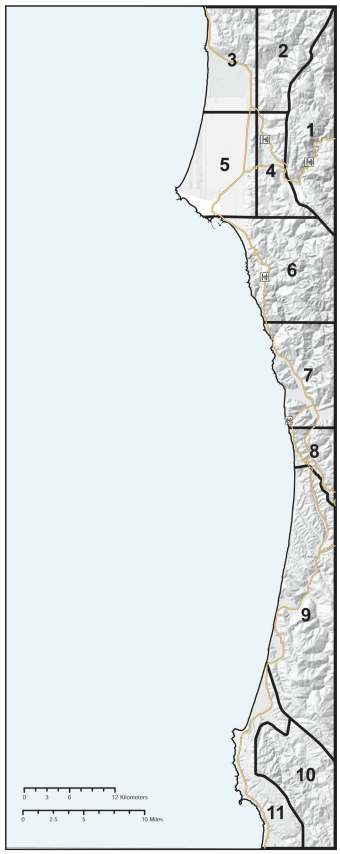
See the GRI Digital Maps and Source Map Citations of this document for how the above source map was used in the completion of the GRI digital geologic-GIS map.

The source geologic map and pamphlet are available for the web at: http://conservation.ca.gov//cgs/rghm/rgm/Pages/preliminary_geologic_maps.aspx

Prominent graphics and text associated with this source.

Index to Geologic Source Data

ABBREVIATED INDEX TO GEOLOGIC SOURCE DATA



(SEE PAMPHLET FOR COMPLETE REFERENCES)

1. Harper, 1980; Elder and Reichert, 2010; Evans, 1984; Stone, 1983, for Wimer Formation; Quaternary mapping by Delattre, this study.
2. Davenport, 1983b; Aalto, 1981; Quaternary mapping by Delattre, this study.
3. Davenport, 1983c; Back, 1957; Aalto and others, 1981; Quaternary mapping by Delattre, this study.
4. Davenport, 1983a; Back, 1957; Aalto and others, 1981; Stone, 1983, for Wimer Formation; Quaternary mapping by Delattre, this study.
5. Davenport, 1982; Back, 1957; Aalto, 2006, for Point St. George area; Polenz and Kelsey, 1999; Quaternary mapping by Delattre, this study.
6. Davenport, 1984a; Aalto and Harper, 1982; Wills, 2000; Ristau, 1979; Quaternary mapping by Delattre, this study.
7. Davenport, 1984b; Aalto and Harper, 1982; Quaternary mapping by Delattre, this study.
8. Aalto and others, 1981; Cashman and others, 1995; Kelsey and Trexler, 1989.
9. Dell'Osso and others, 2003; Cashman and others, 1995; Hardin and others, 1982; Aalto and others, 1981; Quaternary mapping by Delattre and Rosinski, this study.
10. Aalto and others, 1981; Quaternary mapping by Delattre and Rosinski, this study.
11. Aalto and others, 1981; Carver, 1992, Woodward-Clyde Consultants, 1980, and Aalto, 1989b for marine terraces; Quaternary mapping by Delattre and Rosinski, this study.

Graphic from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Correlation of Map Units

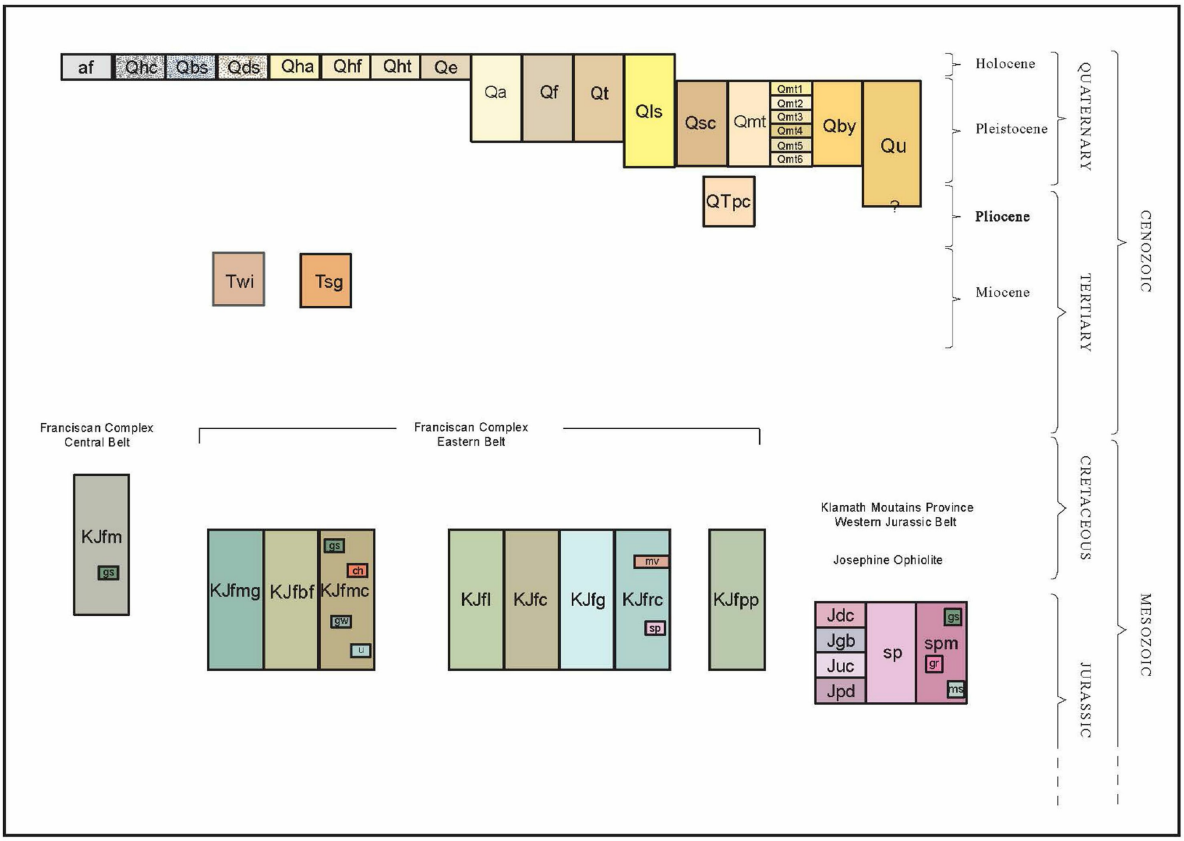
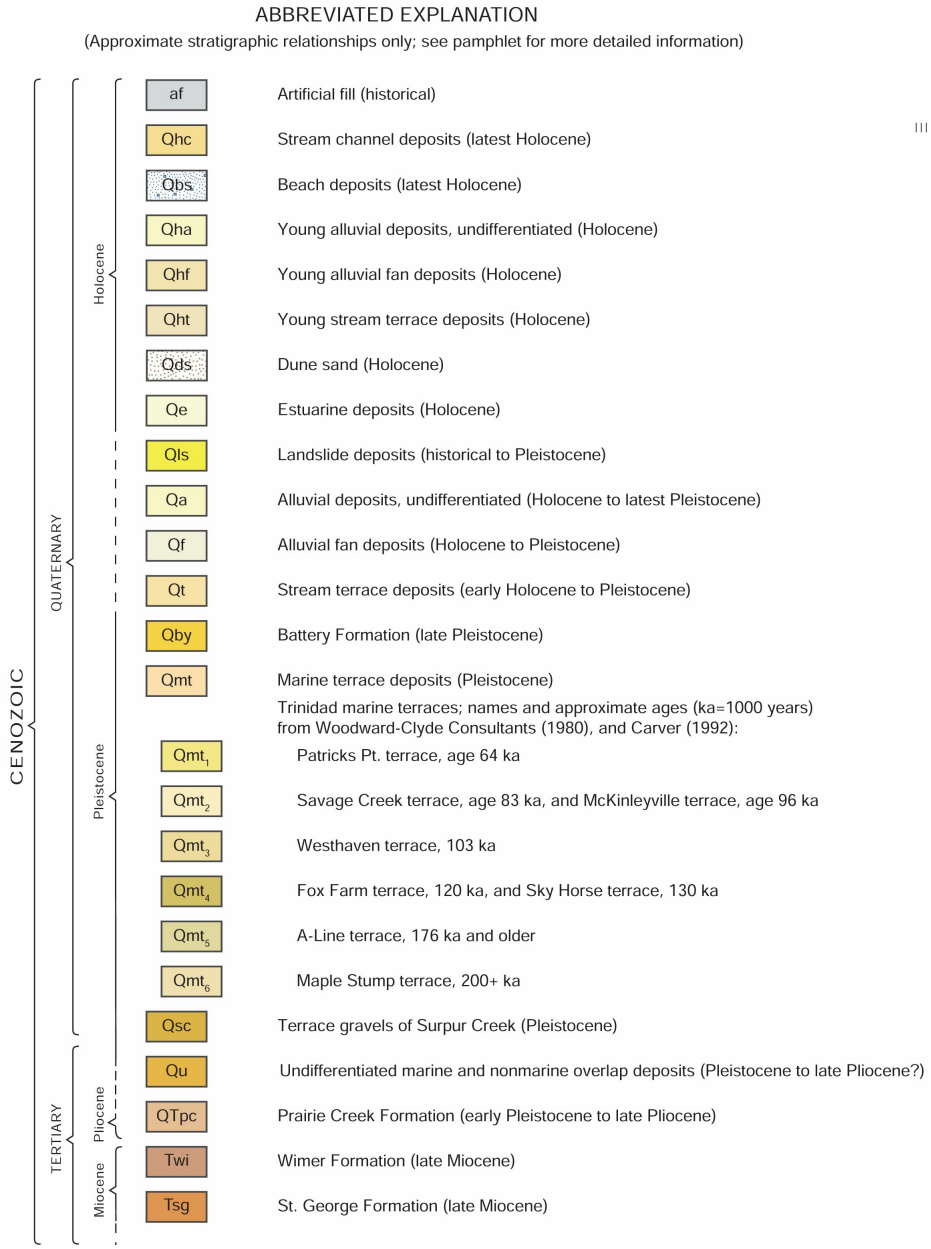
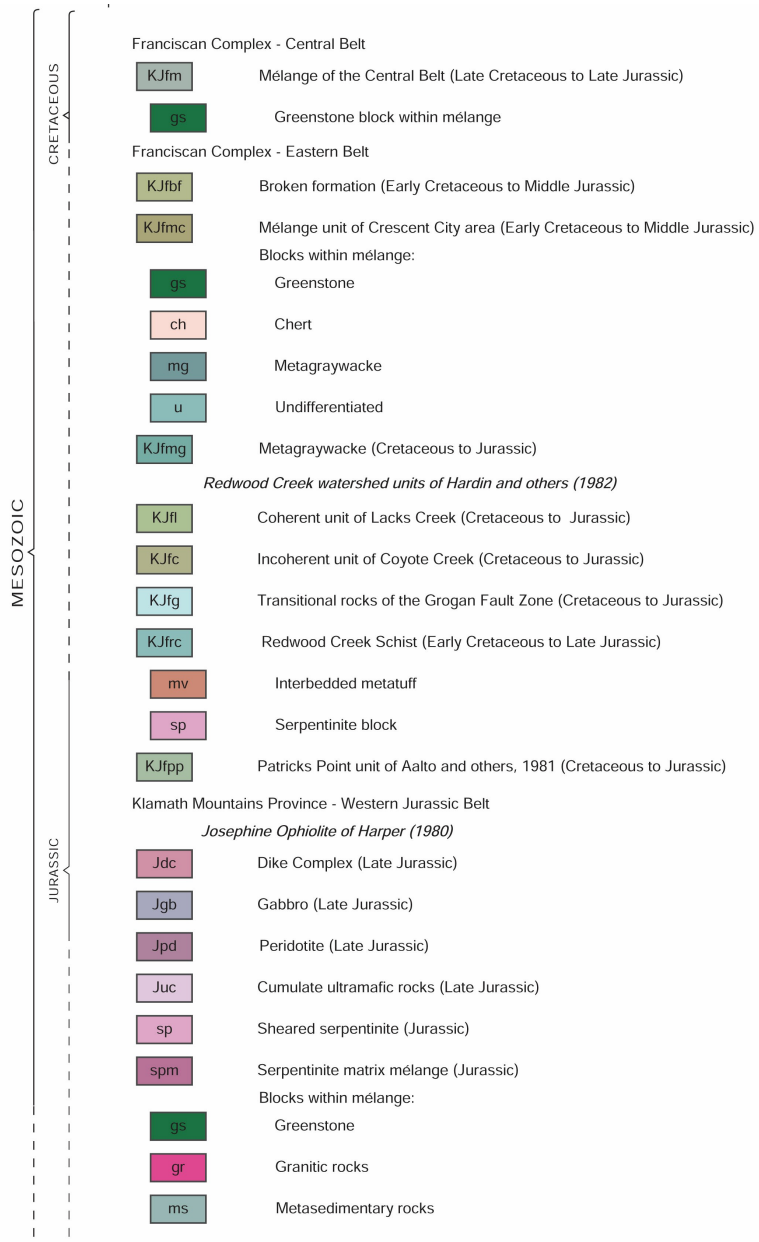


Figure 2. Correlation of map units for the Crescent City and Orick 30' x 60' quadrangles.

Graphic from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

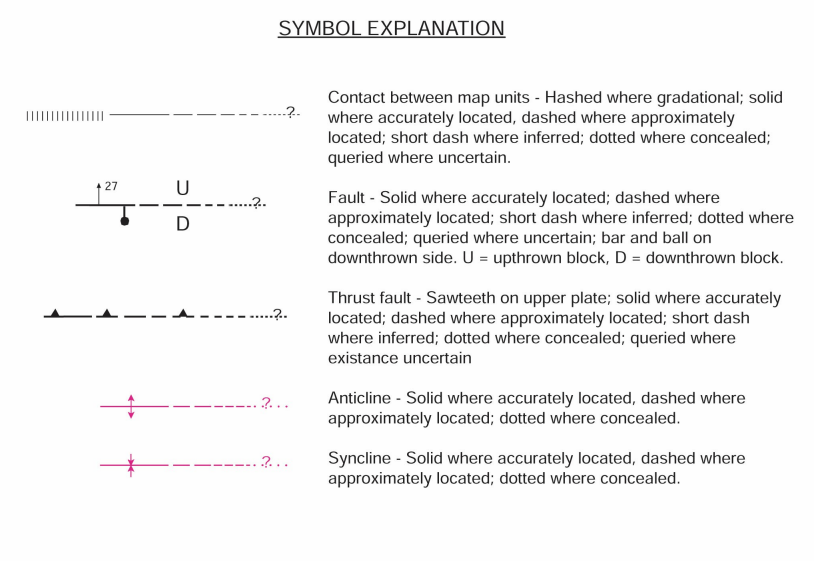
Abbreviated Unit Explanation

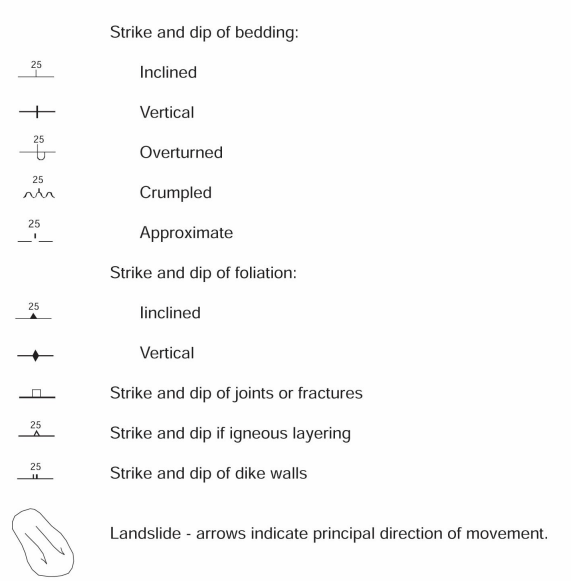




Graphic from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Map Legend





Graphic from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Map Pamphlet

A embedded copy of the Preliminary Geologic Map of the Onshore Portions of the Crescent City and Orick 30' x 60' Quadrangles, California map pamphlet is available as a separate Acrobat document (Crescent_City-Orick_100k_v1-0_pamphlet.pdf). (double-click link to open pamphlet).

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_____1983a, Geology and Geomorphic Features Related to Landsliding, Hiouchi 7.5' Quadrangle, Del Norte County, California: California Division of Mines and Geology, Open-File Report 83-04 S.F., Scale 1:24,000

_____1983b, Geology and Geomorphic Features Related to Landsliding, High Divide 7.5' Quadrangle, Del Norte County, California: California Division of Mines and Geology, Open-File Report 83-18 S.F., Scale 1:24,000.

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References from source map: Crescent City and Orick 30' x 60' Quadrangle (Portions of)

Redwood Creek Watershed (Geology)

The formal citation for this source.

> Dell'Osso, D.R., Falls, J.N., and McGuire, D.J., 2002, Maps, GIS Data and Geologic Report for the Watershed Mapping Series, Map Set 6, Redwood Creek Watershed, Humboldt County, California: California Geological Survey, CD 2002-10, scale 1:100,000 (*GRI Source Map ID 74843*).

See the GRI Digital Maps and Source Map Citations of this document for how the above source map was used in the completion of the GRI digital geohazards-GIS map, as well as for additional information pertaining to this source.

The source map and database are available from the web at: https://www.conservation.ca.gov/cgs/Pages/Program-FWGP/redwood.aspx

Prominent graphics and text associated with this source.

Map Symbols



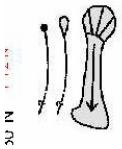
ROCK SLIDE (ROTATIONAL / TRANSLATIONAL LANDSLIDE): Slope movement with bedrock as its primary source material. This class of failure includes rotational and translational landslides; relatively cohesive slide masses with failure planes that are deep-seated in comparison to those debris slides of similar areal extent. The slide plane is curved in a rotational slide. Movement along a planar joint or bedding surface may be referred to as translational. Complex versions with combinations of rotational heads and translational movement or earthflows downslope are common. indicates a scarp; arrows show direction of movement; queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.



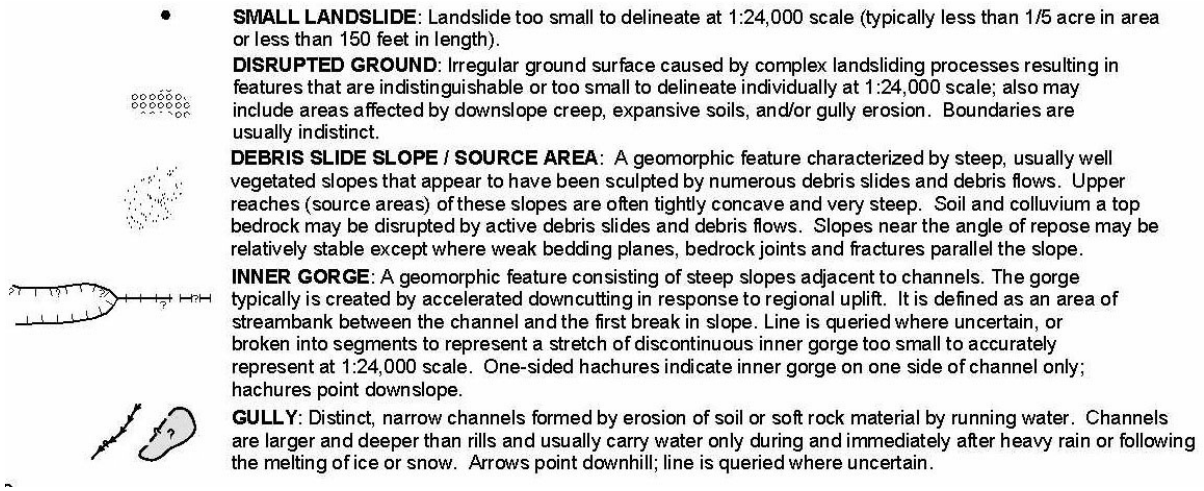
EARTHFLOW: Slow to rapid movement of mostly fine-grained soil with some rocky debris in a semi-viscous, highly plastic state. After initial failure, the mass may flow or creep seasonally in response to changes in groundwater level. These types of slope failures often include complexes of nested rotational slides and deeply incised gullies; boundaries are usually indistinct. indicates a scarp; arrow indicates direction of movement. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.



DEBRIS SLIDE: Mass of unconsolidated rock, colluvium, and coarse-grained soil that has moved slowly to rapidly downslope along a relatively steep, shallow, translational failure plane. Debris slides form steep, unvegetated scars in the head region and possibly irregular, hummocky deposits in the toe region. Scars commonly ravel and remain unvegetated for several seasons depending on slope aspect. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.



DEBRIS FLOW / TORRENT TRACK: Long stretches of bare ground that have been scoured and eroded to bedrock by extremely rapid movement of water-laden debris. Debris flows are commonly triggered by debris sliding in the source area during high intensity rains. Debris is often deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reworked and incorporated into subsequent events; lack of vegetation indicates recent activity. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.



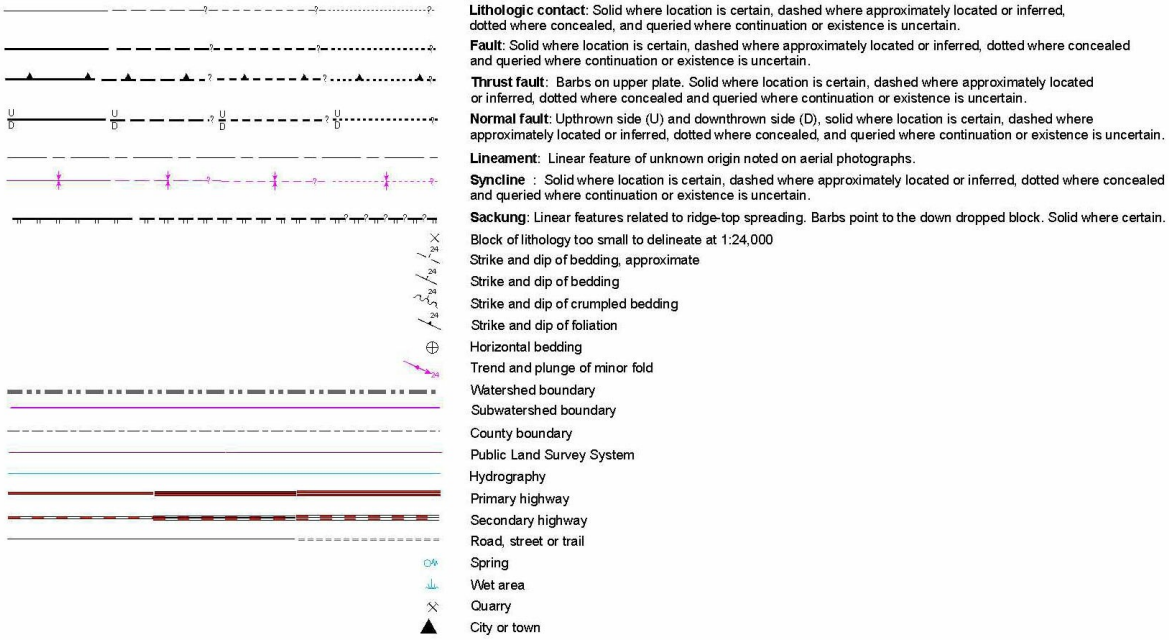
SMALL LANDSLIDE: Landslide too small to delineate at 1:24,000 scale (typically less than 1/5 acre in area or less than 150 feet in length).

DISRUPTED GROUND: Irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at 1:24,000 scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion. Boundaries are usually indistinct.

DEBRIS SLIDE SLOPE / SOURCE AREA: A geomorphic feature characterized by steep, usually well vegetated slopes that appear to have been sculpted by numerous debris slides and debris flows. Upper reaches (source areas) of these slopes are often tightly concave and very steep. Soil and colluvium a top bedrock may be disrupted by active debris slides and debris flows. Slopes near the angle of repose may be relatively stable except where weak bedding planes, bedrock joints and fractures parallel the slope.

INNER GORGE: A geomorphic feature consisting of steep slopes adjacent to channels. The gorge typically is created by accelerated downcutting in response to regional uplift. It is defined as an area of streambank between the channel and the first break in slope. Line is queried where uncertain, or broken into segments to represent a stretch of discontinuous inner gorge too small to accurately represent at 1:24,000 scale. One-sided hachures indicate inner gorge on one side of channel only; hachures point downslope.

GULLY: Distinct, narrow channels formed by erosion of soil or soft rock material by running water. Channels are larger and deeper than rills and usually carry water only during and immediately after heavy rain or following the melting of ice or snow. Arrows point downhill; line is queried where uncertain.



Lithologic contact: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Fault: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed and queried where continuation or existence is uncertain.

Thrust fault: Barbs on upper plate. Solid where location is certain, dashed where approximately located or inferred, dotted where concealed and queried where continuation or existence is uncertain.

Normal fault: Upthrown side (U) and downthrown side (D), solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Lineament: Linear feature of unknown origin noted on aerial photographs.

Syncline : Solid where location is certain, dashed where approximately located or inferred, dotted where concealed and queried where continuation or existence is uncertain.

Sackung: Linear features related to ridge-top spreading. Barbs point to the down dropped block. Solid where certain.

Block of lithology too small to delineate at 1:24,000

Strike and dip of bedding, approximate

Strike and dip of bedding

Strike and dip of crumpled bedding

Strike and dip of foliation

Horizontal bedding

Trend and plunge of minor fold

Watershed boundary

Subwatershed boundary

County boundary

Public Land Survey System

Hydrography

Primary highway

Secondary highway

Road, street or trail

Spring

Wet area

Quarry

City or town

Graphics from source map: Redwood Creek Watershed (Geology)

Geologic Notes

The Redwood Creek watershed lies within the Coast Range geomorphic province in northwest California The area is mountainous with elevations ranging from sea level in the coastal area of the watershed to approximately 5,200 feel at Board Camp Mountain at the southeastern headwaters of Redwood Creek. Tree cover in the watershed is primarily heavy coniferous forest Smaller portions of the watershed are open oak-madrone woodland and grasslands Road cuts and stream channels provide the majority of bedrock exposures within the watershed. Precipitation in the watershed is strongly influenced by the topography and ranges from approximately 60 to 110 inches annually.

The Redwood Creek watershed is a southeast trending drainage covering approximately 282 square

miles It is approximately 6 miles across and 56 miles long The drainage basin is principally underlain by Late Jurassic to Middle Cretaceous sedimentary and metamorphic rocks of the Central and Eastern Belts of the Franciscan Complex The Franciscan rocks are overlain by Pleistocene-Pliocene sediments of the Prairie Creek Formation in the northern reach of the watershed Jurassic age Klamath Terrane rocks form the structurally highest bedrock in the eastern portion of the basin The bedrock is overlain locally by a variety of marine and river terrace deposits, estuarine deposits and alluvium related to modem channel deposits, landslides and beach sands. Several levels of alluvium and terrace deposits present in parts of the watershed indicate that much of this watershed has been uplifted recently in geologic time Landslide features are widespread in the wwatershed. The dominant form of mass wasting varies depending on the composition of the underlying rock

This map was compiled from numerous sources including published maps and reports, unpublished mapping by the California Division of Mines and Geology, United States Geological Survey, United States Forest Service and Redwood National Park Geologic features were compiled from the previous work of Harden et al., 1982, Kilbourne, 1985, Kelsey and Cashman, 1983, unpublished mapping by Kelsey and others, stereoscopic evaluation of aerial photos, and limited geologic and geomorphic reconnaissance mapping. Aerial photograph interpretation and compilation of existing data represent the primary information sources for this product.

Nine sets of stereographic aerial photographs (see Important Notes #2) were evaluated to map geomorphic features related to landsliding throughout the watershed. All photos were black and white, with scales ranging from 1:12,000 to 1: 36,000. Geomorphic features were compiled on plastic overlays and transferred to topographic digital orthophoto quadrangle maps Limited field assessment was completed on the landslide features mapped The information was then incorporated into a Geographic Information System (GIS), with associated data attributes compiled into a spatial database with metadata.

Text from source map: Redwood Creek Watershed (Geology)

Important Notes

1) The scale of this map limits the delineation of some features, and the map should not be substituted for site-specific studies. Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the California Public Resources Code.

2) Landslides and geomorphic features were mapped from historical aerial photographs (see References) as follows: Plate 1, Map Sheet 1 1948, 1954, 1962, 1965, 1977, 1984, 1988, 1996, 2000: Map Sheet 21948, 1962, 1965, 1984, 1988, 2000, Map Sheet 3 1948,1984, 1996, 2000 Map Sheet 3 also included the 1962, 1965 and 1988 aerial photos north of the Grouse Mountain and Maple Creek quadrangles field verification of landslide and geomorphic features was very limited and mapping relied primarily on interpretation of aerial photographs.

3) The bedrock geology depicted on this map was modified from 1:24,000 and 1:62,500-scale non-digital source data (see Index to Geologic and Geomorphic Mapping References and References). Although the geologic information has been represented on this map at a scale of 1:24,000, the detail and accuracy of the bedrock and structural data are limited by the spatial resolution of the original maps.

4) Landslides shown on this map have been divided into groups based on the clarity of their morphology and inferred type of movement. The landslides are also classified according to the confidence of their existence as determined by analysis of aerial photographs The various landslide designations are not intended to, nor should they be interpreted to imply, the actual stability of slopes

involved See Plate 2 for relative landslide potential of the study area

5) Historical mapping by CGS (Kilbourne, 1985: DMG, 1999) was evaluated and incorporated using current interpretive protocols for identifying and classifying geomorphic features and/or landslides. Historical mapping added directly to the Redwood Creek watershed database is referenced in that electronic database with an appropriate citation (see References)

6) Stream-channel deposits were mapped based on Digital Orthophoto Quadrangles (DOQ's) However, the location of the main stem channel locally differs between the DOQ's and current USGS t opographic maps (the DRG image files) Therefore, the map of stream-channel deposits and the lower portions of landslide features does not always fit current USGS topographic maps in some reaches of Redwood Creek

7) Digital data shown on this map, as well as additional landslide and fluvial geomorphology data, are available from the following sources on the CGS website at http://conservation.ca.gov//cgs/Pages/Index.aspx on compact disc from CGS (CD-ROM 2002-10): or on the North Coast Watershed Assessment Program website at www.ncwatershed.ca.gov (now http://coastalwatersheds.ca.gov/ although digital data available from CGS web site)

8) Further study limitations may be found in the text of the accompanying report.

Text from source map: Redwood Creek Watershed (Geology)

Aerial Photographs by Year

Aero Services Corporation: 1947/1948, Black and white aerial photos, Flight CDF-2, night line 14, frames 144-155: night line 15, frames45-61, flight line 16: frames 56-57,148-165, night line 17, frames 107-135, 200-212: flight line 18, frames 72-90, 161-180, flight line 19, frames 124-144, 180-197: flight line 20, frames 1-9, 46-52, 133-142,160-168: flight line 33, frames 86-97, 109-109, 115-138, 146, scale 1:26,400

California Department of Forestry: 1954, Black and white aerial photos, Flight CVL, flight line 14N, frames 50-65, 73-88, 146-158, scale 1:20,000

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Text from source map: Redwood Creek Watershed (Geology)

Landslide Potential

Layer contains five categories indicating relative potential for landsliding. The relative landslide potential data is derivative, based on the following: 1) the occurrence and distribution of landslides, and other types of slope failure and features indicating slope instability; 2) the geology of the area, including bedrock types and lithologic properties relative to slope stability and distribution of various earth materials, as well as the structural framework, such as the folded and faulted strata found throughout the region; and 3) the relative behavior of slopes within the area as interpreted from analysis of historic aerial photographs and recent field observations. The relative landslide potential categories are compiled in a Geographic Information System (GIS) using the geologic and geomorphic information presented on this map. The GIS was used to ensure that, where appropriate, landslide potential categories were applied consistently (for example, areas underlain by geologic unit QTpc, with gentle slopes and no mapped landslide deposits are consistently categorized as low landslide potential). Through this process, consistency in categories was maintained while at the same time specific conditions were identified and categorized.

1) Very Low Landslide Potential - Landslides and other features related to slope instability are very rare to non-existent within this area. This area includes relatively flat marine terraces, lower stream valleys, and the broader portions of flat-topped ridges within the moderate and hard terrains.

2) Low Landslide Potential - Gentle to moderately steep slopes underlain by relatively competent material that is considered unlikely to mobilize under natural conditions. Landsliding in these areas is not common. Areas generally include the narrower flat-topped ridges and gentler side slopes in the hard and moderate terrains, gentler slopes and broad ridgetops within the soft terrain, and Quaternary units with gentler slopes.

3) Moderate Landslide Potential - Moderate to moderately steep, relatively uniform slopes that are generally underlain by competent bedrock, may also include older dormant landslides. Some slopes within this area may be at or near their stability limits due to weaker materials, steeper slopes, or a combination of these factors. This area includes portions of dormant landslides with gentler slopes, flat-topped ridges within the soft terrain, many slopes in the moderate and hard terrains, and debris slide/flow source areas with moderate slope.

4) High Landslide Potential - Moderately steep to steep slopes that include many dormant landslides in upslope areas and slopes upon which there is substantial evidence of downslope creep of surface materials. This area includes many of the larger dormant rockslides and dormant old/mature earthflows, moderately steep to steep debris slide slopes, disrupted ground, moderate to moderately steep slopes in the soft terrain, steeper slopes within the moderate terrain, and historically active debris torrent tracks.

5) Very High Landslide Potential - Areas include historically active landslides (< 150 years old), inner gorges and gullies, as well as debris slide/flow source areas within, and soft terrain on, steep to very steep slopes. Dormant-young rockslides with very steep slopes and dormant-young earthflows with moderately steep to very steep slopes are also included.

Text from source map: Redwood Creek Watershed (Geology)

Report

The Redwood Creek Watershed geology report is available as a separate embedded Acrobat document (Redwood Creek Watershed Report). (double-click link to open report).

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