

Selected Information Resources About the Geology and Natural History of the San Francisco Bay Area

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The following selected information resources can be useful for further exploration of the geology and natural history of the San Francisco Bay area. These resources are arranged by subject categories covering general resources, biology, geographic information, geology, natural hazards, and water. Both electronic and paper publications are included. Paper copies may be available at large academic and public libraries, or from the U.S. Geological Survey libraries.

The abundance of literature about Bay area geology and natural resources is illustrated by a search on the GeoRef database. Produced by the American Geological Institute, this database covers the period 1795 to the present and indexes primarily geoscience journal articles. Searching GeoRef by the names of the counties that make up the greater San Francisco Bay area retrieves more than 5,600 citations.

General Resources

Alt, D., and Hyndman, D.W., 2000, *Roadside geology of Northern and Central California: Missoula, Montana, Mountain Press Publishing Company*, 369 p.

This book gives a general picture of the geology of California. The chapters on the coastal mountains and the coastline describe some of the prominent geologic features that can be seen from major roadways.

California Department of Conservation, Division of Mines and Geology, 1971. *California Geology* [serial]. Sacramento, California.

The bimonthly publication, *California Geology*, is intended for anyone interested in the geologic landscape of the State. Articles are well illustrated with photographs and maps. It also acts as a bulletin about Division of Mines and Geology projects and products. Of special note is the "Teacher Feature" in each issue.

Geoscience Information Society, Guidebooks Committee, Richard Spohn, chair, 1996, *Union list of field trip guidebooks of North America Online* (6th ed.): American Geological Institute. Retrieved May 30, 2001, from the World Wide Web at <http://www.agiweb.org/pubs/unionlist>.

Field trip guidebooks are very valuable for in-depth geologic interpretation for a geographic area. This publication indexes fieldtrips conducted through 1988 by geographic location. The State of California has an extensive list. Many of these guidebooks are available at large academic libraries or at the U.S. Geological Survey Libraries.

Harden, D.R., 1998, *California geology: Upper Saddle River, New Jersey, Prentice Hall*, 479 p.

Harden has written this textbook as an introduction to the diversity and scope of California geology. Of particular interest is the emphasis on planning for and mitigation of future natural hazards.

Norris, R.M., and Webb, R.W., 1990, *Geology of California* (2nd ed.): New York, John Wiley & Sons, Inc., 541 p.

The geology of California as divided into geomorphic provinces, giving detailed explanations of the special features that are unique to each of them.

Biology—animals, plants

California Resources Agency, 2001, *CERES California Environmental Resources Evaluation System*. Retrieved May 24, 2001, from the World Wide Web at <http://ceres.ca.gov>.

As the primary environmental Web site for California resources, CERES has information arranged by geographic area or theme. It has direct links to educational resources pertaining to watershed and wetlands issues. Under a geographic area, searches can be by bioregion, county, or watershed.

Thompson, J., Parchaso, F., Alpine, A., Cloern, J., Cole, B., Mace, O., Edmunds, J., Baylousis, J., Luoma, S., and Nichols, F., 1999, *History and effects of exotic species in San Francisco Bay: San Francisco Bay Project, Water Resources Division*. Retrieved June 11, 2001, from the World Wide Web at <http://sfbay.wr.usgs.gov/access/exotic-species/index.html>.

This is a poster that lists exotic species in San Francisco Bay, how they got there, what impact they have had on the ecosystem, and what is being done about them.

University of California, Berkeley, 2001, Digital library project About the collections. Retrieved May 24, 2001 from the World Wide Web at http://elib.cs.Berkeley.edu/arch/about_collection.html.

The University of California at Berkeley has been instrumental in gathering and mounting datasets for the California digital library project. One of the collections contains botanical data with taxonomical information for more than 8,000 native California plants and is linked to photos and maps. The zoological data comprise similar datasets for amphibians, birds, mammals, and reptiles. There are also geographical data derived from the Bureau of the Census Tiger records for the San Francisco Bay area.

Geographic Information/Maps—geology, topography, bathymetry

Brown, C., Acevedo, W. and Buchanan, J.T., (n.d.), Dynamic mapping of urban regions, growth of the San Francisco/Sacramento Region. Retrieved June 25, 2001, from the World Wide Web at http://edcwww2.cr.usgs.gov/umap/pubs/urisa_cb.html.

An animation of the historical urban growth patterns of the San Francisco-Sacramento area using 1850 to 1990 census data.

National Weather Service, 2001, National Weather Service—San Francisco Bay Area, serving the San Francisco and Monterey Bay area. Retrieved June 5, 2001, from the World Wide Web at <http://www.nws.mbay.net/home.html>.

An agency of the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service provides climatic data, real time forecasting, and warnings or advisories on a regional basis. It also has links to tide tables with correction information for specific points along the coast and estuary, and astronomical information for sunrise/sunset and moonrise/moonset.

U.S. Geological Survey, 2001, San Francisco Bay Area Regional Database (BARD). Retrieved July 6, 2001, from the World Wide Web at <http://bard.wr.usgs.gov>.

This site has digital data in the form of spatial elevation models and orthophoto quadrangles. It includes free software to view the images.

U.S. Geological Survey, 2001, National Geologic Map Database Homepage. Retrieved May 30, 2001, from the World Wide Web at http://ngmdb.usgs.gov/ngmdb/ngmdb_home.html.

The National Geologic Map Database gives citations to maps and related data on geology, geochemistry, hazards, geophysics, paleontology, and marine geology. There are links to both paper and digital maps, to a geologic names database, and to a geographic names index database.

U.S. Geological Survey, (n.d.), SFPORTS San Francisco Bay navigational aids. Retrieved June 11, 2001, from the World Wide Web at <http://sfports.wr.usgs.gov>.

This page is a creation of the U.S. Geological Survey, National Ocean Service, California Office of Oil Spill Prevention and Response, and the Marine Exchange of San Francisco Bay. It shows real-time data for tides, currents, winds, water temperature, air temperature, and air pressure and short-term forecasts of water level and currents.

U.S. Geological Survey, Western Region Coastal and Marine Geology, 2001, Pacific seafloor mapping project. Retrieved June 13, 2001, from the World Wide Web at <http://walrus.wr.usgs.gov/pacmaps>.

Images from this home page give the viewer the choice to see shaded relief or a perspective image of San Francisco Bay's bathymetry.

U.S. Geological Survey, 1997, USGS TerraWeb Central California DEM and bathymetry images. Retrieved June 7, 2001, from the World Wide Web at <http://terraweb.wr.usgs.gov/projects/SFBay/ccdembth.html>.

Digital elevation models of various areas of central California, including the San Francisco Bay area, are available. They can be used to map and study surficial features of the region.

Geology- general geology, subduction, tectonics

Atwater, B. F., Hedel, C.W., and Helley, E.J., 1977, Late Quaternary depositional history, Holocene sea-level changes, and vertical crustal movement, southern San Francisco Bay, California: U.S. Geological Survey Professional Paper 1014, 15 p.

An explanation of estuarine deposits of southern San Francisco Bay from Pleistocene through the Holocene in relation to sea-level changes and subsidence. Includes maps and illustrations.

Blake, M.C., McLaughlin, R.J., and Jones, D.L., 1989, Terranes of the northern coast ranges in Blake, M.D., Jr., Harwood, D.S., McLaughlin, R.J., Jayko, A.S., Irwin, W.P., Dodge, F. C.W., Jones, D.L., Miller, M.M. and Bullen, T., Tectonic evolution of Northern California, Sausalito to Yosemite National Park, California: International Geological Congress, 28th, 1989, Washington, D.C., Field trip guidebook T108, International Geological Congress, 28th, 1989, Washington, D.C., p. 3-18.

This chapter and accompanying field guide give a detailed description of the terranes of the California Coast Range ophiolite in relation to belts of the Franciscan Complex from slightly south of San Francisco Bay northward.

California Division of Mines and Geology, 2001, California Division of Mines and Geology home page. Retrieved May 30, 2001, from the World Wide Web at <http://www.consrv.ca.gov/dmg/index.htm>.

As California's state geological survey, the Division of Mines and Geology collects geologic data and distributes information regarding earthquakes and landslides, minerals, mining, oil, gas, and geothermal resources. The division also maps watershed regions. The home page lists Notes about single subjects such as the state gem, mineral, rock and fossil, how earthquakes are measured, information about debris flows, and how to look for fossils. Some reports can be downloaded from their Web site.

Magoon, L., 2001, Natural oil and gas seeps in California. Retrieved June 19, 2001, from the World Wide Web at <http://seeps.wr.usgs.gov/seeps/index.html>.

This site describes the importance of natural oil and gas seeps in California, what they are, where they are, including locations in Central California, their use by the native peoples, and a link to the most famous one of all—the La Brea Tar Pits.

Rogers, T.H., 1993, Geology of the Hollister and San Felipe quadrangles, San Benito, Santa Clara, and Monterey counties, California: California Division of Mines and Geology, Open-File Report 93-01, 26 p., 3 maps.

This report covers the geologic, seismic and economic geology of the Hollister and San Felipe quadrangles. It describes the seismic setting and history of Hollister, including pictures of the destruction from the 1906 San Francisco Earthquake. It has an inventory of existing and potential landslides and paleontological data for the area.

Sloan, D., and Wagner, D.L., eds., 1991, Geologic excursions in northern California San Francisco to the Sierra Nevada: California Division of Mines and Geology Special Publication 109, 130 p.

This field trip guidebook for the joint meeting of Geological Society of America, Cordilleran Section, and the Seismological Society of America in San Francisco covers the geological setting of the San Francisco Bay Area, the Merced Formation south of San Francisco, the Franciscan Complex and Coast Range ophiolite, and the Great Valley sequence.

U.S. Geological Survey, 2001, Geologic information about California. Retrieved May 30, 2001, from the World Wide Web at <http://geology.wr.usgs.gov/docs/stateinfo/CA.html>.

This site gives useful links to the more general categories of research being conducted in California by the U.S. Geological Survey. Real-time earthquake activity, coastal studies, geologic mapping projects, oil and gas seeps, geophysical mapping, mineral resources, and landslide research are among the topics, with many concentrating on the San Francisco Bay area.

U.S. Geological Survey, 2000, San Francisco Bay Region Project Western Earth Surface Processes Team. Retrieved June 5, 2001, from the World Wide Web at <http://sfgeo.wr.usg.gov>.

This is the primary site for geologic maps, landslide studies, and geologic information about the San Francisco Bay area. Two projects currently being developed are 3-D modeling of the region and a scenario-based hazard map of the Oakland-Berkeley hills.

Wahrhaftig, C., and Sloan, D., eds., 1989, Geology of San Francisco and vicinity: International Geological Congress, 28th, 1989, Washington, D.C., Field trip guidebook T105, 69 p.

This field trip guidebook provides a good overview of the diversity of geologic features and tectonic activity in the San Francisco Bay region. Tectonostratigraphic terranes are defined and the possible origin of the Salinian block is discussed, as is the development of the San Andreas Fault system. Areas of volcanic rocks ranging in age from 24 Ma to less than 0.01 Ma are also delineated.

Wahrhaftig, C., 1984, A streetcar to subduction and other plate tectonic trips by public transport in San Francisco (rev. ed.): Washington, D.C., American Geophysical Union, 76 p.

Wahrhafting uses public transportation to explore plate tectonic evidence in rock formations exposed in San Francisco, the Marin Headlands, Angel Island, and along the Hayward Fault. Includes a geologic time scale, glossary, and selected bibliography. There are many maps and drawings of geologic features.

Hazards earthquakes, landslides, liquefaction, tsunamis

Association of Bay Area Governments, 2001, Bay area shaking hazard maps. Retrieved June 13, 2001, from the World Wide Web at <http://www.abag.ca.gov/bayarea/eqmaps/mapsba.html>.

In association with the U.S. Geological Survey, ABAG has made available on the Internet earthquake ground-shaking intensity maps for all cities of the greater San Francisco Bay area. Maps show the degree of expected shaking according to different fault scenarios. There are also maps showing how areas shook in the 1906 and 1989 earthquakes in the region.

Association of Bay Area Governments, 2001, The REAL dirt on liquefaction. Retrieved June 13, 2001, from the World Wide Web at <http://www.abag.ca.gov/bayarea/eqmaps/liquefac/liquefac.html>.

Similar to the earthquake hazard maps, the liquefaction susceptibility maps and liquefaction hazard maps give information regarding probable damage by liquefaction in the San Francisco Bay area. There are tips on living with liquefaction and how it might impact the community.

Brown, W.M. III, ed., 1989, Landslides in Central California: American Geophysical Union, International Geological Congress, 28th, 1989, Washington, D.C. Field Trip Guidebook T381, 98 p.

A series of workshops about landslides induced by water or earthquakes and how the geology of the San Francisco Bay region requires comprehensive landslide mapping and related mitigation studies.

Collier, M., 1999, A land in motion California's San Andreas Fault: Berkeley, California, University of California Press, 128 p.

Accompanied by aerial photography of some of the San Andreas Fault's features, this is a good explanation of the San Andreas Fault and how scientists study it.

Highland, L.M., Godt, J., Howell, D., and Savage, W.Z., 1998, El Niño 1997-98: Damaging landslides in the San Francisco Bay Area: U.S. Geological Survey Fact Sheet 089-98, 2 p.

This is a brief report on the effects of El Niño during the winter of 1997-98 and the resulting economic impacts for the ten-county San Francisco Bay area.

Hirschfeld, S.E., and Klein, F., 1996, The Hayward Fault we can't ignore it [videorecording]: U.S. Geological Survey Open-File Report 95-814 A, B.

This videorecording gives the destructive history and potential future hazards along the Hayward Fault. Includes a tour of the Hayward Fault and discussion of the possibility of widespread damage for East Bay communities.

Lajoie, K.R., and Mathieson, S.A., 1998, 1982-83 El Niño coastal erosion San Mateo County, California: U.S. Geological Survey. Retrieved May 30, 2001, from the World Wide Web at <http://walrus.wr.usgs.gov/elnino/SMCO-coast-erosion>.

This report includes maps of erosion or stability for the approximately fifty miles of San Mateo County coastline. Lajoie and Mathieson discuss the primary causes of coastal erosion as a natural process rather than as a natural hazard with the purpose of alerting planners and residents to help minimize damage in El Niño years.

Ryan, H., Gibbons, H., Hendley, J.W., II, and Stauffer, P.H., 1999, El Niño sea-level rise wreaks havoc in California's San Francisco Bay region: U.S. Geological Survey Fact Sheet 175-99, 4 p.

El Niño storms of 1997-98 produced high sea levels that in turn caused millions of dollars in damage by coastal flooding and erosion. Sea level records for the past 100 years are presented and the variations in water temperature and sea level are graphically displayed.

Sylvester, A.G., and Crowell, J.C., 1989, The San Andreas Transform Belt—Long Beach to San Francisco, California: International Geological Congress, 28th, 1989, Washington, D.C., Field Trip Guidebook T309, 119 p.

The history and tectonic setting of the San Andreas transform belt is given, along with its seismic creep rate. Of particular interest are the descriptions of activity in and around Hollister.

Tyler, M.B., 1995, Look before you build Geologic studies for safer land development in the San Francisco Bay Area: U.S. Geological Survey Circular 1130, 54 p.

The importance of geologic studies for hazards mitigation is emphasized to avoid loss of life and property. The value of site specific maps for individual parcels vs. general hazardous zone maps is discussed. Tyler also relates the effects of the Loma Prieta earthquake on rebuilding efforts by communities and what lessons can be learned and reflected in building standards.

U.S. Geological Survey, 1995 [rev. and abridged 1997], Debris-flow hazards in the San Francisco Bay region: U.S. Geological Survey Fact Sheet 112-95, 4 p. Retrieved May 30, 2001, from the World Wide Web at http://landslides.usgs.gov/html_files/nlic/sfbayfs97.pdf.

This fact sheet describes the debris flow hazards that exist in the San Francisco Bay area, what they are, where they are located, and how to avoid becoming a victim of one.

U.S. Geological Survey, 1997, San Francisco Bay region landslide folio home page. Retrieved June 13, 2001, from the World Wide Web at <http://wrgis.wr.usgs.gov/open-file/of97-745>.

This folio is composed of six related reports and maps on past landslides, earth flows, and debris flows and on the importance of tracking rainfall thresholds on them for the San Francisco Bay region.

U.S. Geological Survey, 2000, USGS California Hazards-Landslides. Retrieved May 30, 2001, from the World Wide Web at <http://ca.water.usgs.gov/land>.

This site has reports and links to landslide facts and images and landslide hazard maps for the San Francisco Bay area and San Mateo coastal erosion. There is information on landslide recognition and safety. In addition, there is a link to the National Landslide Hazards Program located in Denver, Colorado.

U.S. Geological Survey, 2001, USGS Earthquakes Hazards program—Northern California. Retrieved May 30, 2001, from the World Wide Web at <http://quake.wr.usgs.gov>.

This site has everything about earthquakes and links to other sites that provide earthquake information around the world. It has real-time earthquake maps of California-Nevada, the United States and the world. For the San Francisco area, there is a special regional map, an earthquake probability report, and information on how to prepare for earthquakes at home and at the workplace. A special section addresses topics of particular interest, and there are links to additional resources.

U.S. Geological Survey, 2001, Western Region Coastal and Marine Geology Table of Contents. Retrieved May 30, 2001, from the World Wide Web at <http://walrus.wr.usgs.gov/sitetoc.html>.

This is a portal to research and information from the Western Region Coastal and Marine Geology Team. Topics include environmental quality and pollution, wetlands, coastal erosion with respect to El Niño weather, and salinity of estuarine waters. Of particular interest may be the online publication titled “Tsunami record from the Great 1906 San Francisco Earthquake” (<http://walrus.wr.usgs.gov/tsunami/1906.html>).

Wallace, R.E., ed., 1990, The San Andreas Fault system, California: U.S. Geological Survey Professional Paper 1515, 283 p.

The history, geology, geophysics, and seismology are covered in this comprehensive study of the San Andreas Fault system. It explains the processes occurring along the plate boundaries. There are many photographs and illustrations and an extensive bibliography.

Water—groundwater, surface water, tide tables, wetlands

Alpers, C.N., and Hunerlach, M.P., 2000, Mercury contamination from historic gold mining in California: U.S. Geological Survey Fact Sheet 061-00, 6 p. Retrieved May 21, 2001, from the World Wide Web at <http://ca.water.usgs.gov/mercury>.

Use of mercury was an important element of gold mining in California, and much of it came from the Coast Ranges in and near the San Francisco Bay area. The effects of mercury contamination to human health, the sites of mercury contamination, and location of fish consumption advisories are discussed in this fact sheet.

Association of Bay Area Governments, 2001, San Francisco Estuary Project. Retrieved May 30, 2001 from the World Wide Web at <http://www.abag.ca.gov/bayarea/sfep/sfep.html>.

The San Francisco Estuary Project is part of the National Estuary Program to protect and improve water quality and natural resources of estuaries nationwide. The project has information on wetlands, wildlife, aquatic, and land use resources that pertain to the San Francisco Bay-Sacramento Delta ecosystem.

California Department of Water Resources, 2001, DWR California water page. Retrieved May 30, 2001, from the World Wide Web at <http://www.dwr.water.ca.gov>.

The home page of the California Department of Water Resources has information about the state water project, the CALFED Bay-Delta Program, river and reservoir information, and legislation relevant to California water projects. One of the DWR Web sites includes educational resources and more than 17,000 nature images.

Galloway, D.L., Jones, D.R., and Ingebritsen, S.E., 2000, Measuring land subsidence from space: U.S. Geological Survey Fact Sheet 051-00, 4 p.

Using Interferometric Synthetic Aperture Radar (InSAR), the subsidence of ground caused by compaction of aquifer systems can be detected and measured by satellite. Of particular interest is the section on the subsidence in Santa Clara Valley, where subsidence of 14 feet occurred between 1910 and 1995.

Ingebritsen, S.E., Ikehara, M.E., Galloway, D.L., and Jones, D.R., 2000, Delta subsidence in California The sinking heart of the state: U.S. Geological Survey Fact Sheet 005-00, 4 p.

The delta and the San Francisco estuary are the subject of this fact sheet on the danger of subsidence and the possibility of degradation of water quality if large amounts of fresh water are diverted to other areas.

National Ocean Service, 2001, Marine Sanctuaries. Retrieved May 30, 2001, from the World Wide Web at <http://www.sanctuaries.nos.noaa.gov/oms/oms.html>.

The home page for the Nation's marine sanctuaries links to individual sanctuary Web sites with information about biological, physical, archaeological, and cultural resources. Education activities are also included. The San Francisco Bay area is home to the Cordell Bank, Gulf of the Farallones, and Monterey Bay Marine Sanctuaries.

Oakland Museum of California, 2001, Guide to San Francisco Bay area creeks The Oakland Museum of California Creek and Watershed Information Source. Retrieved May 23, 2001, from the World Wide Web at <http://www.museumca.org/creeks>.

This site has a historical creek map of San Francisco, outlines the current progress of a creek-mapping project in the East Bay and includes images of topographic maps from the late 1800s of watershed areas around San Francisco Bay and links to regional and local information. There is also an animation of the stages of the evolution of San Antonio Creek into the Oakland Estuary.

U.S. Geological Survey, 2001, Access USGS—SF Bay and Delta. Retrieved May 24, 2001, from the World Wide Web at <http://sfbay.wr.usgs.gov>.

This site pulls together biological, geological, mapping, and water resources research studies conducted by the USGS. Some of the topics include the introduction of exotic species into the waterways, restoration of wetlands, and hazards in and around San Francisco Bay.

U.S. Geological Survey, 2001, USGS water resources of California table of contents. Retrieved May 30, 2001, from the World Wide Web at <http://water.wr.usgs.gov/toc.html>.

The table of contents page leads to an incredible number of information resources, available primarily from the USGS. Topics are arranged by the themes of natural resources, environmental concerns, and hazards. Real-time water data, historical data, the hydrodynamics of San Francisco Bay, land subsidence information, San Mateo coastal erosion, and potential San Francisco Bay landslides and seawater intrusion are a few of the subjects covered. Specific reports address issues from around California. There are links to comparable State agencies and to other Federal entities that give weather, tides, and water quality information. There is a category for water education with links to other interesting science resources that include museums and universities.

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