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National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Redwood National and State Parks

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Redwood National and State Parks

redw_geology.pdf

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Geologic Resources Inventory Map Document for Redwood National and State Parks

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Geologic Resources Inventory Map Document

Redwood National and State Parks, California

Document to Accompany Digital Geologic-GIS Data

redw_geology.pdf

Version: 9/30/2013

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

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

For information about the status of GRI digital geologic-GIS data for a park contact:

Tim Connors
Geologist/GRI Mapping Contact
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 969-2093
fax: (303) 987-6792
email: Tim_Connors@nps.gov

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

Stephanie O'Meara
Geologist/GIS Specialist/Data Manager
Colorado State University Research Associate, Cooperator to the National Park Service
1201 Oak Ridge Drive, Suite 200
Fort Collins, CO 80525
phone: (970) 491-6655
fax: (970) 225-3597
e-mail: stephanie.omeara@colostate.edu

About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

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 Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

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: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. 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: http://www.nature.nps.gov/geology/inventory, or contact:

Bruce Heise
Inventory Coordinator
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 969-2017
fax: (303) 987-6792
email: Bruce_Heise@nps.gov

The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Redwood National and State Parks, California (REDW):

Digital Geologic Map of Redwood National and State Parks and Vicinity, California (*GRI MapCode REDW*)

Source map and digital data,

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

Digital Geohazards Map of Redwood National and State Parks and Vicinity, California (*GRI MapCode REDW_geohazards*)

Source map and digital data,

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 1:10000 scale (Redwood Creek Watershed). (*GRI Source Map ID74843*).

GIS data converted from source GIS database with some geologic features captured from the source map by the GRI. Source data included geology and landslide data. Geomorphic and fluvial features were not used

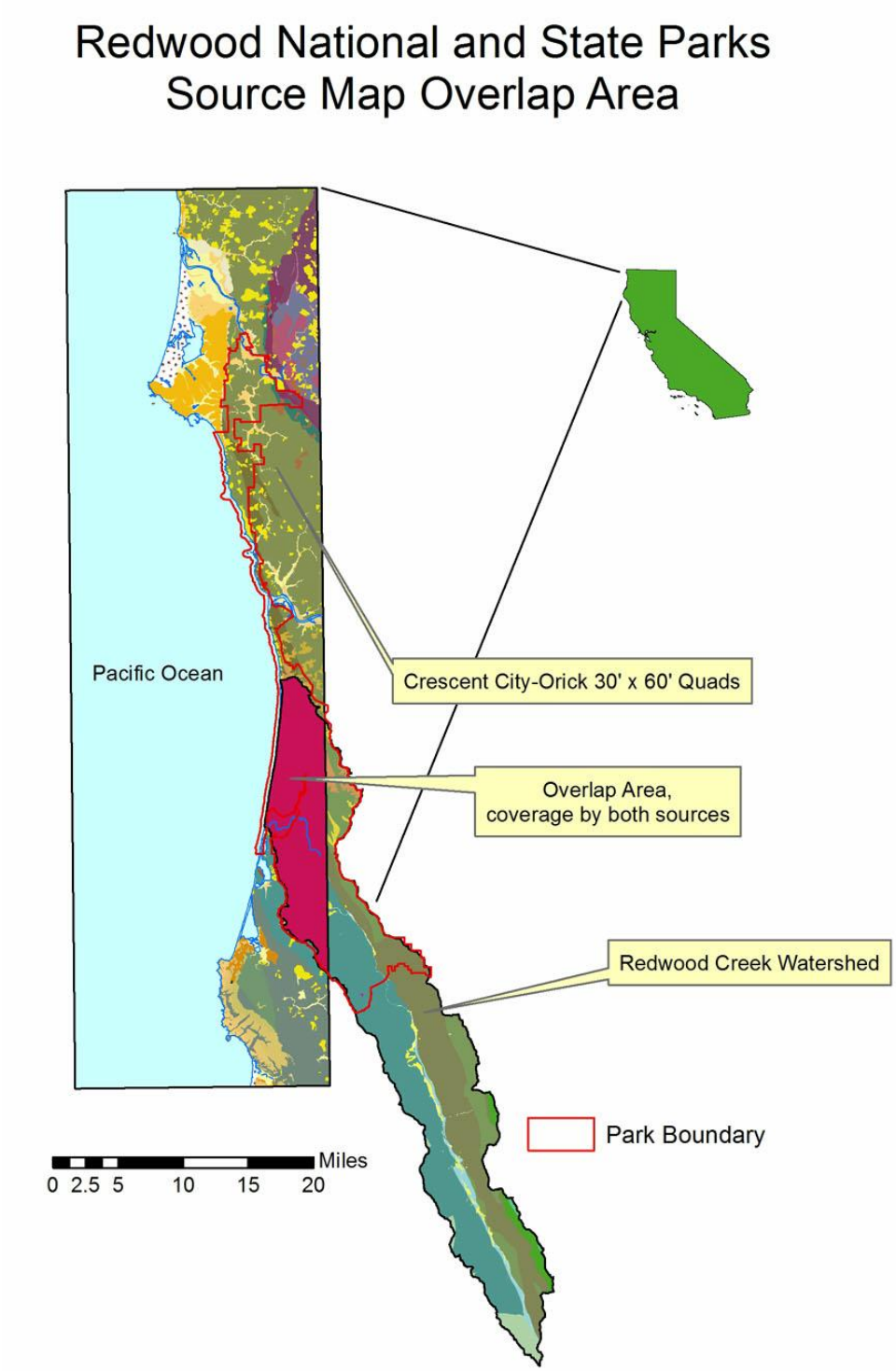
Redwood Creek Watershed landslide potential data is included in the GRI digital geohazards-GIS data. Additional information is available in the Redwood Creek Watershed section of this document. Additional landslide information for geohazard features is also included in the Landslide Information (REDWLSI)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

Features (from the above 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 (*GRI MapCode REDW*), and were not transferred to the GRI digital geohazards-GIS map (*GRI MapCode REDW_geohazards*) as the map extents between the two source maps differ, and the landslide direction lines are associated with landslide deposits (Qls) units present in the Geologic Units (REDWGLG) data layer.

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 both GRI digital geology-GIS maps.

Source Index Map



Created from National Park Service and California Geological Survey data.

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Redwood National and State Parks, California (REDW) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qbs - Beach deposits). 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 geology-GIS data.

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
    Qsc4 - Stream channel deposit, 50 to 100 years
Qds - Dune sand
Qha - Young alluvial deposits, undifferentiated
    Note: In the overlap area Qha is comprised of Redwood Creek Watershed units Qsc3, Qscl, and Qal.
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

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 Hardin and others (1982), coherent unit of Lacks Creek
KJfc - Franciscan units of Hardin and others (1982), incoherent unit of Coyote Creek
KJfg - Franciscan units of Hardin and others (1982), transitional rocks of the Grogan Fault Zone
KJfrc - Franciscan units of Hardin and others (1982), Redwood Creek schist
- KJfrcmv - Franciscan units of Hardin and others (1982), Redwood Creek schist, metatuff
- KJfrcsp - Franciscan units of Hardin and others (1982), Redwood Creek schist, serpentine

KJfpp - Franciscan units of Hardin 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. Additional descriptions of Redwood Creek geologic units can be found in the Redwood Creek Watershed geologic report.

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

Qhc - Stream channel deposit, younger (latest Holocene)

Fluvial deposits within active stream channels composed of loose sand, silt and gravel. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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

Same as Qscu except, deposited during flood stage return periods of 5 to 20 years. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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

Same as Qscu except, deposited during flood stage return periods of 50 to 100 years. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

Qha - Young alluvial deposits, undifferentiated (Holocene)

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

Note: In the overlap area Qha is comprised of Redwood Creek Watershed units Qsc3, Qscl, and Qal.

Qsc3 - Stream channel deposits (Holocene)
Same as Qscu except, deposited during flood stage return periods of 20 to 50 years. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

Qscl - Stream channel deposits (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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

Qe - Estuarine deposits (Holocene)

Qe - Estuarine deposits (Holocene)
Unconsolidated clay, silt, and fine sand deposited in estuary and tidal flat settings near the coast. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

Qe - Estuarine deposits (Holocene-Pleistocene)
Undifferentiated and unconsolidated day, silt and fine sand. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

Ql - Lacustrine deposits (Holocene and Pleistocene)

Undifferentiated and unconsolidated lake deposits of clay, silt and fine sand. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

Qmt, 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): (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

Qmt - Marine terrace deposits (Pleistocene)
Sand and gravel deposited in a shallow marine setting on gently-inclined uplifted wave-cut benches. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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.(*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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.(*GRI Source Map ID 74843)* (Redwood Creek Watershed).

KJfm - Franciscan Complex, Central Belt, mélange 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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit gs) - Large enough to be shown at map scale. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

KJfsc - Franciscan Complex, Central Belt, Sandstone and Mélange 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.(*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

KJfmc - Franciscan Complex, Eastern Belt, mélange 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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit gs) - Individual blocks large enough to be shown at this map scale. Greenstone; mostly agglomerate, felsic tuff, and pillow basalt. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit ch) - Individual blocks large enough to be shown at this map scale. Red and green, thin bedded, radiolarian chert. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit mg) - Individual blocks large enough to be shown at this map scale. Metagraywacke. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit 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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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

(source unit sp) - Serpentine and serpentinized ultramafic rocks. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

KJfl - Franciscan units of Hardin 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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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). (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

KJfc - Franciscan units of Hardin 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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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.. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

KJfg - Franciscan units of Hardin 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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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.(*GRI Source Map ID 74843)* (Redwood Creek Watershed).

KJfrc - Franciscan units of Hardin 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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

KJfrcmv - Franciscan units of Hardin 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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads)

KJfrcv - Metatuff (Cretaceous-Jurassic)
Moderately metamorphosed tuff beds interbedded in the Redwood Creek Schist. (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

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

(source unit sp) - Blocks of serpentinite within Redwood Creek Schist. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

KJfpp - Franciscan units of Hardin 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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

Predominantly medium- to coarse-grained layered and foliated harzburgite tectinite, with subordinate dunite, lehrzolite, and orthopyroxinite. Generally greater than 50% serpentinized; sheared and serpentinized near faults. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

Fault bounded zones of highly sheared serpentinite. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

Jspm - Josephine ophiolite of Harper (1980), serpentinite matrix mélange (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). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit ms) - Mélange blocks of metasedimentary rocks within Serpentinite matrix mélange. (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit gs) - Greenstone Mélange blocks of metasedimentary rocks within Serpentinite matrix mélange.
(*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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

(source unit gr) - Granitic rock mélange blocks within serpentinite matrix mélange (Jspm). (*GRI Source Map ID 75672)* (Crescent City-Orick Quads).

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, 1995). (*GRI Source Map ID 74843)* (Redwood Creek Watershed).

GRI Source Map Information

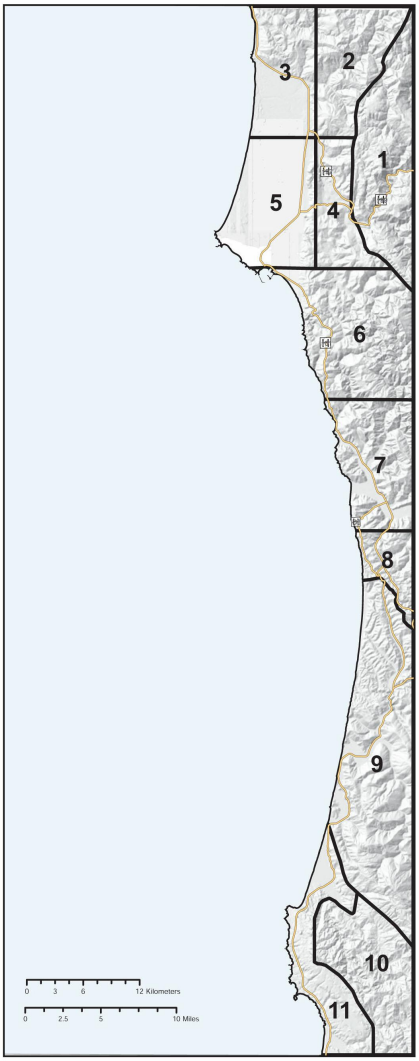
Crescent City and Orick 30' x 60' Quads

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

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

Crescent City-Orick 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.

Extracted from: (Crescent City-Orick Quads).

Crescent City-Orick Correlation of Units

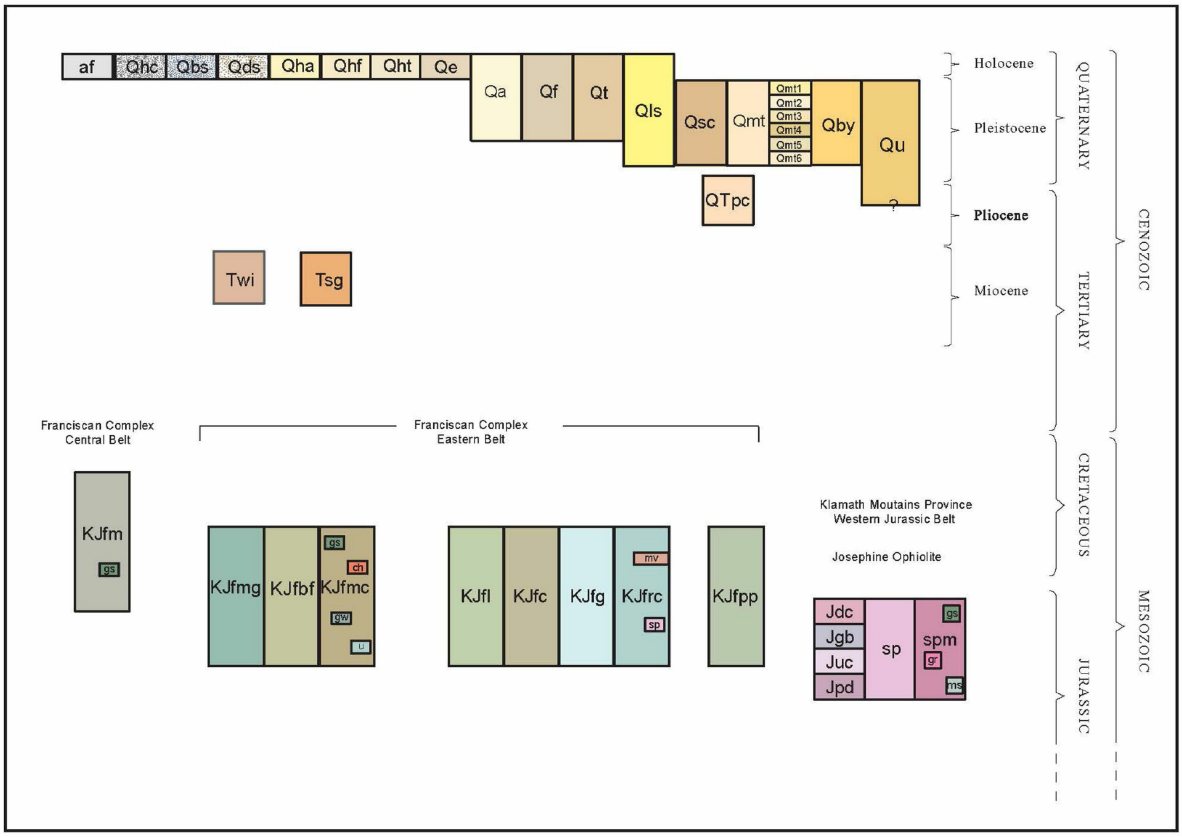


Figure 2. Correlation of map units for the Crescent City and Orick 30' x 60' quadrangles.

Extracted from: (Crescent City-Orick Quads).

Crescent City-Orick Unit Explanation

ABBREVIATED EXPLANATION

(Approximate stratigraphic relationships only; see pamphlet for more detailed information)

CENOZOIC	QUATERNARY	Holocene	af	Artificial fill (historical)
			Qhc	Stream channel deposits (latest Holocene)
			Qbs	Beach deposits (latest Holocene)
			Qha	Young alluvial deposits, undifferentiated (Holocene)
			Qhf	Young alluvial fan deposits (Holocene)
			Qht	Young stream terrace deposits (Holocene)
			Qds	Dune sand (Holocene)
			Qe	Estuarine deposits (Holocene)
		Pleistocene	Qls	Landslide deposits (historical to Pleistocene)
			Qa	Alluvial deposits, undifferentiated (Holocene to latest Pleistocene)
			Qf	Alluvial fan deposits (Holocene to Pleistocene)
			Qt	Stream terrace deposits (early Holocene to Pleistocene)
			Qby	Battery Formation (late Pleistocene)
			Qmt	Marine terrace deposits (Pleistocene)
				Trinidad marine terraces; names and approximate ages (ka=1000 years) from Woodward-Clyde Consultants (1980), and Carver (1992):
			Qmt_1	Patricks Pt. terrace, age 64 ka
			Qmt_2	Savage Creek terrace, age 83 ka, and McKinleyville terrace, age 96 ka
			Qmt_3	Westhaven terrace, 103 ka
			Qmt_4	Fox Farm terrace, 120 ka, and Sky Horse terrace, 130 ka
			Qmt_5	A-Line terrace, 176 ka and older
			Qmt_6	Maple Stump terrace, 200+ ka
			Qsc	Terrace gravels of Surpur Creek (Pleistocene)
			Qu	Undifferentiated marine and nonmarine overlap deposits (Pleistocene to late Pliocene?)
	TERTIARY	Pliocene	QTpc	Prairie Creek Formation (early Pleistocene to late Pliocene)
		Miocene	Twi	Wimer Formation (late Miocene)
			Tsg	St. George Formation (late Miocene)

MESOZOIC

CRETACEOUS

Franciscan Complex - Central Belt

- KJfm — Mélange of the Central Belt (Late Cretaceous to Late Jurassic)
  - gs — Greenstone block within mélange

Franciscan Complex - Eastern Belt

- KJfbf — Broken formation (Early Cretaceous to Middle Jurassic)
- KJfmc — Mélange unit of Crescent City area (Early Cretaceous to Middle Jurassic)
  - Blocks within mélange:
  - gs — Greenstone
  - ch — Chert
  - mg — Metagraywacke
  - u — Undifferentiated
- KJfmg — Metagraywacke (Cretaceous to Jurassic)

Redwood Creek watershed units of Hardin and others (1982)

- KJfl — Coherent unit of Lacks Creek (Cretaceous to Jurassic)
- KJfc — Incoherent unit of Coyote Creek (Cretaceous to Jurassic)
- KJfg — Transitional rocks of the Grogan Fault Zone (Cretaceous to Jurassic)
- KJfrc — Redwood Creek Schist (Early Cretaceous to Late Jurassic)
  - mv — Interbedded metatuff
  - sp — Serpentinite block
- KJfpp — Patricks Point unit of Aalto and others, 1981 (Cretaceous to Jurassic)

JURASSIC

Klamath Mountains Province - Western Jurassic Belt

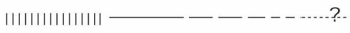
Josephine Ophiolite of Harper (1980)

- Jdc — Dike Complex (Late Jurassic)
- Jgb — Gabbro (Late Jurassic)
- Jpd — Peridotite (Late Jurassic)
- Juc — Cumulate ultramafic rocks (Late Jurassic)
- sp — Sheared serpentinite (Jurassic)
- spm — Serpentinite matrix mélange (Jurassic)
  - Blocks within mélange:
  - gs — Greenstone
  - gr — Granitic rocks
  - ms — Metasedimentary rocks

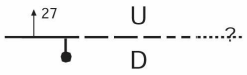
Extracted from: (Crescent City-Orick Quads).

Crescent City-Orick Map Legend

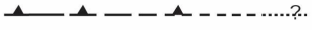
SYMBOL EXPLANATION



Contact between map units - Hashed where gradational; solid where accurately located, dashed where approximately located; short dash where inferred; dotted where concealed; queried where uncertain.



Fault - Solid where accurately located; dashed where approximately located; short dash where inferred; dotted where concealed; queried where uncertain; bar and ball on downthrown side. U = upthrown block, D = downthrown block.



Thrust fault - Sawteeth on upper plate; solid where accurately located; dashed where approximately located; short dash where inferred; dotted where concealed; queried where existance uncertain

Anticline - Solid where accurately located, dashed where approximately located; dotted where concealed.

Syncline - Solid where accurately located, dashed where approximately located; dotted where concealed.

Strike and dip of bedding:

Inclined

Vertical

Overturned

Crumpled

Approximate

Strike and dip of foliation:

Iinclined

Vertical

Strike and dip of joints or fractures

Strike and dip if igneous layering

Strike and dip of dike walls

Landslide - arrows indicate principal direction of movement.

Extracted from: (Crescent City-Orick Quads).

Crescent City-Orick Pamphlet

A copy of the Crescent City-Orick Quadrangle pamphlet is available as a separate PDF (Pamphlet). (Double-click link to open pamphlet).

Extracted from: (Crescent City-Orick Quads).

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Extracted from: (Crescent City-Orick Quads).

Redwood Creek Watershed

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 1:10000 scale. (*GRI Source Map ID74843*).

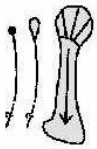
The source map and database are available from the web at: http://conservation.ca.gov//cgs/fwgp/Pages/redwood.aspx

Redwood Creek Watershed 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.

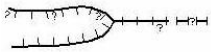


DEBRIS FLOW / TORRENT TRACK: Long stretches of bare ground that have been scoured and eroded to bedrock by extremely rapid movement of water-laden debris. Debris flows are commonly triggered by debris sliding in the source area during high intensity rains. Debris is often deposited downslope as a tangled 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).

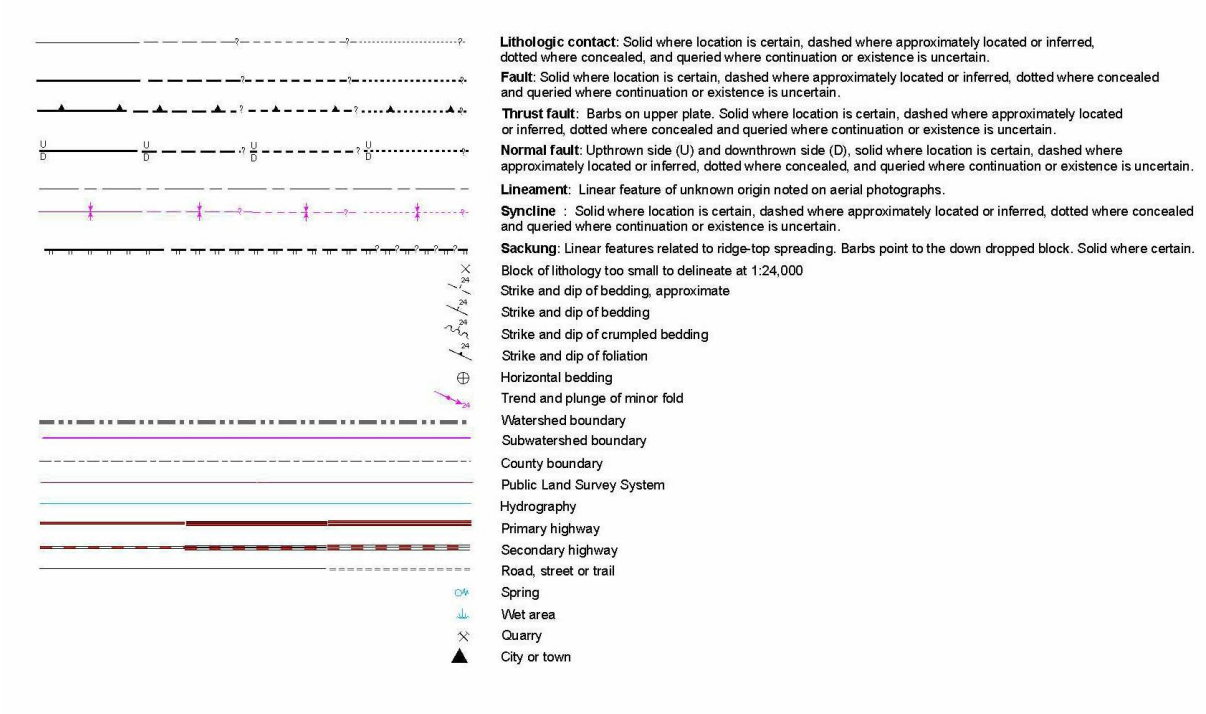
DISRUPTED GROUND: Irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at 1:24,000 scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion. Boundaries are usually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



Extracted from: (Redwood Creek Watershed).

Redwood Creek Watershed 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 southeastem 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 uplilted 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 w ork 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.

Extracted from: (Redwood Creek Watershed).

Redwood Creek Watershed 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 Sheet21948, 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 interpre tation 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 topographic 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.

Extracted from: (Redwood Creek Watershed).

Redwood Creek Watershed 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

Humboldt County Assessor: 1962/1963, Black and white aerial photos, Flight HCN, night line 14B, frames 73-85, flight line 15B, frames 30-52: flight line 16B, frames 63-95, night line 17B, frames 57-58: flight line 18B, frames 23-55: flight line 19A, frames 56-87: flight line 19B, frames 1-9: night line 20, frames 54-90: flight line 21, frames 59-77, flight line 22, frames 50-65: flight line 23A, frames 45-46, flight line 23B, frames 1-18: night line 24, frames 40-57: flight line 25, frames 38-57, flight line 26, frames 29-54: flight line 27, frames 27-56, flight line 28B, frames 5-24: night line RE28B, frames 3-11, flight line 29B, frames 6-38: night line 30, frames 24-55: flight line 31, frames 20-46: flight line 32, frames 18-36: night line 33, frames 15-35, flight line 34, frames 14-28: flight line 35, frames 14-26: flight line 36, frames 21-25: scale 1:12,000

Cartwright Aerial Surveys Incorporated: 1965, Black and white aerial photos, Flight CVL, flight line 3FF, frames 124-138: flight line 5FF, frames 20-29: flight line 13FF, frames 110-113, 141-156: flight line 19FF, frames 18-22, 90-102: flight line 20FF, frames 67-82, 118-136: night line 22FF, frames 88-105, 158-179: flight line 23FF, frames 130-142: night line 24FF, frames 22-47,115-129: scale 1:20,000

Redwood National Park: 1977, Black and white aerial photos, Flight RNP, flight line 21, frames 106-140, 145-148: scale 1:36,000

WAC Corporation, 1984: Black and white aerial photos, Flight 84C, flight line 24, frames 27-38, 121-132: flight line 25, frames 9-11, night line 32, frames 95 100, scale 1:18,500

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Extracted from: (Redwood Creek Watershed).

Redwood Creek Watershed 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.

Extracted from: (Redwood Creek Watershed).

Redwood Creek Watershed Report

The Redwood Creek Watershed geology report is available as a separate PDF (Redwood Creek Watershed Report). (Double-click link to open report).

Extracted from: (Redwood Creek Watershed).

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Extracted from the Geologic Map: (Redwood Creek Watershed).

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