Preliminary geologic map emphasizing bedrock formations in Contra Costa County, California: A digital database

Compiled by R.W Graymer, D.L. Jones, and E.E. Brabb

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Geological Explanation

This map represents an integration of the published and unpublished geologic maps of several previous workers (see Sources of Data in ccsource.txt) and more than 1000 man hours of new geologic mapping and field checking by us. The data are released in a preliminary digital form to provide an opportunity for staff from governmental agencies, consultants, teachers, and other users to have this geologic map long before the final map is published.

Stratigraphy

Bedrock formations in Contra Costa County are divided into six Assemblages with a unique stratigraphic sequence bounded by faults. The distinction may be either the presence of rock types not present in other Assemblages (e.g.. the diatomite (Tdi) in Assemblage III) or a different stratigraphic relationship among similar rock units (e.g.. The Domingene Formation (Td) is depositional on Cretaceous rocks in Assemblage V, but is underlain by other Tertiary rocks (Tm, Tmz) in Assemblage VI). The stratigraphic differences between Assemblages are almost certainly due to angular unconformities and changes in depositional environment in one or more large depositional basins. The significant differences in the stratigraphy of different Assemblages, originally separated but now in close proximity, denotes the juxtaposition of different basins or parts of basins by large offsets along the faults that bound them (as much as hundreds of kilometers, see below).

The Great Valley Sequence is depositionally linked to the Coast Range Ophiolite. Although the contact between the two is a fault everywhere in Contra Costa County, elsewhere in California (as close as Alameda County) the lowest part of the Great Valley Sequence (the Knoxville Formation) is clearly deposited on the ophiolite.

The Franciscan Complex presumably underlies all of Contra Costa County. It was emplaced below the Coast Range Ophiolite by accretionary faulting during Cretaceous time, so the contact between the Franciscan and Coast Range Ophiolite and the overlying Great Valley Sequence is everywhere faulted. This fault is known as the Coast Range fault.

Two types of Tertiary intrusive rocks occur in Contra Costa County, both of which intrude the strata of Assemblage V. In the Concord area, the Markley Formation is intruded by plugs and dikes of Pliocene basalt. East of Mount Diablo, the Great Valley Sequence rocks are intruded by fine grained, quartz bearing rhyolite stocks, dikes, and sills of late Miocene age. The relationship of these hypabyssal intrusives is unknown. Although they occur only in the rocks of Assemblage V, these rocks are not included in the Assemblage because of their intrusive nature.

Paleontology

There are at least hundreds and perhaps thousands of fossil collections from Contra Costa County described in the literature during the past century, and even more unpublished collections made by geologists working for petroleum companies. A partial list of references is provided by White (1990). Preparation of a digital database of this information is under way by scientists at the U.S. Geological Survey and the University of California, Berkeley.

Radiometric Ages

A compilation of the radiometric ages of rocks in Contra Costa and other counties south of latitude 38 degrees is provided by Lindquist and Morganthaler (1991). Additional data are provided by

Brabb and Hanna (1981), Wright (1974), Sarna-Wojcicki (1976, and written communication, 1990), Sarna-Wojcicki and others (1979), and Curtis (1989).

Structure

The structure of Contra Costa County is dominated by broadly distributed transpressional faults, with both strike-slip and reverse motions, trending roughly N30-60W. Most of the faults have been active in the Quaternary and some, such as the Hayward and Concord faults, are creeping now (Lienkaemper, 1992, Herd, 1978a, b). The faults form most of the boundaries of the Assemblages. The juxtaposition of rocks with different stratigraphic histories across these faults lends support to the work of Prowell (1974), who suggested 16 to 72 km of strike slip movement along the Calaveras fault south of the area of this map. Other Assemblage bounding faults have probably undergone a similar amount of offset, based on the juxtaposition of rocks originally deposited a large distance from one another (see above). Dip slip movement may also be extensive, judging from truncation of folds and thick geologic units beneath dipping faults.

Reverse and thrust faults in Contra Costa County tend to occur in zones of northeast or southwest vergence. Thrust faults in the Berkeley Hills verge northeast, for example, wheras those on the west flank of Mount Diablo verge southwest. Some thrust faults on the north and south flanks of Mount Diablo have an east-west trend, at least in part. A few Assemblage bounding faults are thrust faults.

The faults on this map are not intended to show hazards at any specific site, or to take the place of fault-rupture hazard zones designated by the California State Geologist (Hart, 1988). Moreover, there is considerable disagreement about the location and character of Quaternary and Holocene faults in Contra Costa County. See, for example, the different depictions of the Hayward fault by Herd (1978b), Radbruch (1969), and Lienkaemper (1992). References to fault studies in Contra Costa County are provided by White (1990).

DESCRIPTION OF UNITS

Surficial deposits (Quaternary). Overlying bedrock of all Assemblages:

Qu Surficial deposits, undivided (Pleistocene and Holocene) -- Formore detailed reports of surficial deposits, see Helley and others (1979), Atwater (1982), Herd (1978 a, b), and Borchardt and Seelig (1991).

Qls Landslide deposits (Pleistocene and Holocene) -- Landslides are intentionally omitted from most of this map because they are so numerous they would conceal much of the information on bedrock geology. Only a few of the large landslide areas are shown. For more comprehensive reports of landslides in the area, see Nilsen and others (1979) and Ellen and Wieczorek (1988). In addition, a list of pertinent literature on landslides in Contra Costa County is provided by White (1990).

Tertiary Intrusive Rocks

Tb Basaltic intrusive rocks (Pliocene) -- Hypabyssal basalt dikes and sills.

Tsv Silicic intrusive rocks (Miocene) -- Rhyolite to andesite porphyry stocks, dikes and sills.

Rocks that presumably underlie the entire area.

KJf Franciscan Complex (Jurassic to Upper Cretaceous) -- Sheared sedimentary and metamorphic rock with zones and blocksof chert (fc), hard graywacke and shale (fss), greenstone (fg), basalt and chert (fbc), melange of metamorphic rocks including glaucophane and other schistose rocks in sheared sandstone and shale matrix (fm), and sandstone (graywacke) (fs);

also includes small bodies of serpentinite, silica carbonate rocks, and silicic volcanic rocks (keratophyre).

Assemblage I - Berkeley Hills

Tbp Bald Peak Basalt (Miocene) -- Massive basalt flows. Ar/Ar ages 8.37+0.2 and 8.46+0.2 Ma (Curtis, 1989).

Tst Siesta Formation (Miocene) -- Non-marine siltstone, claystone, sandstone, and minor limestone.

Tm Moraga Formation (Miocene) -- Basalt and andesite flows, minor rhyolite tuff. Ar/Ar ages range from 9.0+0.3 to 10.2+0.5 Ma (Curtis, 1989). Interflow sedimentary rocks (Tms) mapped locally.

Tor Orinda Formation (Miocene) -- Conglomerate, sandstone, siltstone. Nonmarine with abundant clasts of rocks from the Franciscan Complex.

Tcc Claremont Chert (Miocene) -- Laminated and bedded diatomaceous chert, minor brown shale and white sandstone. Interbedded sandstone (Tccs) mapped locally.

Tgs Unnamed sandstone and siltstone (Eocene, Oligocene, and Miocene) -- Glauconitic sandstone and brown massive siltstone.

Tsh Greenish gray shale (Eocene).

Great Valley sequence (Late Jurassic and Cretaceous) -- Consists of:

Kph Pinehurst Shale (Late Cretaceous) -- Siliceous shale with interbedded sandstone and siltstone. Includes maroon, concretionary shale at base. This formation was originally considered to be Paleocene, but it contains foraminifers and radiolarians of Late Cretaceous age in its type area and throughout its outcrop extent.

Kr Redwood Canyon Formation (Late Cretaceous) -- Massive, distinctly bedded sandstone with minor interbedded siltstone

Ksc Shephard Creek Formation (Late Cretaceous) -- Mainly shale with minor sandstone.

Ko Oakland Conglomerate (Late Cretaceous) -- Conglomerate containing mainly silicic volcanic clasts and massive biotite-rich quartz sandstone.

Kjm Joaquin Miller Formation (Late Cretaceous) -- Shale with minor sandstone.

JKk Knoxville Formation (Late Jurassic to Early Cretaceous) -- Mainly dark, greenish - gray shale with sandstone interbeds; also, locally includes conglomerate and sandstone in its lower part. Locally contains abundant specimens of bivalve fossil Buchia.

Coast Range Ophiolite (Jurassic) -- Consists of:

Jsv Keratophyre. Altered silicic volcanic rocks including keratophyre and quartz keratophyre.

sp Serpentinite. Mainly sheared serpentinite, but also includes massive harzburgite.

Assemblage II - Hercules Area

Qmz Montezuma Formation (Pleistocene) -- Poorly consolidated sand, with minor gravel, silt, and clay.

Mullholland Formation of Ham (1952) (Pliocene) -- Consists of:

Tmlu Upper member; conglomerate, sandstone, and mudstone.

Tmll Lower member; sandstone and mudstone

Tus Unnamed sedimentary and volcanic rocks (Miocene and Pliocene) -- Includes marine and nonmarine conglomerate, sandstone, and siltstone, as well as basalt (Tub) and limestone (Tul) mapped locally.

Tpt Pinole Tuff (Miocene) -- Tuffaceous sandstone containing pumice fragments. Tuff dated by K/Ar about 5.2 Ma (Sarna-Wojcicki, 1976).

Tlt Lafayette Tuff (Miocene) -- K/Ar age of 8.2 + 2.0 Ma (Sarna-Wojcicki, 1976).

Tn Neroly Sandstone (Miocene) -- Blue, volcanic - rich, shallow marine sandstone, with minor shale, siltstone, tuff, and andesitic conglomerate.

Tc Cierbo Sandstone (Miocene) -- Blue, brown, gray, and white marine sandstone, minor conglomerate, tuff, and shale.

Tbr Briones Formation (Miocene) -- Sandstone, siltstone, conglomerate and shell breccia. The Briones Formation in this assemblage contains a tuffaceous layer with a K/Ar age of 14.5+0.4 Ma (Lindquist and Morganthaler, 1991). In the southern part of the assemblage, divided locally into:

Tbg G member of Wagner (1978) -- Massive sandstone, pebble conglomerate, and shell breccia. Locally subdivided into:

Tbgc Conglomerate

Tbgl Limestone

Tbf F member of Wagner (1978) -- Fine -grained feldspathic sandstone and locally prominent brown shale.

Tbe E member of Wagner (1978) -- Medium - grained sandstone with abundant shell breccia beds; lithologically similar to unit Tbg.

Tbd D member of Wagner (1978) -- Massive, medium -grained sandstone with local conglomerate layers.

In the northern part of the assemblage, divided locally into

Tbu Upper sandstone and shale member.

Tbh Hercules Shale Member; gray shale and siltstone.

Tbl Lower sandstone and siltstone member.

Tro Rodeo Shale, Hambre Sandstone, Tice Shale, and Oursan Sandstone, undivided (Miocene)

Tr Rodeo Shale (Miocene) -- Brown siliceous shale with yellow carbonate concretions.

Th Hambre Sandstone (Miocene) -- Massive, medium - grained sandstone, weathers brown.

Tt Tice Shale (Miocene) -- Brown siliceous shale

To Oursan Sandstone (Miocene) -- Greenish gray, medium - grained sandstone with calcareous concretions.

Tcs Claremont Shale (Miocene) -- Brown siliceous shale with yellow carbonate concretions and minor interbedded chert.

Ts Sobrante Sandstone (Miocene) -- Massive white, medium - grained calcareous sandstone.

Tts Tuffaceous sandstone (Oligocene or Miocene?) -- Light - gray tuffaceous sandstone, minor conglomerate and siltstone, marine. May be equivalent to Kirker Tuff in Assemblage VI.

Tsr San Ramon Sandstone (Oligocene and/or Miocene) -- Massive, medium to coarse - grained, fossiliferous, marine sandstone.

Tshc Shale and claystone (Eocene) -- Also contains minor sandstone.

Assemblage III - Pinole Area

Tcgl Conglomerate, sandstone, siltstone (Miocene and Pliocene) -- Contains abundant clasts of Claremont chert. Includes rhyolite tuff and tuff breccia (Tcglt), correlated with the 5.7 to 6.1 Ma Roblar tuff of Sonoma County (Sarna-Wojcicki, written communication,1990).

Tut Tuff (Miocene) -- Tuffaceous sandstone containing pumice fragments.

Tdi Diatomite (Miocene) -- Light gray to white with minor brown shale.

Tsa Sandstone (Miocene) -- Massive, light gray, fine to medium - grained.

Tmu Mudstone, shale, and siltstone (Miocene).

Assemblage IV - Martinez Area

Tbr Briones Sandstone (Miocene) -- Sandstone, siltstone, conglomerate and shell breccia.

Ts Sobrante Sandstone (Miocene) -- Gray to brown, fine - to medium - grained sandstone and minor conglomerate.

Tsr San Ramon Sandstone (Oligocene and/or Miocene) -- Bluish - gray to brown, medium - grained sandstone with conglomerate locally present in basal part.

Tes Escobar Sandstone of Weaver (1953) (Eocene) -- Massive, medium - to coarse - grained, brown sandstone with shale in basal part. Locally, divided into:

Tehs Sandstone and shale member.

Teh Basal shale member.

Tmr Muir Sandstone of Weaver (1953) (Eocene) -- Massive, yellow - weathering arkosic sandstone. Locally, divided into:

Tmru Upper member. Sandstone, lithologically similar to unit Tmr

Tmrl Lower member. Claystone with thin sandstone in basal part.

Tlj Las Juntas Shale of Weaver (1953) (Paleocene and Eocene) -- Gray shale with minor siltstone. Locally divided into:

Tlju Upper member. Shale.

Tljl Lower member. Sandstone.

Tvh Vine Hill Sandstone of Weaver (1953) (Paleocene) -- Glauconitic sandstone. Locally, divided into:

Tvhu Upper member. Sandstone and shale.

Tvhl Lower member. Glauconitic sandstone.

Ku Great Valley sequence (Cretaceous) -- Sandstone, siltstone, shale, and minor conglomerate. Locally, divided into:

Kcs Gray, massive quartz arenite.

Ksh Siltstone and shale.

Kus Sandstone, siltstone, and shale.

Kuh Massive sandstone, minor siltstone.

Assemblage V - Diablo Valley Area

Tgvt Green Valley and Tassajara Formations of Conduit (1938), undivided (Miocene and Pliocene) -- Non - marine sandstone, siltstone, and conglomerate. Locally includes a 5 meter thick tuff marker bed (Tgvtt). A tuff in this unit has a K/Ar age of 4.0+1.0 Ma, while tuff layers lower in the unit has been correlated with the Roblar tuff in Sonoma County which has K/Ar ages of 5.7+0.5 Ma and 6.1+0.1 Ma and the Pinole Tuff of Assemblage II which has a K/Ar age of 5.2+0.1 Ma (Sarna-Wojcicki, 1976).

Tn Neroly Sandstone (Miocene) -- Brown, massive, marine sandstone with abundant volcanic clasts.

Tc Cierbo Sandstone (Miocene) -- Light - gray, massive sandstone with marine fossils. Contains sandstone and conglomerate near the base (Tcsc).

Domingene Formation (Eocene) -- Consists of:

Tdu Upper member. Massive, pebbly, white sandstone.

Tdl Lower member. Gray shale and minor sandstone. Locally, includes:

Tdls Sandstone. Fine grained, white, quartz sandstone marker bed.

Ku Great Valley sequence (Cretaceous) -- Undivided sandstone, siltstone, and shale. Locally divided into:

Kslt Siltstone with minor shale, claystone, and sandstone.(Late Cretaceous)

Kus Sandstone and shale (Early Cretaceous).

Ksh Shale with minor sandstone (Early Cretaceous).

Assemblage VI - Eastern Area

Ttu Tulare Formation (Pliocene) -- Poorly consolidated, non-marine, gray to maroon siltstone, sandstone, and conglomerate. This formation contains tuff correlated with the Putah Tuff which has a K/Ar age of 3.3+0.1 Ma (Sarna-Wojcicki, 1976).

Tl Lawlor Tuff (Pliocene) -- Non-marine, pumiceous, andesitic tuff. In this area the Lawlor tuff has a K/Ar age of 4.0+0.2 Ma. (Sarna-Wojcicki, 1976).

Tn Neroly Sandstone (Miocene) -- Blue, volcanic - rich, cross-bedded sandstone and conglomerate; mainly nonmarine. The Neroly Sandstone in this assemblage contains tuffs with K/Ar ages of about 9.7 Ma (Black Diamond Park Tuff) and 10-12 Ma (Alves Tuff) (Sarna-Wojcicki, written communication, 1990). Includes minor siltstone, locally mapped (Tns).

Tc Cierbo Sandstone (Miocene) -- Blue, volcanic - rich sandstone with abundant marine fossils.

Tkt Kirker Tuff (Oligocene) -- Pumiceous, white tuff. Includes minor tuffaceous sandstone, conglomerate and siltstone, locally mapped (Tks).

Tmk Markley Formation (Eocene) -- Sandstone and shale. Locally, divided into:

Tmku Upper member. Thin - bedded sandstone, siltstone, and claystone.

Sidney Flat Shale Member. Consists of:

Tsu Upper part. Black shale with minor siltstone and sandstone.

Tsl Lower part. Interbedded shale and sandstone.

Tmkl Lower member. Thin - bedded to massive sandstone with minor siltstone and mudstone. Locally, includes:

Tlu Upper siltstone bed.

Tll Lower siltstone bed.

Tnv Nortonville Shale (Eocene) -- Brown to grayish - green mudstone and claystone with minor siltstone and sandstone; marine rocks.

Td Domingene Formation (Eocene) -- Locally, divided into:

Tdu Upper member. Brown sandstone with minor mudstone and conglomerate.

Tdl Lower member. Siltstone and claystone with minor sandstone and basal conglomerate.

Tm Meganos Formation (Paleocene) -- Sandstone, shale, and conglomerate. Locally, divided into:

Tme Upper member. Greenish - gray to light gray, biotite-rich siltstone and silty mudstone, with abundant plant debris in places. Division E of Meganos Formation of Clark (1921)

Tmd Sandstone member. Medium grained, light gray to bluish-gray sandstone with carbonaceous laminations; pebble conglomerate present locally at base. Division D of Meganos Formation of Clark (1921).

Tmc Shale member. Bluish - gray shale with sandstone interbeds. Division C of Meganos Formation of Clark (1921). Locally includes:

Tmcss Sandstone interbeds

Tma Lower member. Sandstone with basal conglomerate. Medium to coarse grained, clean, white, distinctly cross bedded, biotite bearing arkosic sandstone. Equivalent to Divisions A and B of Meganos Formation of Clark (1921).

Tmz Unnamed sandstone and shale (Paleocene) -- Locally, divided into:

Tmzu Upper member. Siltstone and shale.

Tmzl Lower member. Glauconitic sandstone.

Great Valley sequence (Jurassic and Cretaceous) -- Consists of:

Kdv Deer Valley Sandstone of Colburn (1964) (Late Cretaceous) -- Fine - to medium - grained, gray, distinctly bedded to massive, biotite-bearing arkosic sandstone and minor conglomerate.

Unit E - Siltstone and mudstone (Late Cretaceous) -- Consists of:

Keu Upper member. Light gray siltstone, interbedded with medium to coarse grained, clean, white and orange, lithic sandstone with many large (as much as 50 cm diameter) iron concretions. Weathers to light orange.

Kel Lower member. Light gray to gray-brown, foraminifer bearing siltstone and mudstone. Reddish-brown weathering and iron concretions conspicuous. Locally, includes (mapped in part):

Kels Sandstone interbeds. Coarse grained, clean white, fossiliferous, lithic sandstone. Grains include quartz, feldspar, and black lithic grains. Mica is rare. Iron concretions common.

Kd Unit D - Sandstone (Late Cretaceous) -- Medium to coarse grained, light gray, clean sandstone. Grains include quartz, feldspar, and biotite. Spherical weathering common. In places interbedded with fine to medium grained, biotite and muscovite bearing wacke with mudstone rip-up clasts. Sandstone beds form packages up to 10 meters thick with 1 to 2 meters of interbedded siltstone and mudstone. Locally, divided into:

Kds Shale member. Brown to gray, micaceous mudstone and brown micaceous siltstone. One layer is dark gray-brown to dark gray, massive, foraminifer rich, siliceous mudstone.

Unit C - Sandstone and shale (Late Cretaceous) -- Consists of:

Kcu Upper member. Shale and siltstone. Mapped locally, includes:

Kcus Upper member sandstone. Sandstone interbeds.

Kcm Middle member. Medium grained, brown to gray, biotite rich wacke with some mudstone rip-up clasts. Contains interbeds of siltstone, shale, and conglomerate.

Kcl Lower member. Shale and siltstone with minor sandstone. Mapped locally includes:

Kcls Lower member sandstone. Sandstone interbeds.

Kb Unit B - Sandstone and shale (Early Cretaceous) -- Base marked by 1 m thick bed of cobble conglomerate overlain by 10 meters of conglomeratic sandstone. Includes at least one layer, 10 meters thick, of white rhyolite tuff. Locally, includes (mapped in part):

Kbsh Shale member. Olive-gray mudstone and micaceous siltstone. Forms reddish soil. Contains sandstone interbeds.

Kbs Sandstone member. Medium grained, olive-brown wacke with large biotite grains and many small (3 mm long) mudstone rip-up clasts. Interbedded with thin beds of siltstone and mudstone.

Ka Unit A - Shale, with minor sandstone (Early Cretaceous) -- Olive-brown to dark gray siltstone and mudstone. Spherical concretions common. Locally, includes (mapped in part):

Kas Sandstone member. Fine to medium grained, brown to olive, biotite-rich wacke with micaceous siltstone interbeds. In places grades into coarse grained, bluish-gray wacke with large (up to 3 cm long) mudstone rip-up clasts and phosphate nodules.

JKk Knoxville Formation (Late Jurassic to Early Cretaceous). Mainly dark, greenish - gray shale with sandstone interbeds; also, locally includes conglomeratic sandstone in its lower part. Locally contains abundant specimens of bivalve fossil Buchia.

Coast Range Ophiolite (Jurassic). Consists of:

Jpb Pillow basalt, basalt breccia, and minor diabase.

Jdb Diabase. Mainly sills and dikes; also includes screens of pillow basalt.

sp Serpentinite. Mainly sheared serpentinite, but also includes massive harzburgite.

sc Silica carbonate rocks. Altered serpentinite.