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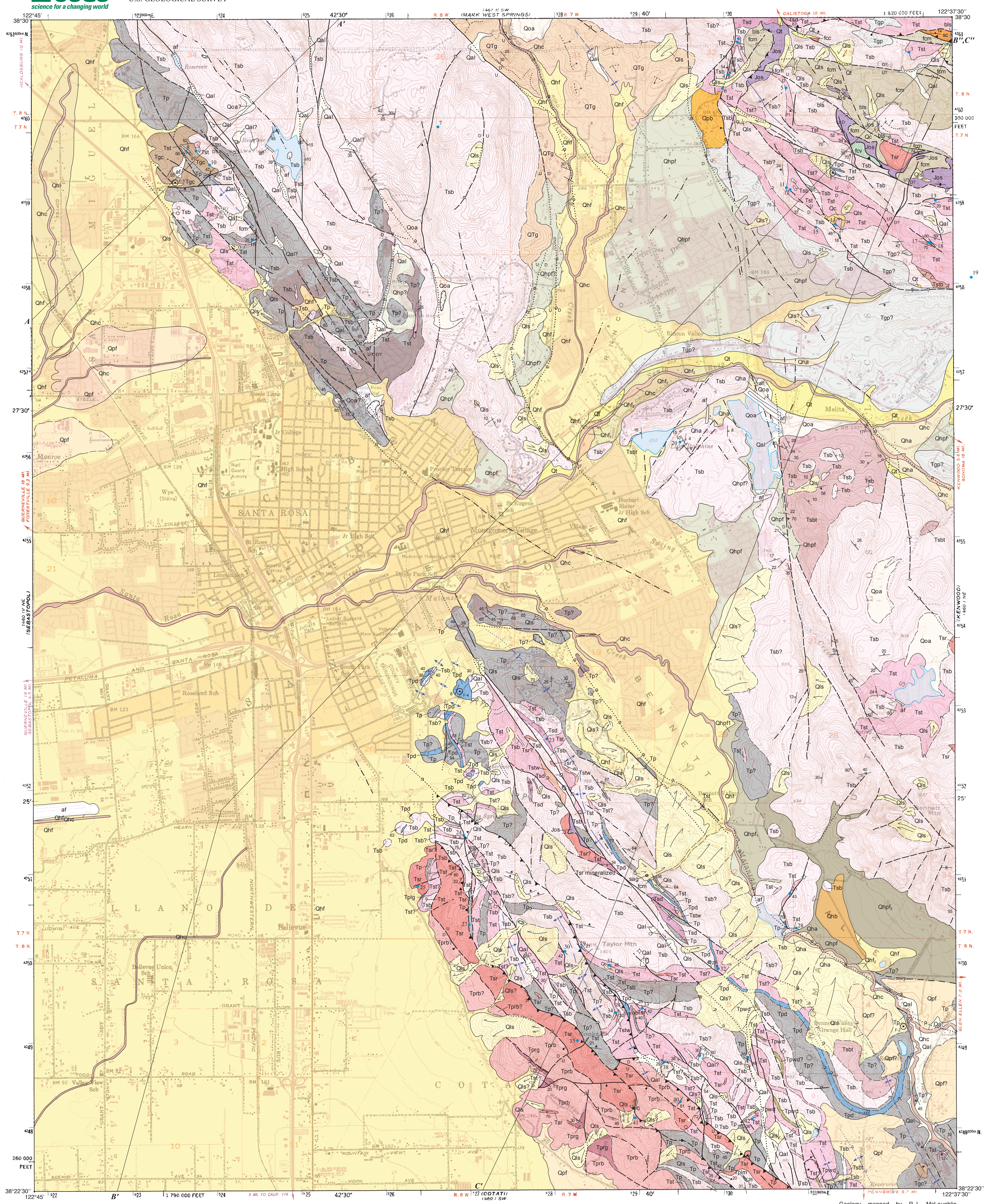
Open-File Report 2008-1009
Sheet 1 of 3
Pamphlet accompanies map



Base from U.S. Geological Survey, Santa Rosa, 1954; photorevised 1980
Universal Transverse Mercator projection

SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

MAP LOCATION

Geology mapped by R.J. McLaughlin, 1996-2005, assisted by C.A. McCabe, 2003-05; compiled in part from Jennings, 1988; Higgins, 1983; Knudsen and others, 2000; and Witter et al., 2006

Digital preparation by C.A. McCabe

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Map A: Geologic Map

By

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DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

af — **Artificial Fill**

Qha — **Alluvium, undivided (Holocene)**

Qhb — **Basin deposits (Holocene)**–Mapped locally, generally includes local silty to muddy alluvial and lacustrine deposits accumulated in low areas where water is ponded

Qhc — **Channels (Holocene)**–Incise older deposits

Qhf — **Alluvial fan and fluvial terrace deposits, undivided (Holocene)**–Gravel, sand and silt, derived primarilly from Pleistocene and older sedimentary and igneous units, including older Tertiary to Pleistocene non-marine gravel, late Tertiary volcanic rocks, and Mesozoic bedrock units of the Franciscan Complex, Coast Range ophiolite and Great Valley sequence. Unit may be further subdivided into the following units.

Qhf1 — **Young Holocene alluvial fan and fluvial terrace deposits**–Inset into old Holocene alluvial fans and fluvial terraces and pre-Holocene deposits

Qhf2 — **Old Holocene alluvial fan and fluvial terrace deposits (Holocene?)**–Inset into older Holocene and pre-Holocene deposits

Qhl — **Natural levee deposits (Holocene)**

Qal — **Alluvial deposits, undivided (Holocene and/or Pleistocene)**

Qc — **Colluvium (Holocene and/or Pleistocene)**–Unconsolidated soil and rock debris generally transported down-slope by gravitational processes

Qhp — **Alluvial deposits, undivided (Holocene and Pleistocene)**

Qhpf — **Alluvial fan and terrace deposits (Holocene? and/or Pleistocene)**–Gravel, sand and silt, that commonly includes cobble to boulder gravel reworked from Tertiary to Pleistocene non-marine gravel, from late Tertiary volcanic rocks and from Mesozoic bedrock. In Bennett Valley, unit is subdivided into the following.

Qhpf1 — **Younger alluvial fan and terrace deposits (Holocene? and/or Pleistocene)**–Deposits on surfaces inset into older undeformed Pleistocene fans and terraces and pre-Pleistocene units

Qhpf2 — **Older alluvial fan and terrace deposits (Holocene? and/or Pleistocene)**–Deposits on surfaces inset into deformed older Pleistocene and pre-Quaternary rocks

Qls — **Landslide deposits (Holocene and Pleistocene)**–Deposits varying from intact slabs of rock, to unconsolidated rock, soil, and colluvium, that are displaced down-slope by gravitational processes. Landslides may vary in area from less than 100 m^2 to greater than 1 km^2

Qoa — **Older alluvium, undivided (Pleistocene)**–Generally uplifted and dissected, isolated surfaces and alluvial fills of small basins, sag ponds, and marshes

Qpf — **Alluvial fans and fluvial terrace deposits, undivided (Pleistocene)**–Gravel, sand and silt in deposits characterized by unsorted character, a relict fan-like morphology, and their presence on elevated surfaces. The unit is distinguished from younger alluvial fan deposits by its dissected irregular surface morphology and incision by younger Pleistocene and Holocene alluvial deposits. Unit unconformably overlies the Petaluma Formation and incises or interfingers with the gravel of Cloverleaf Ranch (Tgc)

Qpb — **Volcanic talus breccia (Pleistocene?)**–Coarse volcanic talus composed of debris from silicic ash and andesitic breccia of the Sonoma Volcanics, present along the northeastern side of Rincon Valley. Unit may be derived from normal fault scarps

Qt — **Alluvial deposits, undivided (Holocene and Pleistocene)**–Includes undivided Holocene and Pleistocene terrace deposits

EARLY QUATERNARY AND TERTIARY UNITS

QTg — **Fluvial and lacustrine deposits (early Pleistocene and Pliocene)**–Gravel, sandstone, siltstone and mudstone, and non-marine diatomite. Minor siliceous ash is present in uppermost part of the unit in northwestern Rincon Valley. Unit includes gravels previously assigned to the Glen Ellen and Huichica Formations; names that are not used here because of new stratigraphic data and inconsistent previous lithologic criteria for separating the Glen Ellen and Huichica Formations. (McLaughlin and others, 2004; Wagner and others, 2005; also discussions in McLaughlin and others, 2005).

Gravel of this unit is pebbly to bouldery, derived predominantly from Tertiary volcanic provenances and pre-Tertiary basement. Locally, gravels have a dominant pre-Tertiary basement provenance from paleodrainage of Dry Creek and the Mayacmas Mountains (McLaughlin and others, 2005).

Stratigraphically high in this unit, fine grained tephra dispersed in a silt bed are correlated with the Bishop Glass Mountain tephra section in the Long Valley area of the southeastern Sierra Nevada Mountains, dated at between 0.8 and 1.2 Ma (Metz and Mahood, 1991; Sarna-Wojcicki and others, 2004). The gravels include rare to common clasts of obsidian with chemical compositions indicating sources in Napa and Franz Valleys (McLaughlin and others, 2005). The gravels are younger than 2.8-3.2 Ma (McLaughlin and others, 2004; McLaughlin and others, 2005), based on the ages of the obsidian clast sources

TERTIARY ROCKS

sc — **Silica carbonate rock (Pliocene-Miocene?)**–Hydrothermally altered ultramafic rocks, composed of quartz and magnesium carbonate mineral assemblages, commonly associated with mercury and other epithermal base metal sulfide occurences (Ag, Au, Pb, Zn, Cu). Age generally is somewhat younger than age of associated Tertiary volcanic rocks that provided hydrothermal heat sources (McLaughlin and others, 1996; Rytuba, 1993; Peabody and Einaudi, 1992)

Tgc — **Gravel of the Cloverleaf Ranch (Pliocene?)**–Fluvial, pebbly to cobbly gravel, pebbly, lithic to quartzose sand, and tuffaceous white clayey mudstone and siltstone. Unit locally contains an undated, waterlain ash layer with a geochemical signature suggesting it is younger than ~ 3.12 Ma (Tables 2.2, 2.3, Loc. 8). Unit also contains common rounded pebbles of obsidian, derived from a source at Annadel State Park, dated at 4.5 Ma (Table 2.1; Loc. 21 Figure 2.2). Unit may be partly coeval with Pleistocene and Pliocene fluvial and lacustrine deposits (QTg), but age of the contained obsidian clast suite and of intercalated ash, suggests that gravels of the Cloverleaf Ranch are largely 2.8 Ma or older

Tgp — **Fluvial and lacustrine deposits of Humbug Creek (Pliocene)**–Gravel, sandstone, siltstone, mudstone, nonmarine diatomite, and locally mapped intercalated siliceous tuff (Tst). In Santa Rosa and western Kenwood quadrangles, unit consists largely of boulder, cobble and pebble gravel, and sand and silt derived from underlying Mesozoic rocks and from Tertiary volcanic rocks and exhibits primarily west-northwest directed paleoflow. On the basis of stratigraphy and the ages of underlying and interbedded volcanic units, we interpret the age of the fluvial and lacustrine deposits of Humbug Creek to be 3.3-4.4 Ma. Unit may be unconformably overlain by Pleistocene and Pliocene fluvial and lacustrine deposits (QTg) in Rincon Valley

Tw — **Wilson Grove Formation (Pliocene and Miocene)**–The Wilson Grove Formation is not exposed at the surface in the Santa Rosa or Kenwood 7.5' quadrangles, but it underlies much of the Santa Rosa Plain (cross sections B and C). The Wilson Grove Formation includes marine pebbly sandstone, siltstone and distinctive well rounded, friable, matrix- and clast-supported pebbly gravel, with quartz, dark chert and porcellanitic shale clasts (Cotati lithofacies of the Wilson Grove and Petaluma formations) in a sandy to silty matrix. Unit is partly coeval with late Miocene part of Petaluma Formation and it locally includes the Roblar tuff, radiometrically dated at 6.26 ± 0.4 Ma (Ar-Ar)

Tp — **Petaluma Formation (Pliocene and Miocene)**–Dominantly sandy to silty gravel, silty sandstone, siltstone, and mudstone (Tp). Contains diatomite (Tpd) and clayey diatomaceous shale with local lenses of lignite and lignitic mudstone (Tplg), silicified wood (Tpwd), and fresh water limestone (Tplm). Petaluma Formation strata were deposited in fluvial, lacustrine, and brackish to estuarine settings and the formation locally contains the 6.26 ± 0.4 Ma (Ar-Ar) Roblar tuff. Depositional settings are locally constrained by invertebrate fossils, diatoms, ostracodes, rare foraminifers and rare land mammals. The formation locally includes interbedded gravel with well rounded and polished pebbles of banded porcellanite, milky quartz and black chert and argillite correlative with the gravels of Cotati (Fox, 1983), a lithofacies of the Petaluma and Wilson Grove Formations
The Petaluma Formation is older than ~4.8-5.0 Ma and younger than ~8.0 Ma where exposed along the E side of Santa Rosa Plain. Beneath the Santa Rosa Plain and southwest of Cotati and Rohnert Park, the lower Petaluma Formation is intercalated with the older, ~8.5-10 Ma Tolay Volcanics, and overlies Mesozoic basement of the Franciscan Complex, Coast Range ophiolite and Great Valley sequence. The Petaluma Formation locally includes the following units.

Tpd — **Diatomite and diatomaceous mudstone**–The diatom flora in these strata (fossil locality 4) suggest a shallow, eutrophic, neutral to slightly alkalic, stagnant lacustrine setting (S. Staratt, written commun. 2006)

Tplg — **Lignite and lignitic mudstone**

Tpwd — **Silicified (petrified) wood**

Tplm — **Limestone**–Brackish or fresh water depositional setting, locally fossiliferous, present as lenses in the upper parts of basaltic andesite flows and breccias

Tprb — **Breccia**–Composed dominantly of angular, tectonically slickened clasts of rhyodacitic rocks with variable textures, interpreted to represent a fault scarp-derived breccia. Breccia includes clasts up to 3m in a comminuted matrix derived from rhyodacitic intrusives, flows and tuffs. Breccia locally includes:

Tprg — **Gravel lenses**–Intercalated in breccia, up to ~5m thick, unsorted to poorly sorted, un-organized to weakly segregated and cross-bedded. Gravel is composed of rounded to subangular pebbles to cobbles derived from Franciscan and related Mesozoic sources and from older Tertiary volcanics deposited in alluvial fans, debris flows and talus settings

LATE TERTIARY VOLCANIC ROCKS

Sonoma Volcanics (Pliocene and Miocene)–Rhyolitic to dacitic ash-flow and air fall tuff, andesitic water-lain tuff, and rhyolitic to basaltic flows and flow breccia. Regionally, the volcanic section becomes increasingly silicic up-section, and youngs from southwest to northeast, across the Rodgers Creek-Healdsburg and Maacama faults (McLaughlin and others, 2005; Fox and others, 1985). The Sonoma Volcanics consist of the following units.

Tsd — **Dacitic flows**–Mapped near the northeast corner of the Santa Rosa quadrangle and in the southeast half of the quadrangle along the Rodgers Creek Fault Zone. The dacite lacks macroscopic quartz or K-feldspar, commonly contains plagioclase phenocrysts, and rare hornblende

Tsr — **Rhyolitic and rhyodacitic flows and intrusive rocks**–Porphyritic to aphanitic, with phenocrysts of quartz and plagioclase. Includes the rhyodacitic rocks of Zamaroni Quarry (7.26±0.04 Ma), the rhyodacitic rocks of Cook Peak (7.94±0.02 Ma), and perlitic to banded rhyolitic to rhyodacitic flow rocks and obsidian in Annadel State Park (4.5±0.01 Ma)

Tst — **Rhyolitic to dacitic and minor andesitic pumiceous tuff**–Mostly ash-flows and minor air fall. This unit includes named and unnamed tephra layers of different ages in the Sonoma Volcanics (see Tephra data Tables 2.2 and 2.3, figure 2.2, and discussion in pamphlet)

Tstw — **Crystal-rich rhyolitic to rhyodacitic welded tuff**–Welded zones locally at tops of tuff layers that are overlain by flows of andesite or basalt

Tstb — **Andesitic to rhyodacitic breccia (Pliocene)**–Mapped locally in the northeast part of Santa Rosa 7.5' quadrangle, between the 4.83 Ma Lawlor Tuff and overlying basaltic andesite. Breccia consists of angular boulders and blocks of basalt, andesite, and vitric, porphyritic rhyodacite, in a lithic rhyo-dacitic pumiceous tuff matrix. The breccia may be associated with syn-volcanic faulting and (or) proximal pyroclastic venting

Tsb — **Andesite, basaltic andesite and basalt**–Subaerial andesitic to basaltic flows, flow breccia and tuff-breccia, local waterlain andesitic tuff and minor dacitic ash-flow tuff, aerially between the Healdsburg and southern Rodgers Creek segments of the Rodgers Creek Fault Zone and the Mark West Fault Zone. Unit may compose a relatively thin cover to pre-Miocene basement (cross sections A-C). Andesitic rocks are intercalated with and underlain by the Petaluma Formation and the numerous named and unnamed rhyodacitic to andesitic tuffs (Tst), and local rhyodacitic flows and intrusive rocks (Tsr) of the Sonoma Volcanics.

Dated andesitic rocks in the Santa Rosa 7.5' quadrangle (table 2.2, and figure 2.2) span a significantly narrower age range than the tephra units (Tst). Andesite along Fountain Grove Parkway northeast of the Healdsburg Fault Zone is dated at 5.0 ± 0.4 Ma. Basaltic andesite from the Cloverleaf Ranch area yielded a plateau age of 4.53 ± 0.04 Ma. Andesitic flows in an area of abandoned cobblestone quarries east of Lake Ralphine are dated at 4.4 ± 0.03 Ma. East of the Bennett Valley Fault in Annadel State Park, a lithologically and texturally similar plagioclase-rich, olivine-bearing andesite is dated at 4.7 ± 0.03 Ma.

Near the northeast corner of Santa Rosa 7.5' quadrangle, porphyritic basaltic andesite that overlies the 4.83 Ma Lawlor Tuff, is dated at 4.63 ± 0.02 Ma. Collectively, andesitic rocks northeast of the Rodgers Creek-Healdsburg Fault Zone and southwest of the Maacama Fault appear to range in age from ~5.4 to 4.4 Ma

Tsbt — **Andesitic to dacitic tuff, breccia and minor flows**–Includes air fall and ash flow tuffs and some possibly reworked waterlain tuff (Higgins, 1983). Unit underlies basaltic andesite flows dated at 4.7 ± 0.03 Ma. Andesitic tuff breccia also overlies andesitic flows and breccias (Tsb) and rhyolitic rocks (Tsr) northeast of Bennett Mountain, that are probably correlative with the obsidian of Annadel State Park (4.5 ± 0.01 Ma)

Tvt — **Tolay Volcanics (Miocene)**–Rhyolite, andesite and basalt, interbedded with the sedimentary rocks of the Petaluma Formation. Unit is not present at the surface in Santa 7.5' Rosa quadrangle, but is mapped in the adjacent Cotati 7.5' quadrangle (Clahan and others, 2003) and beneath Santa Rosa plain, based on exploratory oil and gas well data (cross section C; figure 2.3A)

PRE-TERTIARY ROCKS

KJso — **Great Valley Sequence and Coast Range Ophiolite, undivided (Cretaceous and Jurassic)**–Marine sedimentary rocks of the Cretaceous and Jurassic Great Valley Sequence and (or) igneous and pelagic rocks of the Jurassic Coast Range ophiolite, inferred to be locally present beneath Santa Rosa plain and beneath Miocene and younger units between the Rodgers Creek-Healdsburg and Maacama Fault Zones. Great Valley Sequence strata includes thin- to medium-bedded, shaly to arkosic, sandy turbidites and thick bedded to massive, conglomeratic submarine channel deposits. No exposures of Great Valley Sequence strata are recognized at the surface in the map area but are inferred in the subsurface based on along-strike and down-plunge projection from exposures in adjacent quadrangles

Coast Range Ophiolite (Jurassic)–Rocks presumed to be derived from the Coast Range Ophiolite in the map area include:

Jos — **Serpentinized ultramafic rocks**–Predominantly serpentinized non-cumulate tectonitic harzburgite and dunite. Serpentine mineral assemblage is typically a mixture of lizardite and chrysotile. In places, unit includes minor cumulate ultramafic to gabbroic rocks. Locally, pods and lenses of unit are imbricated with mélange of Franciscan Complex Central Belt

Central Belt of the Franciscan Complex (Upper Cretaceous to Lower Jurassic)

fcm — **Undifferentiated melange**–Largely penetratively sheared sandstone and argillite, containing blocks of varying lithology. Where blocks are large enough to map, includes:

bls — **Blueschist blocks**–Mafic to felsic igneous and pelagic rocks, metamorphosed to high blueschist grade. Includes eclogite and amphibolite-grade blocks partially retrograded to blueschist and locally, tuffaceous pelitic rocks that contain chrome mica (fuchsite), white mica, lawsonite and sodic amphibole

fcc — **Radiolarian chert of Marin Headlands-Geysers terrane**–Red to green, locally tuffaceous, and in places depositional on, or interlayered with, basaltic volcanic rocks. Where section is complete, radiolarian chert overlies pillow basalt, is of early Late Cretaceous (Cenomanian) to Early Jurassic (Pliensbachian) age (McLaughlin and Pessagno, 1978; Hagstrum and Murchey, 1993) and is depositionally overlain by terrigenous metasandstone and shale

fcv — **Basaltic volcanic rocks**–Massive to pillowed basaltic flows, breccia and tuff, generally metamorphosed to low-greenschist grade, containing epidote and pumpellyite. Includes basaltic rocks of Marin Headlands-Geysers terrane

Contact–Dashed where approximately located; dotted where concealed; queried where uncertain

Fault–Dashed where approximately located or inferred; dotted where concealed; queried where uncertain

Normal fault–Showing geometry of fault plane and sense of slip. Bar and ball on down-dropped block; U on upthrown block; D on down-dropped block where fault dip unknown. Arrows show direction of relative horizontal movement. Dip of fault plane shown by arrow normal to fault with dip amount indicated where known; arrow and number at angle to fault indicates rake of lineation; diamond astride fault indicates vertical dip

Thrust fault–Sawteeth on upper plate

Fault lineament–Inferred from linear features on aerial photography; dotted where projected beneath surficial deposits; queried where uncertain. Arrows show relative horizontal motion

Fault scarp–Showing fault line at base of scarp. Hachures point downscarp

Fold–Dashed where approximately located; dotted where concealed; queried where uncertain

Anticline

Syncline

Overturned syncline–Showing dip

Minor syncline–Showing bearing and plunge

Closed depression or sag pond

Strike and dip of beds

Inclined

Inclined–Top of beds known from local features

Vertical

Approximate–Determined by sighting from distant location; dip indicated where measured

Strike and dip of foliation in sheared or foliated rock

Inclined

Vertical or near vertical

Strike and dip of volcanic flow unit

Fossil locality

Radiometric dating and tephrochronology localities–Numbers refer to figures 3*A*,*B* and tables 1-3

Spring

Water well

Area of hydrothermal alteration

Landslide–Arrows indicate direction of movement

Figure 1. Index map, showing location of Santa Rosa 7.5' quadrangle (red box) within the grids of Napa and Healdsburg 30' x 60' quadrangles, northern California. Green box on inset map shows location of index map.

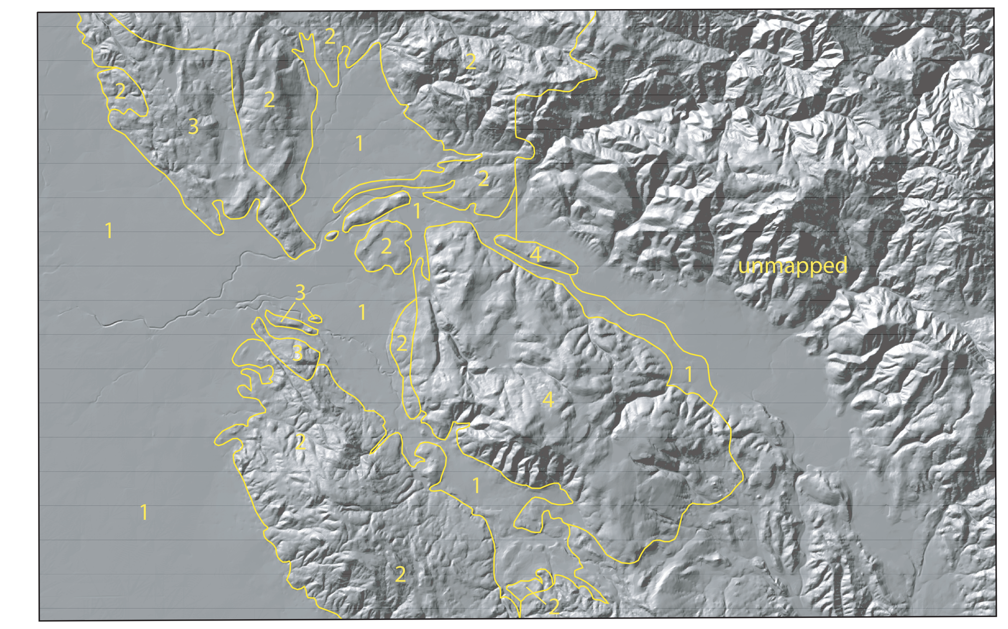
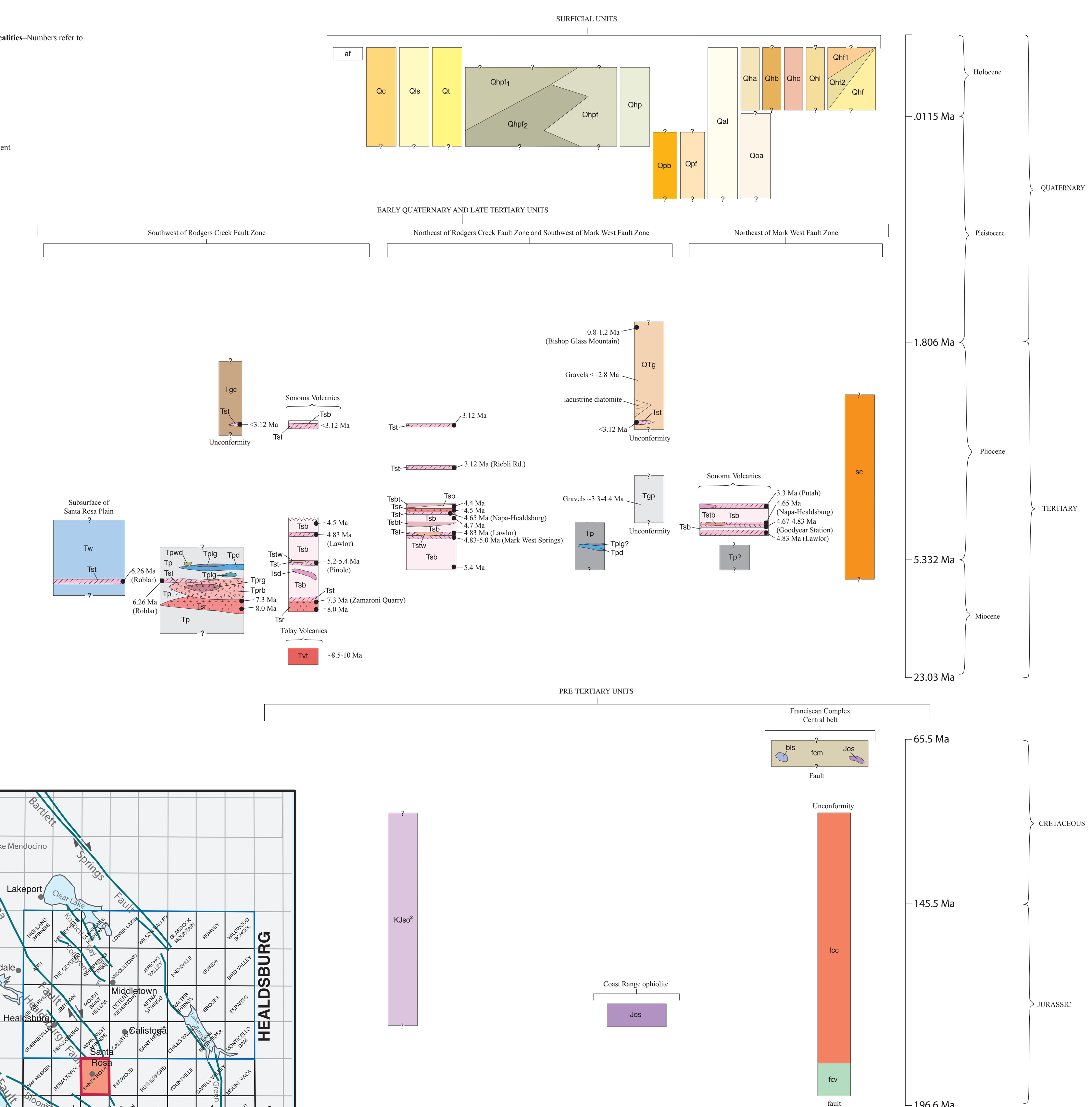


Figure 2. Sources of Geologic Mapping in the Santa Rosa and western Kenwood 7.5' quadrangles. Mapping in parts of Santa Rosa quadrangle began in 1996, together with work in adjacent quadrangles. The mapping presented here was completed in September, 2005. The sources include: 1. Quaternary geology, from McLaughlin, this study and partly compiled and modified from Knudsen and others, 2000; and Witter and others, 2006. 2. R.J. McLaughlin, fieldwork between 1996 and 2005, assisted at times by C. McCabe 2003-05. Area sampled for tephrochronology with A.M. Sarna-Wojcicki and for geochronology with R.J. Fleck. Joint traverses at times were conducted with V.E. Langenheim, D.K. McPhee and C.A. McCabe during collection of gravity data. 3. Mapping compiled from Jennings, 1988, field checked and locally modified by McLaughlin. 4. Geologic mapping of the Annadel State Park area largely compiled from Higgins, 1983, field checked with minor modifications along SW boundary of park by McLaughlin; sampled for obsidian geochemistry and geochronology with Sarna-Wojcicki and J. Walker in 1999; again sampled for geochronology of andesites with R.J. Fleck in 2004.

CORRELATION OF MAP UNITS



Geologic and Geophysical Framework of the Santa Rosa 7.5' Quadrangle, Sonoma County, California

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