

Preliminary Geologic Map of the Lodi 30'x 60' Quadrangle, California

Compiled by
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INTRODUCTION

The *Preliminary Geologic Map of the Lodi 30'x60' Quadrangle, California* was compiled from existing geologic mapping covering the area between 38° and 38°30' N. latitude and 121° and 122° W. longitude. This map was prepared by the Department of Conservation, California Geological Survey (CGS) and was supported in part by the U.S. Geological Survey (USGS) STATEMAP award No. 08HQAG0102. The map is a compilation of existing geologic mapping from a number of sources (see index map on map sheet and references). Where available, existing digital data was used in this compilation, as shown on Figure 1. For areas where digital data was not available, contacts and geologic features were digitized in ArcGIS 9.3 by CGS from scanned geologic maps obtained from the USGS Publications Warehouse (<http://pubs.er.usgs.gov>).

Because much of the available digital data were compiled at a larger scale (1:24,000), numerous small artificial fills and artificial levees are too small to be shown on the map. However, these have been preserved in the digital database as a separate feature class. Along the eastern half of the map, artificial levees were not mapped on the original source map. For consistency across the map, these artificial levees and larger fills have been digitized by CGS as shown on 1:24,000-scale USGS topographic base maps and are included in the digital database.

BASE MATERIAL

The base materials used for the geologic map of the Lodi 30'x 60' quadrangle consists of a shaded-relief and a topographic map image. The topographic base map is taken from the USGS digital raster graphic (DRG) of the Lodi 1:100,000-scale quadrangle available from the California Spatial Information Library (CaSIL) (<http://www.atlas.ca.gov/>). The shaded-relief image originates from a hillshade image based on the National Elevation Dataset (NED) at 30 meter resolution. Hydrography shown on the map is taken from the digital source data and supplemented with USGS National Hydrography Data (NHD) for areas that were digitized for this compilation.

DESCRIPTION OF MAP UNITS

af	Artificial fill (Historic) - May be engineered and/or non-engineered. Locally includes artificial dam fill and tailings associated with dredge mining.	Qhty	Stream terrace deposits (latest Holocene, <1,000 years) - Stream terraces are deposited as point bar and overbank deposits. Composed of moderately sorted clayey sand and sandy clay with gravel.
afbm	Artificial fill placed over bay mud (Historic) - May be engineered and/or non-engineered.	Qhl	Fan levee deposits (Holocene) - Natural levees deposited as long, low ridges oriented down fan. The deposits contain coarser material than the adjoining interlevee areas.
alf	Artificial levee fill (Historic) - May be engineered and/or non-engineered.		
ads	Artificial dredge fill (Historic) - Fill located adjacent to channels dredged for navigation.	Qhbm	Bay mud (Holocene) - Estuarine silt, clay, peat, and fine sand deposited at or near sea level in the San Francisco Bay estuary.
ac	Artificial stream channel (Historic) - Modified stream channels including straighten channels, flood control channels, and concrete canals.	Qhdm	Delta Mud (Holocene) - Sediment deposited at, or near sea level in tidal marshes of the Sacramento - San Joaquin delta
gq	Gravel quarry (Historic) - Excavations, spoil piles, and disturbed ground in areas being used for the extraction of sand and gravel.	Qht	Stream terrace deposits (Holocene) - Sediment deposited in point-bar and overbank settings. Includes sand, gravel, silt, and minor clay. Moderately to well sorted and bedded.
Qhc	Stream channel deposits (late Holocene to modern <150 years) - Deposits in active, natural stream channels. Consists of loose alluvial sand, gravel, and silt.	Qhb	Basin deposits (Holocene) - Fine grained sediments of late Holocene age with horizontal stratification deposited in topographic lows.
Qhay	Alluvial deposits, undivided (latest Holocene, <1,000 years) - Fluvial sediment deposited on the modern flood plain.	Qha	Alluvium, undivided (Holocene) - Alluvium deposited on fans, terraces, or in basins. Sand, gravel, and silt that are poorly to moderately sorted. Mapped where separate types of alluvial deposits are not delineated.
Qhly	Alluvial fan levee deposits (latest Holocene, <~1,000 years) - Natural levee deposits of latest Holocene alluvial fans.	Qhf	Alluvial fan deposits (Holocene) - Alluvial fan sediment deposited by

streams emanating from the mountains as debris flows, hyper-concentrated mudflows, or braided stream flows. Sediments include sand, gravel, silt and clay, that are moderately to poorly sorted, and moderately to poorly bedded; Qhff - fine-grained facies.

Qa **Alluvium, undivided (latest Pleistocene to Holocene)** - Undivided alluvium consisting of flat, relatively undissected fan, terrace, basin deposits, and small active streams.

Qds **Dune sand (latest Pleistocene to Holocene)** - Very well-sorted fine- to medium-grained eolian sand.

Qf **Alluvial fan deposits (latest Pleistocene to Holocene)** - Sand, gravel, silt, and clay mapped on gently sloping, fan-shaped, relatively undissected alluvial surfaces. Moderately to poorly sorted, and poorly to moderately bedded.

Qt **Stream terrace deposits (latest Pleistocene to Holocene)** - Sand, gravel, silt, minor clay on relatively flat surfaces. Moderately to well sorted, and moderately to well bedded.

Qls **Landslides (Pleistocene to Holocene)** - Large, complex slides consisting of chaotic deposits of sand, silt, clay, boulders, and blocks of bedrock. Only the largest landslides included by Graymer and others (2002) are shown.

Qpb **Basin deposits (Late Pleistocene)** - Older alluvium exposed at the toe of the Putah Creek fan. Commonly in basins between deposits of younger alluvium.

Qpf **Alluvial fan deposits (latest Pleistocene)** - Sand, gravel, silt, and clay that is moderately to poorly sorted and bedded. Similar to Holocene fans (Qhf), but they are more dissected.

Qm **Modesto Formation (Late Pleistocene)** - Arkosic alluvium, sand with minor gravel and silt, forming low terraces, high floodplains, and alluvial fans along the Consumnes and Mokelumne Rivers. Qm2 - Upper member, undivided alluvium; Qm2b - Upper member, fine-grained, alluvium of flood basins, lower fans, and intertributary fan areas; Qm1 - Lower member, undivided alluvium; Qm1b - Lower member, fine-grained, alluvium of flood basins, lower fans, and intertributary fan areas

Qr **Riverbank Formation (Middle to Late Pleistocene)** - Arkosic alluvium, sand with and silt, forming terraces, and alluvial fans along the Consumnes and Mokelumne Rivers. Qr3 - Upper unit; Qr2 - Middle unit; Qr1 - Lower unit.

Qoa **Alluvial deposits, undivided (early to late Pleistocene)** - Alluvial fan, stream terrace, basin, and channel deposits. Topography is gently rolling with little or no original alluvial surfaces preserved; moderately to deeply dissected.

Qof **Alluvial fan deposits (early to late Pleistocene)** - Sand, gravel, silt, and clay, deeply dissected. Topography is moderately rolling with little or no original alluvial surfaces preserved.

Qmz **Montezuma Formation (early Pleistocene)** - Orange-weathering,

	soft, brown, poorly sorted quartz-lithic sand, silt, and pebble gravel. Pebbles include red chert and volcanics	Mc	Cierbo Sandstone (late Miocene) – Light-gray, light-blue, and black, massive to bedded quartz-mica-lithic arenite, conglomerate, siltstone, and tuff.
Qtl	Turlock Lake Formation (Pleistocene) – Arkosic alluvium, sand with some silt and minor gravel.	Mpb	Putnam Peak Basalt (Miocene) - Olivine basalt flow. Correlated to the Lovejoy Basalt of the Sierra Nevada foothills.
QTu	Sandstone, siltstone, and gravel (late Pliocene and early Pleistocene) – Semi-consolidated to unconsolidated poorly sorted gravel, sand, silt and clay.	OMvs	Valley Springs Formation (Oligocene to Miocene) – Rhyolitic sandstone and interbedded tuffs.
QTnm	North Merced gravels (Pliocene and early Pleistocene) – Thin, locally-derived pediment gravel, caps older Tertiary deposits.	Ei	Ione Formation (Eocene) – Light-colored conglomerate, sandstone, and claystone.
Pl	Laguna Formation (Pliocene) – Cobble gravel, sand, and minor silt of mixed metamorphic, granitic, and volcanic source.	Emk	Markley Sandstone (Eocene) – Yellow- and tan-weathering, white to light-gray quartz-muscovite and quartz lithic sandstone and siltstone. Emku – Upper member, brownish, gray shale with thin sandstone beds. Emkl – Lower member, brownish gray silty shale.
Pth	Tehama Formation (Pliocene) – Poorly consolidated, nonmarine, gray to maroon siltstone, quartz arenite sandstone, tuff, and pebble to cobble conglomerate.	Env	Nortonville Shale (Eocene) - Gray-weathering, brown shale. Also contains thin beds of fine-grained, quartz-lithic, glauconitic sandstone. Envu – Upper member, Brownish-gray shale with thin sandstone beds.
Plt	Lawlor Tuff (Pliocene) - Nonmarine, pumiceous, andesitic ash-flow tuff. Ar/Ar age of 4.83 ± 0.04 Ma.	Ed	Domengine Sandstone (Eocene) - Light colored, fine- to coarse-grained quartzose sandstone. Locally includes conglomerate with pebbles of quartz, chert, and andesite, as well as thin beds of shale.
MPm	Mehrten Formation (Miocene and early Pliocene) – Mudstone, claystone, siltstone, and minor sandstone and conglomerate derived from andesitic volcanic source areas near the crest of the Sierra Nevada.	Esh	Shale (Eocene) – Brown, thin-bedded and laminated, foraminiferal shale and mudstone.
Mnr	Neroly Sandstone (late Miocene) – Blue-gray, fine to coarse-grained lithic sandstone.		

F _{epu}	Sandstone and shale (Paleocene) – Brown, glauconitic, mica-lithic wacke and gritstone; gray, fine-grained quartz-biotite-lithic wacke; gray foraminiferal shale and mudstone.	Kg	Guinda Formation (Late Cretaceous) – Thick-bedded to massive, coarse to fine-grained, biotite-quartz-feldspar-lithic wacke.
F _{emz}	Martinez Formation (Paleocene) - Light-brown and light-gray fine-grained micaceous sandstone and mudstone.	Kuhs	Great Valley Complex (Late Cretaceous) – Sandstone and shale. Kuss – Sandstone.
Ksh	Great Valley Complex (Late Cretaceous) – Siliceous shale containing radiolarians and foraminifers of Late Cretaceous age.	Jss	Salt Springs Slate – Dark gray slate with some mica schist.
Kfo	Forbes Formation (Late Cretaceous) – Thick beds of massive, fine- to coarse-grained biotite-feldspar-lithic wacke grading up into interbedded siltstone and shale.	Jgo	Gopher Hill Volcanics – Metamorphosed mafic to felsic pyroclastic rocks.

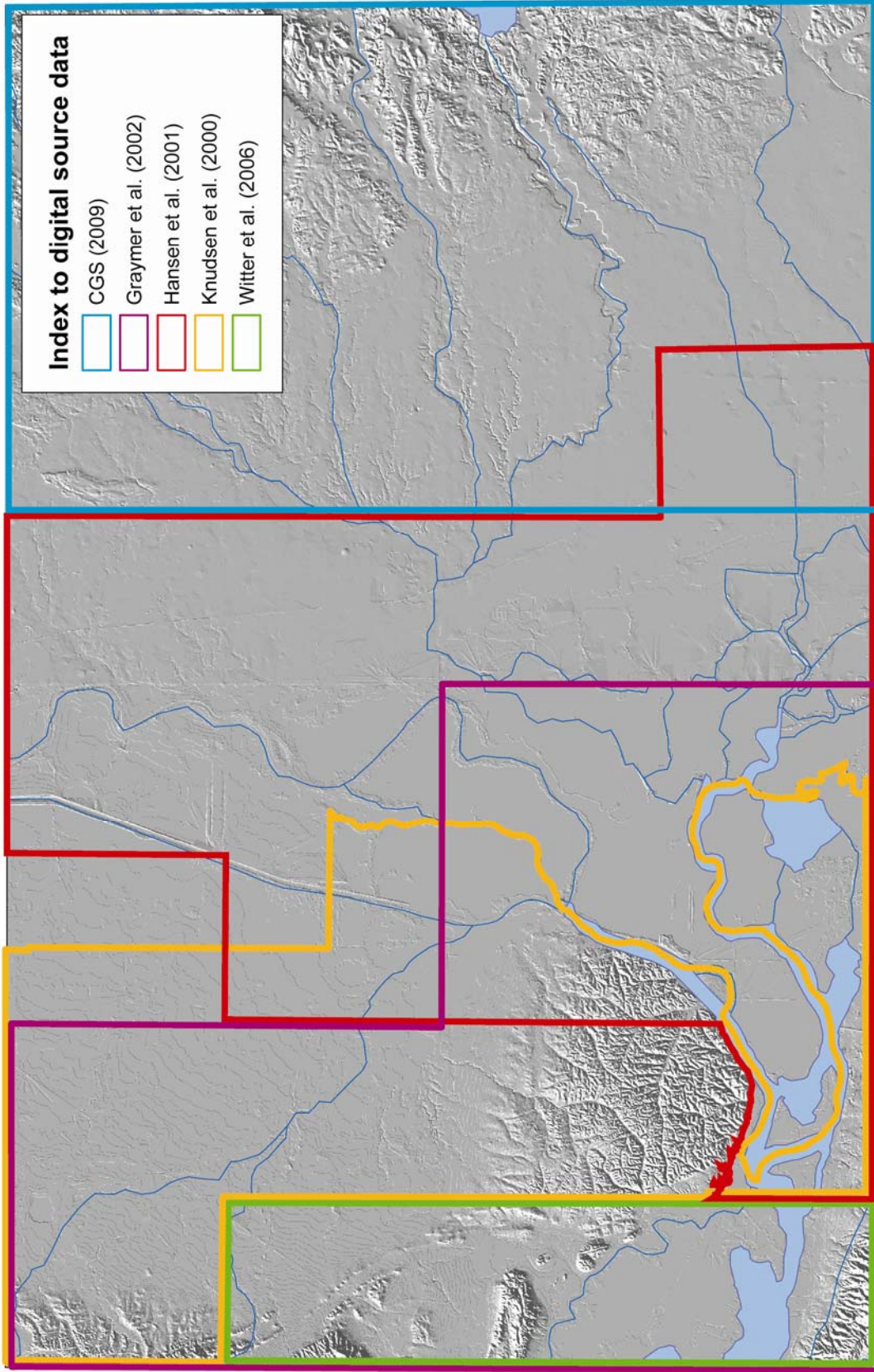


Figure 1. Sources of digital data used in this compilation.

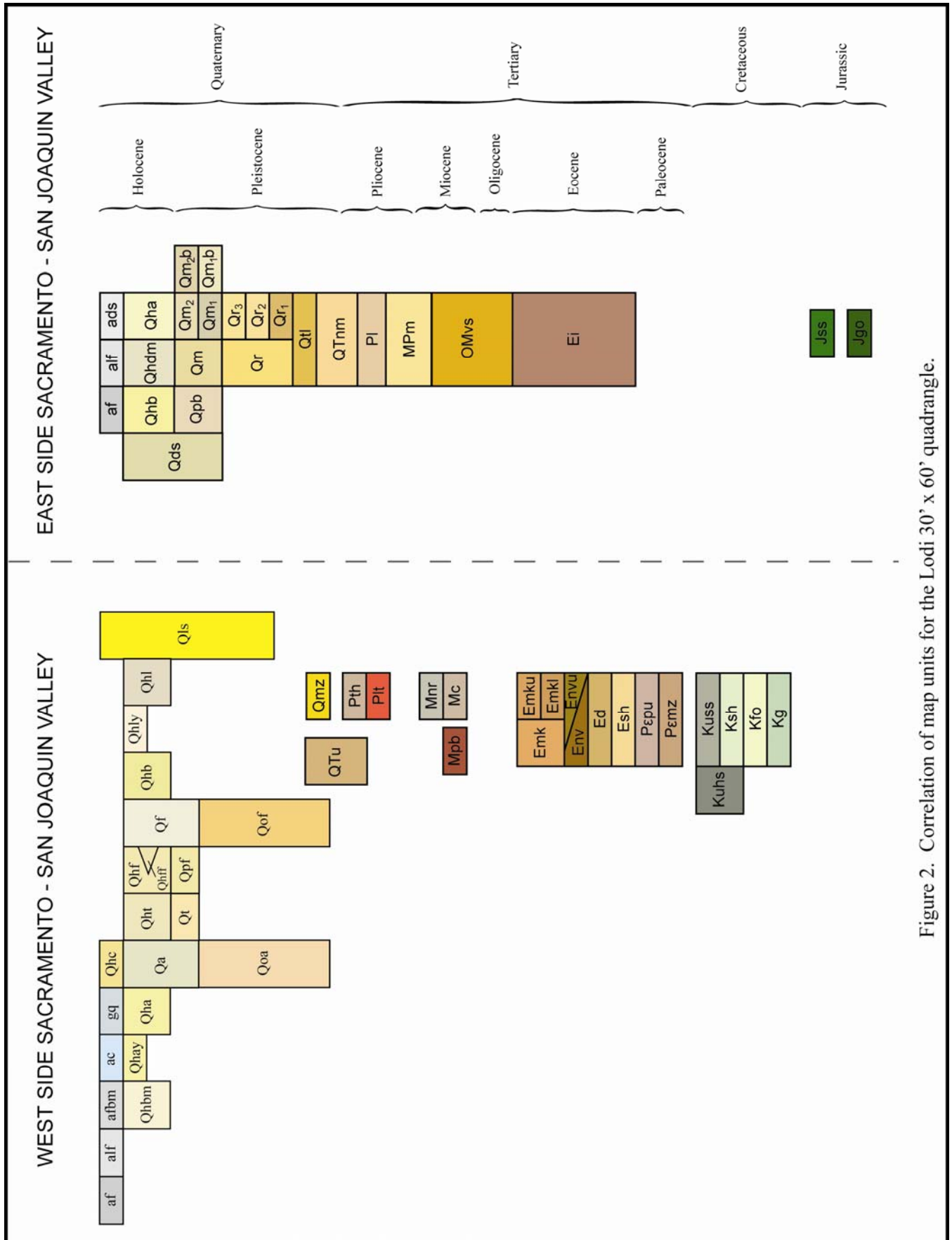


Figure 2. Correlation of map units for the Lodi 30' x 60' quadrangle.

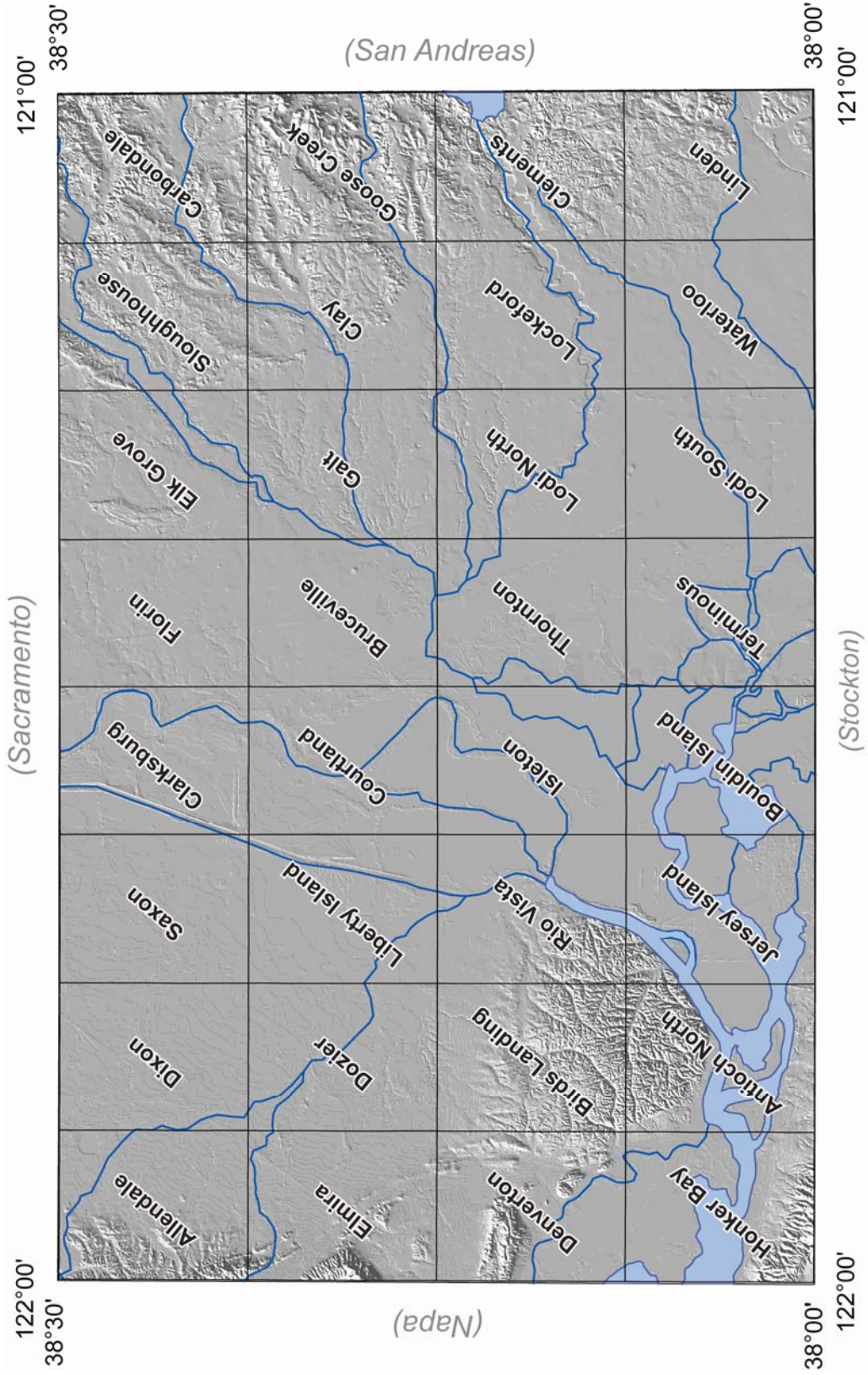


Figure 3. Index to 7.5-minute quadrangles in the Lodi 30' x 60' quadrangle.

Sources of mapping of the Lodi 30' x 60' quadrangle. For complete citation see the reference section following this list.

Allendale

Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Antioch North

Atwater, B.F., 1982; Bryant, W.A. (compiler), 2005; Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Birds Landing

Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Bouldin Island

Atwater, B.F., 1982; Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Bruceville

Atwater, B.F., 1982; Helley, E.J. and Harwood, D.S., 1985.

Carbondale

Clark, L.D., 1964; Bartow, J.A. and Marchand, D.E., 1979.

Clarksburg

Atwater, B.F., 1982; Helley, E.J. and Harwood, D.S., 1985.

Clay

Bartow, J.A. and Marchand, D.E., 1979.

Clements

Marchand, D.E. and Bartow, J. A., 1979.

Courtland

Atwater, B.F., 1982; Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Denverton

Bryant, W.A. (compiler), 2005; Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000; Witter, R.C., Knudsen, K.L., Sowers, J.M., Wentworth, C.M., Koehler, R.D. and Randolph, C.E., 2006.

Dixon

Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Dozier

Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Elk Grove

Atwater, B.F. and Marchand, D.E., 1980.

Elmira

Bryant, W.A. (compiler), 2005; Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000; Witter, R.C., Knudsen, K.L., Sowers, J.M., Wentworth, C.M., Koehler, R.D. and Randolph, C.E., 2006.

Florin

Atwater, B.F., 1982.

Galt

Atwater, B.F. and Marchand, D.E., 1980.

Goose Creek

Bartow, J.A. and Marchand, D.E., 1979.

Honker Bay

Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000; Witter, R.C., Knudsen, K.L., Sowers, J.M., Wentworth, C.M., Koehler, R.D. and Randolph, C.E., 2006.

Isleton

Atwater, B.F., 1982; Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Jersey Island

Atwater, B.F., 1982; Bryant, W.A. (compiler), 2005; Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Liberty Island

Atwater, B.F., 1982; Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Linden

Marchand, D.E. and Bartow, J. A., 1979; Cosby and Carpenter, 1937.

Lockeford

Marchand, D.E. and Bartow, J. A., 1979.

Lodi North

Marchand, D.E. and Atwater, B.F., 1979.

Lodi South

Atwater, B.F., 1982; Marchand, D.E. and Atwater, B.F., 1979; Cosby and Carpenter, 1937.

Rio Vista

Atwater, B.F., 1982; Bryant, W.A. (compiler), 2005; Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Saxon

Helley, E.J. and Harwood, D.S., 1985; Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000.

Sloughhouse

Bartow, J.A. and Marchand, D.E., 1979.

Terminus

Atwater, B.F., 1982; Marchand, D.E. and Atwater, B.F., 1979.

Thornton

Atwater, B.F., 1982; Marchand, D.E. and Atwater, B.F., 1979.

Waterloo

Marchand, D.E. and Bartow, J. A., 1979.

REFERENCES CITED

- Atwater, B.F., 1982, Geologic maps of the Sacramento-San Joaquin Delta, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1401, scale 1:24,000.
- Atwater, B.F. and Marchand, D.E., 1980, Preliminary maps showing late Cenozoic deposits of the Bruceville, Elk Grove, Florin, and Galt 7.5-minute quadrangles, Sacramento and San Joaquin counties, California: U.S. Geological Survey Open-File Report 80-849.
- Bartow, J.A. and Marchand, D.E., 1979, Preliminary geologic map of Cenozoic deposits of the Clay Area, California: U.S. Geological Survey Open-File Report 79-667.
- Bryant, W.A. (compiler), 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0: California Geological Survey Web Page: http://www.consrv.ca.gov/CGS/information/publications/QuaternaryFaults_ver2.htm (last accessed 2009/06/02).
- Clark, L.D., 1964, Stratigraphy and structure of part of the western Sierra Nevada metamorphic belt, California: U.S. Geological Survey Professional Paper 410, 70 p.
- Cosby, S.W. and Carpenter, E.J., 1937, Soil Survey of the Lodi area, California: U.S. Department of Agriculture, 52 p., 1:62,500.
- Graymer, R.W., Jones, D.L. and Brabb, E.E., 2002, Geologic map and map database of northeastern San Francisco Bay Region, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2403, <http://pubs.usgs.gov/mf/2002/2403/> (last accessed 2009/10/01).
- Hansen, D.T., West, G.J., Welch, P., Simpson, B., 2001, Geomorphology_Delta.mdb - Geology of the Sacramento - San Joaquin Delta, California: U.S. Bureau of Reclamation, archived on the Cal Atlas Web Site: <http://gis.ca.gov/ceic/showSourceXML.epl?id=29584;style=1> (last accessed 2009/10/01).
- Helley, E.J. and Harwood, D.S., 1985, Geologic Map of Late Cenozoic Deposits of the Sacramento Valley and Northern Sierran Foothills, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1790.
- Knudsen, K.L., Sowers, J.M., Witter, R.C., Wentworth, C.M. and Helley, E.J., 2000, Preliminary maps of Quaternary deposits and liquefaction susceptibility, nine-county San Francisco Bay Region, California: A Digital Database: U.S. Geological Survey Open-File Report 00-444: <http://pubs.usgs.gov/of/2000/of00-444/> (last accessed 2001/10/01).
- Marchand, D.E. and Atwater, B.F., 1979, Preliminary geologic map showing Quaternary deposits of the Lodi Quadrangle, California: U.S. Geological Survey Open-File Report 79-933.
- Marchand, D.E. and Bartow, J. A., 1979, Preliminary geologic map of Cenozoic deposits of the Bellota Quadrangle, California: U.S. Geological Survey Open-File Report 79-664.
- Retzer, J.L., Glassey, T.W., Goff, A.M., and Harradine, F.F., 1951, Soil survey of the Stockton area: U.S. Department of Agriculture, 121 p., 1:31,680.
- Witter, R.C., Knudsen, K.L., Sowers, J.M., Wentworth, C.M., Koehler, R.D. and

Randolph, C.E., 2006, Maps of Quaternary deposits and liquefaction susceptibility in the central San Francisco Bay Region, California: U.S. Geological Survey Open-File Report 2006-1037:

<http://pubs.usgs.gov/of/2006/1037/>

(last accessed 2009/10/01).