DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Annotated bibliography of selected publications by the U.S. Geological Survey pertinent to a sand budget for the California coast from Ragged Point, San Luis Obispo County, north to the Oregon border

by

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Open-File Report 88-590

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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TABLE OF CONTENTS

TABLES

INTRODUCTION

This report annotates selected publications by the U.S. Geological Survey that contain information pertinent to a sand budget for the California coast from Ragged Point in San Luis Obispo County north to the Oregon Border. In addition to annotations, a listing of U.S. Geological Survey aerial photography of the coastline of the study area is presented. Annotations are included for reports, maps, atlases, and ground photographs published through 1984 and tend to concentrate on portions of the publications relevant to a sand budget. Since publications are selected on the basis of their applicability to a sand budget study, publications on the geologic history, geophysics, and ground water of the area are not well represented in this report. Despite this selection process, the report can be used to find much of the work published by the U.S. Geological Survey before 1984 about the coastal system of central and northern California.

There are three sections to this report. The first section contains annotated bibliographies of publications arranged in alphabetical order by the first authors last name. The second section presents a table of aerial photographs of the coastline taken from 1940 to 1978 by the USGS. In the final section the publications are indexed by county, inland-to-offshore position, and subject. The subject index is very general breaking the reports into four categories; hydrology, geologic record, geomorphology, and sediments.

A variety of methods were used in the preparation of this report in an attempt to make it complete. These methods included scanning compilations of U.S. Geological Survey literature, searching computer databases, and interviewing scientists currently working at the U.S. Geological Survey Western Regional Center in Menlo Park, California. Scanning compilations was, by far, the most productive method for finding pertinent literature. The main sources for this report are two of these compilations, Publications by the U.S. Geological Survey and Reports for California by Geological Survey Water-Resources Division. Information on U.S. Geological Survey aerial photographs was gathered from flight-line diagrams available from the National Cartographic Information Center.

The literature search and initial writing for this report were funded by the San Francisco District of the Army Corps of Engineers as part of the Coast of California Storm and Tidal Wave Study. The final preparation was done under the auspices of the U.S. Geological Survey. The author would like to thank three colleagues; Roberto Anima, Beth Laband, and Abby Sallenger, for their helpful criticism of the manuscript.

ANNOTATED BIBLIOGRAPHY

Alpha, T. R., Dingler, J. R., Jones, D. R., Molzan, D. E., Peterson, C. D., and Morley, J. M., 1981, Physiographic diagram of the upper Carmel Canyon and Point Lobos, California: U.S. Geological Survey Open-File Report 81-440, 1 sheet.

This is one in a series of physiographic diagrams by Tau Rho Alpha and others. A physiographic diagram gives a perspective view of the topography. The diagram is accurate, although it is difficult to measure distances on it because the scale varies according to position on the diagram. The direction of view is toward the southeast in this portrait of Carmel Canyon and the Point Lobos peninsula. The large scale allows manmade structures to be recognized. Carmel Canyon, which has its head at Monastery Beach, descends steeply and eventually connects with Monterey Canyon to the northwest. Outcrops depicted in Carmel Canyon and on Point Lobos are predominately granite.

Arnold, R., ca. 1904, Photograph of north of the mouth of Waddell Creek, looking south, Santa Cruz County, California : Photograph no. 12 in Subject Album v. 51, p. 14, at the U.S. Geological Survey Photographic Library, Denver, Colorado.

A view of the monoclinal structure in Oligocene-Miocene shales just north of the mouth of Waddell Creek, looking south. Horses and buggy on the beach in the photograph's foreground can be used for scale.

Arnold, R., May 29, 1905, Photograph taken 2.5 miles north of Pigeon Point, San Mateo County, California: U.S. Geological Survey Photographic Library Photograph (no. 109), Denver, Colorado.

A view of thin-bedded sandstones in the Pescadero series, 2 1/2 miles north of Pigeon Point, San Mateo County, California. A rocky beach is in the foreground of the photograph. The photograph was taken at 10 A.M. on May 29, 1905, a partly hazy day.

Arnold, R., May 29, 1905, Photograph taken 2.5 miles north of Pigeon Point, San Mateo County, California: U.S. Geological Survey Photographic Library Photograph (no. 110), Denver, Colorado.

A view, looking northwest, of steeply dipping conglomerate of the Chico Formation on the coast 2 1/2 miles north of Pigeon Point, San Mateo County, California. The conglomerate forms a wave-cut platform.

Arnold, R., May 30, 1905, Photograph of Pigeon Point light station, looking northwest, San Mateo County, California: U.S. Geological Survey Photographic Library Photograph (no. 112), Denver, Colorado.

A view of Pigeon Point light station, looking northwest, showing the lowest marine terrace and a conglomerate promontory at the shoreline. This photograph was taken at 8:30 A.M. on May 30, 1905. The day was partly hazy.

Arnold, R., May 30, 1905, Photograph taken 1 mile east of Point Ano Nuevo, San Mateo County, California: U.S. Geological Survey Photographic Library Photograph (no. 117), Denver, Colorado.

A view looking east from the top of the 40-foot marine terrace, 1 mile east of Point Ano Nuevo. Large scale cusps are apparent on the shoreface of the beach below the cliffs. This photograph was published in 1909 as figure 7 in U.S. Geological Survey Folio 163.

Arnold, R., May 31, 1905, Photograph of the mouth of Waddell Creek, showing sand dune, Santa Cruz County, California: Photograph no. 118 in Subject Album v. 26, p. 64, at the U.S. Geological Survey Photographic Library, Denver, Colorado.

A view looking southeast across the mouth of Waddell Creek, Santa Cruz County, showing a sand dune "climbing" up the terrace. This photograph was taken at 12:30 P.M. on May 31, 1905.

Arnold, R., May 31, 1905, Photograph of San Vicente Creek, Santa Cruz County, California: Photograph no. 120 in Subject Album v. 91, p. 7, at the U.S. Geological Survey Photographic Library, Denver, Colorado.

A view looking southwest along the east side of the mouth of San Vincente Creek, showing a small ravine on the left which has been "robbed" by the creek. There is a waterfall of a small stream in the foreground. This photograph was taken at 4:00 P.M. on May 31, 1905.

Arnold, R., 1909, Photograph of a natural bridge in the Monterey Shale, Santa Cruz County, California: Photograph no. 16 in the general collection at the U.S. Geological Survey Photographic Library, Denver, Colorado.

A view, three miles west of Santa Cruz, looking seaward through a natural bridge in the Monterey Shale. The bridge is overlain by 15 feet of Quaternary (younger than 2 million years old) deposits which form the surface of the lowest marine terrace. A horse and buggy is on top of the bridge and can be used for scale. This photograph was published as figure 6 in U.S. Geological Survey Folio 163 in 1909.

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, p. 15.

Sediments collected for bridge foundation studies in southern San Francisco Bay, Calif., record estuaries that formed during Sangamon (100,000 years ago) and post-Wisconsin (less than 10,000 years ago) high stands of sea level. The evolution of the present-day bay can be reconstructed from the elevations and C14 ages of plant remains from the 13 core samples collected.

Sea level in the vicinity of southern San Francisco Bay rose about 2 cm/yr from 9,500 to 8,000 years ago. The rate of relative sea-level rise then declined about tenfold from 8,000 to 6,000 years ago, and it has averaged 0.1-0.2 cm/yr from 6,000 years ago to the present. This submergence history indicates that the rising sea entered the Golden Gate 10,000-11,000 years ago and spread across land areas as rapidly as 30 m/yr until 8,000 years ago. Subsequent shoreline changes were more gradual because of the decrease in rate of sea-level rise.

Atwater, B., 1978, Central San Mateo County, California: Land-use controls arising from erosion of seacliffs, landsliding, and fault movement, in Robinson, G.D., and Spieker, A.M. eds., "Nature to be commanded ... " earth science maps applied to land and water management: U.S. Geological Survey Professional Paper 950, p. 11-19.

One of 9 short articles appearing in a soft-covered, oversized professional paper illustrating the use of maps in land and water management. This article focuses on the area from S. Half Moon Bay to Montara. Five color, small scale (about 1:125,000) maps present information about the coastline's: (1) general geology, (2) average rates of bluff erosion based on aerial and ground photography from 1926 to 1970 and maps made from 1850 to 1956, (3) resistance to erosion, (4) landslides more than 50 feet long, and (5) subaerial slopes. Planning maps showing county regulations for bluff-top development and maximum residential density allowed by San Mateo are also included *in this* paper.

Back, W., 1957, Geology and ground-water features of the Smith River Plain, Del Norte County, California: U.S. Geological Survey Water-Supply Paper 1254, p. 76.

Geologic information in this report is presented in a 1:62,500 scale color geologic map. The map shows that the ten miles of coastline north of Pt. George to the mouth of the Smith River is covered with sand dunes. Also included in this report is precipitation information. For example; maximum, normal, and minimum monthly precipitation near Crescent City is summarized in a bar graph.

Bergquist, J. R., 1978, Depositional history and fault-related studies, Bolinas Lagoon, California: U.S. Geological Survey Open-File Report 78-802, p. 164.

This report investigates the depositional system of Bolinas Lagoon. An emphasis is placed on the effects of the 1906 earthquake and logging in the mid-nineteenth century on the lagoon. Topographic surveys taken from 1854 to 1950 and previously unpublished photographs taken from 1906 to 1977 are used to elucidate the changing morphologies of the lagoon and bluffs near the lagoon. Seismic profiling and coring were used to determine the low-resolution, long-time-frame depositional history.

Four of the major points made are: (1) cliffs to the northeast of the lagoon receded 30-70 m between 1854 and 1929 and are continuing to erode, (2) mid-nineteenth-century redwood logging correlates with sediment accumulation rates of 1.3 to 1.9 cm/yr that are three to six times higher than post-1906 rates of 0.3 to 0.4 cm/yr, (3) up to 115 cm of sediment has accumulated since 1849 in some parts of the lagoon, (4) an anomalously coarse-grained sediment was found during coring that may correlate with the 1906 earthquake.

Blodgett, J. C. and Poeschel, K. R., 1984, Peak flow, volume, and frequency of the January 1982 flood, Santa Cruz Mountains and vicinity, California: U.S. Geological Survey Open-File Report 84-583, p. 22.

Data for 5 precipitation stations and 37 streamflow sites located in the Santa Cruz Mountains were used to compare the January 1982 and December 1955 floods. The study area included basins with major flooding and adjacent basins both east and west of the Santa Cruz Mountains divide and south of the major areas of flooding. Recurrence intervals of the precipitation and peak flow and the effects of prestorm conditions, such as antecedent precipitation, on runoff were evaluated.

Brabb, E. E. and Pampeyan, E. H., 1972, Preliminary geologic map of San Mateo County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-328, scale 1:62,500, 1 sheet, p. 10.

A single sheet, 1:24,000 scale, black-and-white, geologic map presenting detailed information including bedding attitudes and locations of small faults. Special attention is given to Holocene (younger than 10,000 years old) deposits, which are divided in 7 mapping units. This map is superseded by a color version published in 1983 by Brabb and Pampeyan as U.S. Geological Survey Miscellaneous Investigation Series Map I- 1257A. However, this map is more useful than the latter map for distinguishing the boundaries of small outcrops.

Brabb, E. E. and Pampeyan, E. H., 1972, Preliminary map of landslide deposits in San Mateo County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-334, scale 1:62,500, 1 sheet.

A single sheet, 1:62,500 scale map of landslides larger than 50 feet in maximum dimension. Direction of slumping shown for about half of the slides. The largest slide along this section of coast is near Pt. San Pedro in the Devils Slide area. Thorton Beach in Daily City has numerous small slides. The coast is free of mapped slides elsewhere in the mapped area except between San Gregorio Beach and Martins Beach, and between Pillar Point and Moss Beach.

Brabb, E. E. and Pampeyan, E. H., 1978, Landslide susceptibility in San Mateo County, California: U.S. Geological Survey Miscellaneous Field Studies Map 360, scale 1:62,500.

A black-and-white, 1:62,500 scale map classifying landslide susceptibility into 7 categories from low to high. The map was constructed from three earlier maps: (1) a geologic map of San Mateo County (Brabb and Pampeyan, 1972, USGS MF-328); (2) a map inventory of landslides (Brabb and Pampeyan, 1972, USGS MF-344) ; and (3) an unpublished experimental slope map.

Brabb, E. E., 1980, Preliminary geologic map of the La Honda and San Gregorio quadrangles, San Mateo County, California: U.S. Geological Survey Open-File Report 80-245, scale 1:24,000.

This 1:24,000 scale, black-and-white, geologic map includes the San Mateo County coastline between 1.5 miles north of Pigeon Point and Martin's Beach. The map shows numerous bedding attitudes. A major map feature is the northwest-trending San Gregorio Fault zone which intersects the coastline about 1/2 mile north of San Gregorio Beach.

Brabb, E. E. and Pampeyan, E. H., 1983, Map showing direction and amount of dip in sedimentary rocks in San Mateo County, California: U.S. Geological Survey Miscellaneous Investigation Series Map I-1257C, scale 1:62,500, 1 sheet.

A 1:62,500 scale map that color codes the bedding dips. Good for an overall impression of the variability of bedding dips in San Mateo County. The raw data is also plotted on the map. Along the coast the maximum dips are about 70 degrees.

Brabb, E. E., 1983, Geologic map of San Mateo County, California: U.S. Geological Survey Miscellaneous Investigation Series Map I-1257A, scale 1:62,500, 1 sheet, p. scale 1:62,500, 1 sheet.

A color 1:62,500 scale map with bedding attitudes. Coloring was done by a digital process using a computer and a laser. The process did not detect small map units, especially thin elongate units, causing errors in their coloration. A more useful map for delineating the small units is, " A preliminary geologic map of San Mateo County" by Brabb and Pampeyan published as U.S.G.S. Miscellaneous Field Studies Map MF-328 in 1972.

Brown, W. M., III, 1971, A preliminary investigation of suspended-sand discharge of the Russian River, Sonoma County, California: U.S. Geological Survey Open-File Report, p. 24.

This report compiles periodic observations from November 1965 to March 1967 and daily observations from April 1967 to September 1969 to determine the suspended-sand discharge of the Russian River to the River's estuary. An estimated 380,000 cubic yards per year, for a 5-year period beginning October 1, 1964, reach the estuary. Initially the Russian River's sand discharge was estimated using a rating curve of suspended-sand discharge vs. average daily discharge. However, this method failed because of too few data points (25) resulting in a poorly defined relationship at high discharges, where most of the sand transport is expected to occur. So, the total suspended-sediment discharge was used and an assumed 10 percent sand or coarser component to estimate the sand transport at Guerneville gaging station. This sand discharge was extrapolated to a discharge at the estuary based on drainage area.

Two notes of caution about the report: (1) because of the complexity of sediment processes in the estuary, it is not clear how much of the sediment reaching the estuary ends up in the ocean, and (2) the data is effected by the large storms of 1964- 65.

Brown, W. M., III and Ritter, J. M., 1971, Sediment transport and turbidity in the Eel River Basin, California: U.S. Geological Survey Water-Supply Paper 1986, p. 70.

The Eel River has the highest recorded average annual suspended- sediment yield per square mile of drainage area of any river its size or larger in the United States. This yield, in tons per square mile, is more than 15 times that of the Mississippi River and more than four times that of the Colorado River.

During the 10-year period beginning October 1957, the Eel River discharged an average suspended load of more than 31 million tons per year according to measurements made at the Eel River at Scotia, the station farthest downstream on the main stem of the Eel River. An additional suspended-sediment discharge averaging more than 1 1/2 million tons per year during the same period was derived from the basin of the Van Duzen River, a tributary which enters the Eel River a few miles downstream from Scotia.

This project also determined the quantity of sediment transported by streams in different areas of the Eel River basin in order to compare sediment yields among selected regions of the basin, and studied the relation of turbidity to the concentration of suspended sediment.

Brown, W. M., III, 1973, Streamflow, sediment, and turbidity in the Mad River Basin, Humboldt and Trinity Counties, California: U.S. Geological Survey Water-Resources Investigation 36-73, p. 57.

Streamflow, sediment discharge, and turbidity characteristics, as they relate to a proposed reservoir on the Mad River near Butler Valley and the river system downstream from it, are addressed in this report. The findings are based on using pre-1970 data from 15 sites in the Mad River basin and additional data collected at three of the sites between 1970 and 1973. There is no grain-size data presented in this report.

The major findings of this study were that: (1) the Mad River discharged an average suspended-sediment load of 2,710,000 tons per year during a 13-year period beginning October 1957, (2) about 66 percent of the suspended sediment was derived from sources upstream from a proposed reservoir site on the Mad River near Butler Valley, and (3) the high rate of suspended-sediment discharge and the corresponding sediment-induced turbidity of the streamflow constitute potential problems in the operation of the proposed reservoir.

Brown, W. M., III and Jackson, L. E., Jr., 1973, Preliminary map of erosional and depositional provinces and descriptions of sediment-transport processes in the south and central San Francisco Bay region, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-515, scale 1:125,000, 3 sheets, pamphlet 21 p..

A preliminary report addressing the sediment system of the south and central San Francisco Bay region. Although mainly conceptual, examples from selected reservoirs and creeks elucidate the typical processes of the sediment system. The text describes the major factors-- geology and topography, soils, vegetation communities, land use rainfall and runoff, and erodibility-- affecting the sediment system and how these factors interact within each province with respect to the sediment system. Quantitative information is provided on the three map sheets which include case studies of typical processes of the sediment system in the study area.

Brown, W. M., III, 1973, Erosion processes, fluvial sediment transport, and reservoir sedimentation in a part of the Newell and Zayante Creek Basins: U.S. Geological Survey Water Resources Open-File Report, p. 31.

Sediment transport in the Newell and Zayante basins, about eight miles north of Santa Cruz, California, were estimated from (1) a reservoir survey of Loch Lomand in 1971 that was compared with a preconstruction survey of 1960, and (2) sampling of sediment transported in suspension by Zayante Creek during the 1970 and 1971 water years. At least 46 acre-feet of sediment transported in suspension accumulated in Loch Lomond in a 10-year period, and an unmeasured quantity of very fine sediment in the form of a thin layer over much of the reservoir bottom was observed. This sediment occupied less than 1 percent of the original capacity of Loch Lomond, but the volume of measured sediment deposition is probably conservative in view of the unmeasured deposits observed and a 95 percent reservoir trap efficiency.

Brown, W. M., III, 1974, Sediment sources and deposition sites and erosional and depositional provinces, Marin and Sonoma Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-625, scale sheet 1, 1:125,000, scale sheet 2, 1:250,000, pamphlet 32 p..

Geomorphic features were mapped at 1:125,000 scale to help elucidate sediment transport processes along the coast of Marin and Sonoma Counties. These features were those detectable on 1:60,000 or 1:120,000 scale, stereoscopically paired, color- infrared, vertical aerial transparencies taken on March 30-31, 1971. Several field-checking trips in 1971-72 augmented the photographic work.

On the basis of these geomorphic features, the coastline between the mouth of the Gualala River and the Golden Gate was divided into 19 stretches composed of nearly alternating erosional and depositional areas. Sediment along this stretch of coast is principally derived from wave erosion of sea cliffs and coastal landslide masses. The Gualala and Russian Rivers are the most significant fluvial sources of sediment to the coast in the study area.

Brown, W. M., III, 1975, Sediment transport, turbidity, channel configuration, and possible effects of impoundment of the Mad River, Humboldt County, California: U.S. Geological Survey Water-Resources Investigation 26-75, p. 63.

Sediment-transport conditions were determined at stations on the Mad River near Arcata and Kneeland. Using a release-flow model and an empirical equation, the long-term suspended-sediment discharge at Kneeland was estimated to be about 60 percent of the long-term suspended-sediment discharge at the Arcata station. Long-term (100-yr) suspended-sediment discharge at Mad River near Arcata is computed to be 2,220,000 ton/yr, of which 615,000 ton/yr is sand size. During 1971-72, bedload transport in the Mad River near Arcata was an estimated 60,000 ton/yr or about 2 percent of the suspended-sediment discharge.

The study of the proposed impoundment determined that: (1) release flows could transport the expected inflow of sediment particles less than 2 millimeters in diameter for the reach of the river downstream from the impoundment site, (2) release flows could transport about 130,000 tons per year of bed material particles less than 76 millimeters in diameter, (3) release flows could be expected to degrade the channel for about 24 kilometers downstream from the impoundment, and (4) turbidity of release flows would be about the same as pre-impoundment turbidity for an average year.

Cardwell, G. T., 1965, Geology and ground water in Russian River Valley areas and in Round, Laytonville, and Little Lake Valleys, Sonoma and Mendocino Counties, California: U.S. Geological Survey Water-Supply Paper 1548, p. 154.

This report provides fundamental geologic and hydrologic information about 10 valleys in Sonoma and Mendocino Counties, California. The study area includes seven valleys along the 110 mile course of the Russian River in Sonoma and Mendocino Counties and three valleys in the upper drainage basin of the Eel River in Mendocino County. Coastal information is given for the Russian River only.

recovered seabed drifters.

Curtis, W. F., Culbertson, J. K., and Chase, E. B., 1973, Fluvial-sediment discharge to the oceans from the conterminous United States: U.S. Geological Survey Circular 670, p. 17.

Suspended-sediment discharge data obtained from 27 drainage areas during the period 1950-69 were used to estimate the sediment mass contributed to the oceans from the conterminous United States. The quantity of sediment transported as bedload was estimated and added to the suspended load to arrive at a total sediment yield.

Sediment yields to the oceans from individual basins, presented in a table, are also compared to estimates by previous workers. The table includes average annual total sediment yields for San Francisco Bay (3,585 tons/yr), Mad River (2691 tons/yr), and the Eel River (29,345 tons/yr). Average annual water and suspended-sediment discharge are also given for the gaging stations closest to the ocean for the Salinas, Russian, Eel, Mad, and Klamath rivers.

Unfortunately, no sediment-size data is given for the samples so it is difficult to determine the amount of beach sediment supplied by the rivers. Also, the 400 year flood of 1964 in northern California was not included in the analysis.

Dale, R. H. and Rantz, S. E., 1966, Hydrologic reconnaissance of Point Reyes National Seashore Area, California: U.S. Geological Survey Open-File Report 66-22, p. 37.

A hydrologic reconnaissance of the Point Reyes National Seashore Area was performed in 1964-65 to appraise potential sources of water supply at park sites where visitors accommodations are proposed. This report includes discharge data for 1964-65 for the creeks in the park; a 1:62,500 scale, generalized geologic map of the park; and runoff and precipitation maps.

A substantial portion of the report is devoted to precipitation patterns. Rainfall in the park is orographically influenced with mean annual precipitation ranging from 20 inches near the ocean to about 40 inches at a 1400' elevation at the park's east boundary. The variation of the mean annual precipitation is illustrated by a 64 year record (1878 to 1943) at the lighthouse where rainfall ranged from a low of 9.56 inches in 1924 to a high of 45.91 inches in 1890.

Dibblee, T. W., Jr., 1973, Geologic map of the Pt. Sir Quadrangle, California: U.S. Geological Survey Open-File Map, scale 1:62,500.

A black-and-white geologic map with numerous bedding attitudes in the Point Sur area. The coast is mainly granitic and metamorphic rocks with about half of the coastline backed by elongate, coast parallel, bodies of alluvium. Three northwest trending bifurcating faults, the Sir, Colorado, and Church Creek, intersect the coast in eight places between Hurricane Point and Soberanes Point.

Dibblee, T. W., Jr. and Clark, J. C., 1973, Geologic map of the Monterey Quadrangle, California: U.S. Geological Survey Open-File Map, scale 1:62,500, sheet 4 of 7.

A black-and-white geologic map with numerous bedding attitudes in the Monterey and Carmel areas, but no bedding attitudes at Fort Ord and north to the Salinas River. Offshore structure is shown on the map. The Carmel/Monterey area coast is composed of a combination of granitic, metamorphic, and Quaternary (younger than 2 million years old) sedimentary rocks. Two small faults intersect the coast near Seaside while two larger faults, the Navy and Cypress Point faults, intersect the coast on either side of the Monterey headland.

Dupre, W. R., 1975, Maps showing geology and liquefaction potential of Quaternary deposits in Santa Cruz County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-648, scale 1:62,500, 2 sheets.

Guerneville , the closest station to the coast on the Russian River, had a mean annual precipitation of 48 inches based on 16 years of data (1940-1956). The average annual discharge at Guerneville during this time was 2200 cfs. A generalized geologic map shows Jurasic (190 to 136 million years old) and Cretaceous (136 to 65 million years old) Franciscian formation outcropping near the mouth of the Russian River.

Carlson, P. R. and McCulloch, D. S., 1974, Aerial observations of suspended-sediment plumes in San Francisco Bay and the adjacent Pacific Ocean: U.S. Geological Survey Journal Research, v. 2, no. 5, p. 519-526.

Aerial observations of suspended-sediment patterns in the San Francisco Bay estuary system, together with shipboard water- property measurements, show that a plume of highly turbid, low-salinity water associated with the Sacramento-San Joaquin River system bifurcates in the central bay. During a winter storm period when Sacramento-San Joaquin discharge was about 7800 cu. m/s, one lobe of the plume flowed 15 km south of the San Francisco-Oakland Bay Bridge while the main lobe flowed seaward 30 km, covering an area of about 900 sq. km. Salinity differences of 1-2 parts per thousand and light transmission differences of 15-20 percent were measured between the plume and the ambient waters. As the discharge from the Sacramento-San Joaquin River system decreased to 100 cu. m/s, the surface area of the plume in the Gulf of the Farallones decreased to about 100 sq. km.

Clark, J. C., 1970, Geologic map of the Davenport area, Santa Cruz County, California: U.S. Geological Survey Open-File Report, scale 1:24,000.

This map is superceded by a more complete version appearing in U.S. Geological Survey Professional Paper 1168.

Clark, J. C., Dibblee, T. W., Jr., Greene, H. G., and Bowen, O. E., 1974, Preliminary geologic map of the Monterey and Seaside 7.5-minute quadrangles, Monterey County, California, with emphasis on active faults: U.S. Geological Survey Miscellaneous Field Studies Map MF-577, Scale 1:24,000, 2 sheets.

A 1:24,000 scale, black-and-white, geologic map covering the coastline from Point Lobos to Seaside. Holocene (younger than 10,000 years old) deposits are mapped in 9 units, including a unit of beach sands. One-half of the second sheet is text describing the major faults in the map area.

Clark, J. C., 1981, Stratigraphy, paleontology, and geology of the central Santa Cruz Mountains, California Coast Ranges: U.S. Geological Survey Professional Paper 1168, p. 51.

This paper describes the petrology, stratigraphy, paleontology, inferred age, and depositional environment of the rock formations of the central Santa Cruz Mountains. The aerial distribution of the formations is shown on a 1:24,000 scale geologic map which covers the coastline from Santa Cruz Yacht Harbor to Point Ano Nuevo.

Conomos, T. J., Peterson, D. H., Carlson, P. R., and McCulloch, D. S., 1970, Movement of seabed drifters in the San Francisco Bay estuary and the adjacent Pacific Ocean: a preliminary report: U.S. Geological Survey Circular 637-B, p. B1-B8.

1345 seabed drifters were released during March 5-6, 1970 in San Francisco Bay and on the continental shelf within 90 kilometers of the Golden Gate to determine the near bottom water circulation pattern in the vicinity of the bay. All releases were made in water depths less than 180 m (100 fathoms). By April 22, 1970, only 18 percent of the drifters had been recovered along shorelines. This report presents two figures showing the locations of release and recovery for the

This field study report includes two 1:62,500 scale black-and- white maps covering Santa Cruz County. One map is a geologic map showing only Quaternary (younger than 2 million years old) deposits. The Quaternary broken up into 16 units west of Soquel Creek and 12 units east of Soquel Creek. The second map rates the liquefaction potential of the same area. The areas with a high liquefaction potential are younger flood plains, some of the the older flood plains and alluvial deposits, basin deposits, beach sands, and abandoned channel fill. A low liquefaction potential is assigned to eolian deposits and continental deposits. No bedding attitudes are shown.

Dupre, W. R. and Tinsley, J. C., III, 1980, Map showing geology and liquefaction potential of northern Monterey and southern Santa Cruz Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1199, scale 1:62,500, 2 sheets.

Two 1:62,500 scale maps of Monterey and southern Santa Cruz Counties are presented in this field studies report. The first sheet is a black-and-white geologic map, without bedding attitudes, that divides Quaternary (younger than 2 million years old) rocks into 34 map units. The second sheet rates the liquefaction potential of the same area in five categories from low to very high and shows locations with historical evidence of liquefaction.

Evenson, R. E., 1959, Geology and ground-water features of the Eureka area, Humboldt County, California: U.S. Geological Survey Water-Supply Paper 1470, p. 80.

Geological information in this report is presented in a 1:62,500 scale, color geologic map. Nearly all of the about 30 miles of coastline shown on the map is covered by a narrow strip of Quaternary (younger than 10,000 years old) sand dunes. Precipitation data, summarized in bar graphs, is presented for Eureka and Scotia in the text section.

Field, M. E., Clarke, S. H., Jr., and White, M. E., 1980, Geology and geologic hazards of offshore Eel River Basin, Northern California Continental Margin: U.S. Geological Survey Open-File Report 80-1080, p. 80.

This report summarizes the offshore and onshore geology of the Eel River Basin, California and presents grain-size data pertinent to onshore/offshore transport. In 1977, gravity cores were taken at 63 stations to characterize surface sediments and obtain stratigraphic information. The cores were taken as close as 5 miles offshore in water depths as shallow as 50 m. Sediment from the upper 10 cm of each core was analyzed for grain size. The textural data from surface sediments were used to modify and extend the boundaries of the lithologic map of Welday and Williams (1975).

Fischer, H. B., 1972, A Lagrangian method for predicting pollutant dispersion in Bolinas Lagoon, Marin County, California: U.S. Geological Survey Professional Paper 582-B, p. B1-B32.

A numerical method is described which is capable of predicting the movement and dispersion of a pollutant in a tidal embayment. The method requires a knowledge of the embayment geometry and of a typical tidal cycle of water surface elevations at various interior points. The model includes a convective step, a diffusive step, and a concentration-decay step.

The model was verified by predicting the dispersion of a slug of Rhodamine WT dye tracer discharged near the mouth of Bolinas Lagoon, California. Bolinas Lagoon is typical of many tidal embayments in that, while it includes a number of branching eroded channels, most of its interior consists of mudflats which are exposed at high tide.

The report includes the code and an annotated flow chart for the model's computer program.

Folger, D. W., 1972, Characteristics of estuarine sediments of the United States: U.S. Geological Survey Professional Paper 742, p. 94.

Essentially an atlas, this report compiles data on texture and composition of bottom sediments, including the hydrologic factors that influence them, in 45 estuaries in the conterminous United States. Three pages are devoted to a summary of the state of knowledge in 1972 for San Francisco Bay. A paragraph of references from the 1950's and 1960's is also included.

Gardner, J. V., Barron, J. A., Dean, W. E., Poore, R. Z., Quintero, P. J., Stone, S. M., and Wilson, C. R., 1983, Quantitative microfossil, sedimentologic, and geochemical data on core L13-81-G138 and surface samples from the continental shelf and slope of northern California: U.S. Geological Survey Open- File Report 84-369, p. 118.

This report presents stratigraphic data from core L13-81-G138 and data from 75 surface samples collected from the continental slope and shelf off northern California adjacent to the Russian River. The samples were taken in water depths ranging from about 20 to 3500 m. Data is presented, in tabular form, on fossils, sediment grain size, pollen, inorganic chemistry, clay and silt mineralogy.

Gardner, J. V. and Klise, D. H., 1983, Mineralogical and sedimentological data collected on the shelf and upper slope adjacent to the Russian River, northern California: U.S. Geological Survey Open-File Report 83-517, p. 35.

This report documents textural and mineralogical analyses of surface sediments from the shelf and upper slope of the continental margin west of the Russian River, northern California. During three cruises in 1980-81, 56 sampling stations, in water depths ranging from 20 to 2000 m, were occupied and sediment samples were collected using gravity, piston, van Veen, and box corers. The surface samples were taken from the upper 10 cm of the cores.

In addition to textural analyses, petrographic studies of the silt fraction and x-ray diffraction of the clay fraction were carried out to determine the mineralogy of the samples. The data are presented in 17 plots; but, interpretations of the data are not included in this report.

Greene, H. G., 1977, Geology of the Monterey Bay region: U.S. Geological Survey Open-File Report 77-718, p. 340.

This study makes a thorough marine geological exploration of the Monterey Bay area using modern geophysical and geological tools and methods. The data is integrated with evidence from onshore geological studies. The resulting synthesis clarifies the Tertiary evolution of this portion of the Pacific margin. An emphasis is placed on faulting and tectonic history of the area.

Harden, D. R., Janda, R. J., and Nolan, K. M., 1978, Mass movement and storms in the drainage basin of Redwood Creek, Humboldt County, California -- a progress report: U.S. Geological Survey Open-File Report 78-486, p. 161.

Precipitation and runoff patterns for major flood-producing storms of 1953, 1955, 1964, 1972, and 1975 were analyzed to evaluate the relationship between flooding and landslide activity in the Redwood Creek basin. Precipitation and historical information for floods of the late 19th century were also examined in order to compare that series of storms and floods with those of the past 25 years. The results of the analysis indicate that the individual storms in a late-19th-century series of storms in northwestern California were similar in magnitude and spacing to those of the past 25 years.

Harden, D. R., Kelsey, H. M., Morrison, S. D., and Stephens, T. A., 1983, Geologic map of the Redwood Creek drainage basin, Humboldt County, California: U.S. Geological Survey Open-File Report 81-496, scale 1:62,500, 1 sheet.

A 1:62,500 scale, color, geologic map of the Redwood Creek Basin with extensive descriptions of the geologic units. Very few bedding attitudes are shown on the map. References to previous workers who described the geologic units are included on the map sheet.

Hawley, N. L. and Jones, B. L., 1969, Sediment yield of coastal basins in northern California, 1958-64: U.S. Geological Survey Open-File Report [64-124], p. 19.

Results of a sediment data-collection program in the Eel, Mad, Van Duzen, and Trinity river basins during the 7-year period October 1957 to September 1964 indicate that sediment discharge of the Eel River was greater than any of the other three rivers. Average annual suspended-sediment discharge of the Eel River at Scotia, the measuring site farthest downstream, was 13,480,000 tons. Average annual sediment yields for the Mad River near Arcata and the Van Duzen River near Bridgeville were 1,401,170 and 1,400,000 tons- respectively. Particle size analyses show that the suspended sediment from the Eel, Mad, and Van Duzen Rivers average about 40 percent clay, 40 percent silt, and 20 percent sand.

Bedload discharges, computed using a bedload-transport curve and flow duration tables, at the various sediment-measuring stations ranged from 4 to 30 percent of the suspended-sediment discharge.

Helley, E. J. and LaMarche, V. C., Jr., 1968, December 1964, A 400-year flood in northern California: U.S. Geological Survey Professional Paper 600-D, p. D34-D37.

In both 1955 and 1964, record-breaking floods occurred over large areas of northern California. The true long-term recurrence intervals of these destructive floods is difficult to estimate by conventional flood-frequency analysis because prediction of a given flood discharge is based solely on historical records of flood peaks. Geomorphic and botanical evidence of a major prehistoric flood has been investigated on Blue Creek, a tributary to the Klamath River in northern California. Radiocarbon analysis, supplemented by tree-ring counts, established a date about 400 years ago of a flood event that had about the same order of magnitude as the devastating floods of 1964. A later paper, Professional Paper 485-E, revised the estimated recurrence interval for the 1964 flood downward towards 100 years.

Helley, E. J. and LaMarche, V. C., Jr., 1973, Historic flood information for northern California streams from geological and botanical evidence: U.S. Geological Survey Professional Paper 485-E, p. 16.

Observations of erosion and deposition produced by the devastating floods of December 1964 allowed comparison and identification of ancient flood deposits. Age limitations were assigned to these ancient flood deposits at four widely scattered detailed study sites in northern California. Long-lived coniferous trees, both living and those killed by 1964 floods, were used to assign minimum ages to these deposits. Maximum ages were determined by radiocarbon dating of material entrained in the same deposits. Comparison with historic records at the sites suggest that severe floods of magnitude similar to that of December 1964 have occurred several times in the last few hundred years.

Hill, G. W. and Chin, J. L., 1982, Map showing geophysical tracklines, south-central Monterey Bay: U.S. Geological Survey Open-File Report 82-837, scale 1:24,000, 1 sheet.

Approximately 275 km of geophysical tracklines taken in south- central Monterey Bay in July 1981 using Uniboom and minisparker seismic systems are shown on this 1,24,000 scale map. Trackline locations were determined using a shipboard precision navigation system. The shore-normal tracklines usually started within one- half kilometer of the shoreline and extended seaward to about the 100 m contour. Other types of data collected in this study include fathometer

profiles, underwater video transects, gravity cores, and surface grab samples.

Hill, G. W., Chin, J. L., and Ho, B. D., 1982, Map showing surface grab samples and gravity core locations, south-central Monterey Bay, California (July '81 - February '82): U.S. Geological Survey Open-File Report 82-838, scale 1:24,000, 1 sheet.

Locations of surface grab samples and gravity cores taken in southern Monterey Bay between Fort Ord and Moss Landing during July 1981 to February 1982 are shown on a 1:24,000 scale map. The samples were all taken in less than 100 m water depth. Sixteen of the samples were taken within one-half km of the coast. Surface grab samples are currently being processed for grain size information. Gravity cores were split into archive and working halves. Archive halves were put into permanent storage in the U.S.G.S. Sedimentation Lab (Palo Alto, Ca.). Working halves were logged for lithology and structures, and then x-radiographed. Cores will be subsampled for grain size, paleontology and heavy mineral determinations at a latter date.

Hirschaut, D. W. and Dingler, J. R., 1982, A field study of large-scale oscillation ripples in a very coarse-grained, high- energy marine environment: U.S. Geological Survey Open-File Report 82-773, p. 33.

Monastery Beach, Carmel, California is a pocket beach that sits within 200 m of the head of Carmel Submarine Canyon. Coarse to very-coarse sand covers both the beach and adjacent shelf; in the latter area incoming waves have shaped the sand into large oscillation ripples.

On three separate occasions, scuba divers measured ripples and collected sand samples from ripple crests near reference stakes along three shore-normal transects. Both sand grain size and ripple wavelength decreased with an increase in water depth. Sediment sorting was best closest to the surf zone and poorest at the rim of Carmel Canyon.

Carmel Canyon refracts waves approaching Monastery Beach causing wave energy to focus towards the northern and southern portions of the beach, leaving the central part of the beach lower in energy. This energy distribution causes spatial variations in the ripples and grain sizes with the shortest wavelengths and smallest grain sizes in the central portion of the shelf.

Hofmann, W. and Rantz, S. E., 1963, Floods of December 1955 - January 1956 in the Far Western States--part 1, description: U.S. Geological Survey Water-Supply Paper 1650-A, p. 156.

The floods of December 1955-January 1956 in the Far Western States were in many respects the greatest in the area in the history of recorded streamflow. One outstanding feature of the floods was the unusually large area involved- the western one- third of Nevada, the northern two-thirds of California, the western half of Oregon, one-third of Idaho, and minor parts of Washington.

The floods were caused by a series of storms from December 15 to January 27; three occurring from December 15 to 27 and three more from January 2 to 27. In all but a few areas the storm of December 21-24 was the most severe. The coastal area of northern California and southern Oregon had measurable rainfall on 38 of the 43-day period from December 15 to January 27.

This report includes descriptions of the precipitation, stream discharges, and stream stages in central and northern California during the storms. The effectiveness of reservoirs in mitigating the peak flood discharges is also addressed in the report. More detailed information on the hydrology during the floods is given in the companion Water-Supply Paper, 1650-B.

Hofmann, W. and Rantz, S. E., 1963, Floods of December 1955 - January 1956 in the far western states--part 2, streamflow data: U.S. Geological Survey Water-Supply Paper 1650-B, p. 580.

This paper presents basic hydrologic information on the floods of December 1955-January 1956 and complements the descriptive material in Water-Supply Paper 1650-A. Data presented consists

of records of stage and discharge for gaging stations, and peak- stage and peak discharge information for numerous miscellaneous sites and partial-record stations in or on the fringe of the area of intensive flooding. The records are presented in more detail than those in the regular annual reports. In general, the information presented for each gaging station is: a description of the station, a tabulation of daily mean discharges for December 1955-January 1956, and a tabulation of stages and discharges at selected intervals (sometimes only an hour apart) during each day of the flood's rise and recession for the two or three highest floodpeaks during the 2-month period.

Hunter, R. E. and Clifton, H. E., 1982, Description of beds exposed at Fort Funston, Golden Gate National Recreation Area, northwestern San Francisco Peninsula, California: U.S. Geological Survey Open-File Report 82-1055, p. 30.

A thick section of Pleistocene beds is well exposed in wave-cut bluffs on the northwestern San Francisco Peninsula, California. These exposures extend from near Fleishhacker Zoo on the north to near Mussel Rock, where the San Andreas fault intersects the shoreline, on the south. Although the intention of this report is to describe the geology of the cliffs, grain- size information for the units is also given allowing the volume of beach material supplied by the cliffs to be estimated if bluff erosion rates are known.

Irwin, G. A., 1976, Water-quality investigation, Salinas River, California: U.S. Geological Survey, Water-Resources Investigation 76-110. 41 p.

The concentration of dissolved solids in the Salinas River is variable and ranges from 164 to 494 milligrams per liter near Bradley and from 170 to 1,090 milligrams per liter near Spreckles. The higher concentrations near Spreckles are caused mainly by sewage inflow about 50 m upstream. The bulk of the data presented is water chemistry information.

Iwatsubo, R. T., Nolan, K. M., Harden, D. R., Glysson, G. D., and Janda, R. J., 1975, Redwood National Park studies, data release number 1, Redwood Creek, Humboldt County, California September 1, 1973-April 10, 1974: U.S. Geological Survey Open-File Report, p. 175.

This report presents a tabulation of the data collected in the Redwood Creek drainage basins between September 1, 1973, and April 10, 1974 and a brief description of the conditions of the study area at the time of data collection. Most of the data was colleted during the winter storm-runoff period. Stream discharge and water quality data were collected at 27 stations. Measurements included the following variables: (1) stream stage and discharge; (2) sediment size and concentrations; and (3) the chemical, physical, and biological characteristics of the water. Additional data presented include changes in geometry at 42 stream-channel cross sections along Redwood Creek, distribution of erosional landforms in the drainage areas of six tributaries to Redwood Creek, and quantity and chemical composition of rainfall in the basin.

Iwatsubo, R. T., Nolan, K. M., Harden, D. R., and Glysson, G. D., 1976, Redwood National Park studies, data release number 2, Redwood Creek, Humboldt County, and Mill Creek, Del Norte County, California, April 11, 1974 - September 30, 1975: U.S. Geological Survey Open-File Report 76-678, p. 247.

This report, the second in a series, presents a tabulation of the data collected in the Redwood Creek and Mill Creek drainage basins between April 11, 1974, and September 30, 1975 and a brief description of the conditions of the study area at the time of data collection. Most of the data was colleted during the winter storm-runoff period.

This report presents physical data including: (1) stream- channel cross sections, (2) a map of erosional landforms, (3) precipitation, (4) stream stage and discharge, (5) turbidity, (6) suspended-sediment and bedload discharges. Particle-size distributions are given for the

suspended load, bedload, and streambed materials. Biological data and chemical data from analyses of rainwater and stream water are also included in this report.

Jackson, L. E., Jr., 1977, Dating and recurrence frequency of prehistoric mudflows near Big Sur, Monterey County, California: U.S. Geological Survey Journal of Research, v. 5, no. 1, p. 17- 32.

Botanical evidence based on the dendrochronology and root horizons of redwoods and radiocarbon dating were used to date prehistoric mudflows near Big Sur. At least three periods of mudflow activity were delineated for the approximate prehistoric period 1370-1800. Two historic periods of mudflow activity have occurred, 1908-1910 and 1972-73. This documentation of mudflows as characteristic surficial processes in the Santa Lucia Range indicates a hazard to development on recent mudflow deposits in this region.

Janda, R. J., Nolan, K. M., Harden, D. R., and Colman, S. M., 1975, Watershed conditions in the drainage basin of Redwood Creek, Humboldt County, California, as of 1973: U.S. Geological Survey Open-File Report 75-568, p. 266.

This report describes the physical condition of the drainage basin of Redwood Creek as of 1973, and identifies processes that are modifying or are threatening to modify the Redwood National Park ecosystem. The major topics approached are the geology, physiography, climate, vegetation, and streamflow of the Redwood Creek basin. Sections addressing the rate of suspended load and bedload transport do not include grain-size information. Data collected in 1974 at six sites along Redwood Creek, as well as data from similar nearby streams, suggest that bedload probably accounts for 15 to 35 percent of the total sediment load of Redwood Creek.

Janda, R. J., 1978, Summary of watershed conditions in the vicinity of Redwood National Park, California: U.S. Geological Survey Open-File Report 78-25, p. 81.

In 1977 the Chairman of the Senate Subcommittee on Parks and Recreation requested that the U.S. Geological Survey summarize its recent findings on the watershed conditions in the vicinity of Redwood National Park, California. This report synthesizes the key facts and ideas of previous reports, and updates the data to include more recent observations.

The impact of major channel-modifying floods on suspended sediment discharge is addressed. In the short term, one major flood can discharge more suspended sediment than years of non-flood conditions. For example, the suspended-sediment discharge for the Mad River at Arcata from December 18 through 31, 1964 was estimated to be about 10 million tons or approximately seven times the average total annual suspended-sediment discharge for the 5-year period 1958-62. In the long term, channel-modifying floods increase suspended-sediment discharge by increasing the amount of readily erodible sediment in and immediately adjacent to the stream channel. For example, suspended-sediment discharges immediately following the 1964 floods were two to five times greater than they were immediately prior to the floods.

Knott, J. M., 1971, Sedimentation in the Middle Fork Eel River Basin, California: U.S. Geological Survey Open-File Report, p. 60.

The Middle Fork Eel River Basin is one of several areas in northern California that is a potential source of water to augment water supplies in the Sacramento-San Joaquin Delta.

Estimates of long-term sediment yields from several of the larger tributaries in the Middle Fork Eel River basin and probable distribution characteristics of sediment within the largest and smallest of the proposed reservoirs were made to determine the feasibility of a reservoir. Sedimentation data used in the study were obtained during 1956-58. The bulk of these data consisted of records of daily suspended-sediment discharge and analyses of periodic sediment samples from hydrologic stations established on several of the larger tributaries. Special measurements were

made during the 1968 storm season to determine parameters required for the indirect computation of bedload discharge using the Meyer-Peter and Muller equation. Estimates of total sediment yield were made by extending short-term sediment- and water-discharge data on the basis of long-term flow records.

Lajoie, K. R., 1971, Photograph of Sea cliffs at Moss Beach in Montara, San Mateo County, California: U.S. Geological Survey Photographic Library (Photograph no. 1), Denver, Colorado.

Seacliffs at Moss Beach in Montara have receded 165 feet between 1866 and 1971 (1.6 feet per year). The positions of the cliffs from an 1866 map and a 1914 photograph are marked on an overlay which is included with this 1971 photograph.

Lajoie, K. R., Helley, E. J., Nichols, D. R., and Burke, D. B., 1974, Geologic map of unconsolidated and moderately-consolidated deposits of San Mateo County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-575, scale 1:62,500, 2 sheets

The geology of unconsolidated and moderately consolidated deposits of San Mateo County is presented in two sheets. The first sheet is a 1:62,500 scale, black-and-white, geologic map that maps only unconsolidated and moderately consolidated deposits. The second sheet is a table describing the geologic units including information on geology, planning, and engineering properties of these units.

Leslie, R. B., 1981, Continuity and tectonic implications of the San Simeon-Hosgri fault zone, central California: U.S. Geological Survey Open-File Report 81-430, p. 59.

High-resolution seismic reflection data off central California were interpreted, in conjunction with pre-existing seismic and aeromagnetic data, to determine if there is a connection between the offshore Hosgri fault, the major southern fault of the San Gregorio-Hosgri system, and the onshore San Simeon fault. The faults were found to be connected. This connection allows, but does not prove, large right lateral offset along the San Simeon- Hosgri fault trend.

McGlashan, H. D. and Briggs, R. C., 1939 [1940], Floods of December 1937 in northern California: U.S. Geological Survey Water-Supply Paper 843, p. 497.

During the period December 6-12, 1937, streams in northern California were subjected to severe floods which, at 80 measurement stations, exceeded previously recorded maximum discharges. The floods were caused by an exceptionally intense rainstorm of wide extent, which formed over the Pacific Ocean and moved rapidly eastward into northern California on December 9. It was a well-defined single storm, and most of the precipitation fell within a 48-hour period.

This Water-Supply paper presents records of flood stage and discharge at about 170 stream-measurement stations and records of storage in all the larger reservoirs. This report also includes meteorological data, results of rainfall and runoff studies, and discussions of flood characteristics. The main flood report is followed by a section on floods that occurred before the beginning of systematic stream-flow records.

Moore, G. W. and Silver, E. A., 1968, Gold distribution on the sea floor off the Klamath Mountains, California: U.S. Geological Survey Circular 605, p. 9.

Analyses of 82 samples from the surface of the continental shelf between the Oregon-California border and Eureka, California, indicate that the background gold content on this shelf is about 0.1 ppb (part per billion). Four anomalous tracts, which range in extent from 10 to 30 square kilometers, have gold values above 10 ppb, and the richest sample contains 390 ppb. The anomalous areas seem to lack a close correlation with water depth, but they are related to areas underlain by

soft Cenozoic (younger than 60 million years old) strata that contain small quantities of dispersed gold originally derived from lodes in the Klamath Mountains. This relationship suggests that the offshore gold accumulations are lag concentrations produced from the Cenozoic deposits by wave erosion during the post-glacial rise in sea level. Gold contents at the surface are too low for economic recovery, and drilling will be required to determine whether the anomalous areas are underlain by higher-grade material.

Muir, K. S., 1972, Geology and groundwater of the Pajaro Valley area, Santa Cruz and Monterey Counties: Water-Resources Investigations Open-File Report, p. 33.

Deposits that range in age from Pliocene (2 million to 10,000 years old) to Holocene (younger than 10,000 years old) make up the ground-water reservoir of the Pajaro Valley area. These include, from oldest to youngest, the Purisima Formation, Aromas Red Sands of Allen (1946), terrace deposits, alluvium, and dune sand. A general description of the geologic units and a 1:62,500 scale, black-and-white, geologic map without bedding attitudes is included.

Moore, G. W. and Silver, E. A., 1968, Geology of the Klamath River delta, California: U.S. Geological Survey Professional Paper 600-C, p. C144-C148.

Acoustic-reflection profiles show that the submerged deltaic sediment of the Klamath River forms a lens-shaped body about 60 m thick. These deposits are thickest 10 km offshore and 15 km north of the mouth of the Klamath River. A slight doming of the upper surface of the deltaic lens, and transport of sediment generally toward the north as indicated by spits at the mouths of the Klamath and nearby rivers, both suggest that the offset with respect to the river mouth is partly depositional. However, the long axis of the thickest part of the lens coincides with a major syncline in the underlying rocks, indicating that the position of the deltaic lens probably is, in part, also controlled by Recent deformation.

Nason, R., 1980, Damages in San Mateo County, California, from the earthquake of 18 April 1906: U.S. Geological Survey Open- File Report 80-176, p. 52.

The San Mateo County area was greatly affected by the earthquake of 18 April 1906. This report compiles the 1906 earthquake damages in San Mateo County. The damages have been organized and listed by locality. Five landslides along the coast of northern San Mateo County triggered by the 1906 earthquake are described.

Noble, R. D. and Jackman, A. P., 1983, Meteorological, water- temperature, and discharge data for the Mattole River basin, Humboldt County, California: U.S. Geological Survey Water- Resources Investigation 78-81, p. 93.

Synoptic meteorological, water-temperature, and discharge data were obtained in the Mattole River basin in northern California during the period June 10 through August 31, 1975. The variables monitored were water temperature and discharge, wind velocity, air temperature, solar radiation, water velocity, and axial dispersion coefficients. River-temperature models can be tested from this detailed set of data.

Nolan, K. M., Marron, D. C., and Collins, L. M., 1983, Stream- channel response to the January 3-5, 1982, storm in the Santa Cruz Mountains, west-central California: U.S. Geological Survey Open-File Report 84-248, p. 56.

Intense rainfall on January 3-5, 1981, in the Santa Cruz Mountains caused high streamflow and widespread landsliding. Recurrence intervals for maximum rainfall intensities were in excess of 100 years.

This report assesses the effects of high streamflow on stream-channel geometry and sediment transport in three drainage basins within the steep terrain of the Santa Cruz Mountains and relates effects to hillslope processes operating during the storm. Data presented have been collected from sites of previously established stream-gaging stations as well as from post-flood field investigations.

Porterfield, G., Hawley, N. L., and Dunnam, C. A., 1961, Fluvial sediments transported by streams tributary to the San Francisco Bay area: U.S. Geological Survey Open-File Report, p. 70.

Fluvial-sediment input into the San Francisco Bay system was either directly measured, calculated, or estimated in order to determine the daily average total sediment load entering the system from 1909 to 1959. Suspended sediment was measured from 1957-59 at locations where the major part of the sediment transported by streams to the bay area could be determined. That part of the sediment load not measured with the suspended- sediment sampling equipment was computed by applying Colby's and Hembree's method (1954) to flow data collected between 1909 and 1959. This figure was added to the suspended load to obtain the total sediment load. The sediment contributed to the bay system from areas where no sediment measuring stations were located was estimated on the basis of measured sediment-discharge rates from adjoining areas. The measured sediment load was 75 percent of the total sediment load, the computed load was 16 percent and the estimated load was 9 percent of the total.

The estimated daily average sediment input into the San Francisco Bay system for the 51-year period based on 1959 conditions is about 16,000 tons. About 13,800 tons come from the Central Valley, 500 tons enter directly into Suisun Bay, 1000 tons enter directly into San Pablo Bay, and 800 tons enter directly into San Francisco Bay.

Porterfield, G., 1972, An inventory of published and unpublished fluvial-sediment data for California, 1956-70: U.S. Geological Survey Open-File Report, p. 26.

This inventory was prepared to provide a convenient reference to published and unpublished fluvial-sediment data for water years 1956-70, and substantially updates previous inventories. Sediment stations are listed in downstream order. An alphabetical index of stations is presented at the end of the report. All sediment samples listed were analyzed for concentration, by weight, of sediment in the water-sediment mixture. Selected samples were analyzed for particle-size distribution. A graph showing frequency of observations and a table with period of record is also included.

Porterfield, George, 1981, Sediment transport of streams tributary to San Francisco, San Pablo, and Suisun Bays, California, 1909-66: U.S. Geological Survey Water-Resources Investigation 80-64, p. 92.

Hydraulic mining ceased in California in 1884 but the effects on streams continued. In 1917, G. K. Gilbert estimated that sediment transported to the Sacramento-San Joaquin Delta averaged about 2 million cubic yards annually prior to the discovery of gold in 1848 and increased to about 18 million cubic yards annually during 1849 to 1914. Gilbert also predicted that hydraulic-mining effects would continue for about 50 years after 1914, with annual sediment transport averaging not less than 8 million cubic yards. To test Gilbert's prediction, sediment transported to the San Francisco Bay system was estimated based on sediment inflow data collected during 1957-66. During the period 1909-66, sediment was transported to the San Francisco Bay system at an average rate of 8.6 million cubic yards per year. About 7.4 million cubic yards, or 86 percent, of this sediment was derived from the Sacramento-San Joaquin River basins upstream from their confluence near Antioch. Gilbert's prediction was reasonably accurate.

Rantz, S. E., 1959, Floods of 1952 in California, Flood of January 1952 in the South San Francisco Bay region: U.S. Geological Survey Water-Supply Paper 1260-D, p. 531-575.

The flood of January 1952 in the south San Francisco Bay region was the result of a storm that centered near the summit of the Santa Cruz Mountains, where rainfall totals exceeded 8 inches. This report presents data on stages and discharges at 14 gaging stations, an analysis of flood damages, a brief analysis of the characteristics of the flood hydrographs, and other data pertaining to the flood. Data is presented for Pescadero and Soquel creeks, and the San Lorenzo River.

Rantz, S. E., 1959, Floods of January 1953 in western Oregon and northwestern California: U.S. Geological Survey Water-Supply Paper 1320-D, p. 321-339.

Coastal basins in California north of the Mattole and lower Eel Rivers were affected by the floods of January, 1953. This report presents a map of precipitation during the flood and an analysis of peak discharges for the Klamath River, Redwood Creek, and the Mad River. Discharge hydrographs and peak flood stages and discharges for selected streams are also presented.

Rantz, S. E. and Harris, E. E., 1963, Floods of January - February 1963 in California and Nevada: U.S. Geological Survey Open-File Report, p. 74.

Intense precipitation, on January 29-31, 1963, following a record-breaking 42 day drought caused flooding in California and Nevada. Coastal areas between Big Sur and Jenner were flood-affected. Peak discharges and stages for the 1963 flood and for the maximum previously recorded flood are presented for selected streams in the flood-affected area. An isohyetal map for the storm is also presented.

Rantz, S. E., 1964, Surface-water hydrology of coastal basins of northern California: U.S. Geological Survey Water-Supply Paper 1758, p. 77.

An analysis of the surface-water hydrology of coastal basins of California that are north of the southern boundary of the Eel River Basin is presented. A 60-year base period, 1900 to 1959, has been used in this report to study mean annual basin-wide precipitation, runoff, and water loss in drainage basins above key gaging stations and above the mouths of principal streams. This base period includes several series of wet and dry years, so the mean annual runoff for this period is therefore probably somewhat representative of the long-term mean.

Rantz, S. E., 1965, Flood of December 1964 in redwood areas of North Coastal California: U.S. Geological Survey Open-File Report [65-130], p. 39.

Intense rainfall during late December produced a record-breaking flood in the redwood areas of north coastal California. In a large part of this area, rainfall, lasting for 1 of more days, and peak discharge were of such magnitude that they indicate an average return period in excess of 100 years. Only data analyzed before March 1, 1965 is presented; therefore, later reports will include more current data. However, peak discharge, maximum suspended-sediment concentrations, and precipitation data for selected basins are presented here.

Rantz, S. E. and Moore, A. M., 1965, Floods of December 1964 in the Far Western United States: U.S. Geological Survey Open-File Report [65-131], p. 205.

The floods of December 1964 in the Far Western States were the most damaging in the history of the area. They were outstanding not only for record-breaking peak discharges, but also for the unusually large area involved -- Oregon, northern California, western Nevada and Idaho, and southern Washington.

Coastal drainage basins in California north of San Francisco Bay were flood-affected.

Damage was relatively light in the small coastal basins between San Francisco Bay and the Russian River. Damage was substantial in basins to the north of the Russian River and flood peaks were commonly the highest ever recorded.

Maximum stage and discharge data are given for selected coastal streams in northern California. Daily suspended-sediment data for the period of the storm is given for the Russian and Mad Rivers.

Rantz, S. E. and Thompson, T. H., 1967, Surface-water hydrology of California coastal basins between San Francisco Bay and Eel River: U.S. Geological Survey Water-Supply Paper 1851, p. 60.

This report presents an analysis of the surface-water hydrology of the coastal basins of California that lie between the north shore of the San Francisco Bay and the south boundary of the Eel River basin. Precipitation, runoff, flow, and flood frequency information is presented for basins and streams within the study area.

Seven major floods have occurred in the region in the past 25 years. In many of the coastal basins south of the Russian River, six of the seven floods were of nearly equal magnitude. In the Russian River basin the flood of December 1964 was generally the maximum of these events, but in the coastal basins north and west of the Russian River the flood of December 1955 generally produced the greatest peak discharges. A flood- frequency study of the region indicates that the magnitude of floods of any given frequency can be related to size of drainage area and to mean annual basinwide precipitation. Mean annual basinwide precipitation is an excellent index of the relative magnitude of storms of any given frequency because the bulk of the precipitation occurs during several general storms each year, and the same number of general storms occur at all stations in any given year.

Rantz, S. E., 1968, Floods of October 1962 in northern California: U.S. Geological Survey Water-Supply Paper 1820, p. 121-126.

A storm from October 10-14, 1962 caused severe flooding in northern California. In the San Francisco Bay area, total precipitation during the storm ranged from 5 to 8 inches at the low altitudes and up to 22 inches in the Santa Cruz Mountains to the south, where daily catches of more than 13 inches were reported. The runoff, although heavy, was generally lighter than might be expected from the rainfall because this was the first storm of the season and large soil-moisture deficiencies existed. Included in the peak stream discharge and stage data are three coastal streams stations: (1) Pescadero Creek, (2) San Lorenzo River, and (3) Soquel Creek.

Rantz, S. E., 1968, Average annual precipitation and runoff in north coastal California: U.S. Geological Survey Hydrologic Investigation Atlas HA-298, scale 1:1,000,000, 1 sheet, pamphlet 4 p..

Four 1:1,000,000 scale maps are presented showing the hydrologic characteristics of California coastal basins north of San Francisco Bay. The maps show the area's principal drainage systems and hydrologic units and include isopleths of average annual precipitation, runoff, and evaporation. A close relationship between average annual runoff and average annual precipitation and potential evapotranspiration is apparent from looking at these maps. Multiple linear regression equations relating these elements are derived for each of the two physiographic sections or subregions in the study area -- the Coast Ranges and the Klamath Mountains.

Rantz, S. E., 1968, Floods of October in northern California in Summary of floods in the United States during 1962, Rostvedt, J. O. ed.: U.S. Geological Survey Water-Supply Paper 1820, p. 121- 126.

A storm from October 10-14, 1962 caused severe flooding in northern California. In the San Francisco Bay area, total precipitation during the storm ranged from 5 to 8 inches at the low altitudes and up to 22 inches in the Santa Cruz Mountains to the south, where daily catches of more than 13 inches were reported. The runoff, although heavy, was generally lighter than might be expected from the rainfall because this was the first storm of the season and large soil-moisture deficiencies existed. Included in the peak stream discharge and stage data are three coastal streams stations: (1) Pescadero Creek, (2) San Lorenzo River, and (3) Soquel Creek.

Rantz, S. E., 1972, Runoff characteristics of California streams: U.S. Geological Survey Professional Paper 2009-A, p. 38.

The general relationships between runoff characteristics and climate, topography, and basin geology for California streams are addressed in this report. A 1:250,000 scale, color map divides California into precipitation zones. Along the north coast of California, a mean annual rainfall is usually greater than 40 inches. In central coastal California mean annual precipitation ranges form 10 to greater than 40 inches. Mean annual water discharges for six Coast Range streams are also included in this report.

Ritter, J. R., 1967, Bed-material movement, Middle Fork Eel River, California: U.S. Geological Survey Professional Paper 575-C, p. 219-221.

The Middle Fork Eel River, at a discharge of about 3,750 cfs and an average velocity of about 6 fps, moved bed material of cobble size. The size of the transported material was determined by actually noting, through the use of photographs, which individual rocks had been removed from painted areas on the riverbed; particle size of these rocks is proportional to average velocity and to tractive force.

Ritter, J. R., 1969, Measurement of water flow and suspended- sediment load, Bolinas Lagoon, Bolinas, California: U.S. Geological Survey Professional Paper 650-B, p. B189-B193.

Measurements of water flow and sediment load at the Bolinas Lagoon inlet for a 10-hour tidal period (floodtide and ebb-tide) on June 22, 1967, revealed that 152 tons of suspended sediment was carried into the lagoon by the floodtide, whereas only 36 tons was carried out of the lagoon by the ebbtide. However, the major ebbtide which was not measured probably carried the largest load of the day. Bedload made up as much as 18 percent of the total load during floodtide and 15 percent during ebbtide. The maximum measured water flow and maximum average velocity during floodtide were 5,810 cubic feet per second and 3.5 feet per second, respectively; during ebbtide the maximums were 3,720 cfs and 2.4 fps.

Ritter, J. R., 1970, A summary of preliminary studies of sedimentation and hydrology in Bolinas Lagoon, Marin County, California (with a section on mineralogy by E.J. Helley): U.S. Geological Survey Circular 627, p. 22.

A program investigating sedimentary and hydrologic conditions in Bolinas Lagoon, beginning in May 1967 and continuing into 1970, was undertaken by the U.S. Geological Survey. Only the study results analyzed before June 1968 are summarized in this report.

Two series of measurements of suspended-sediment load and water discharge in the lagoon inlet showed that much of the suspended sediment is sand and that the average velocity was as much as 4.7 feet per second. In most of the lagoon, median size of bottom sediment was a fine sand derived chiefly from Monterey Shale. Circulation velocities in the lagoon decrease rapidly away from the inlet, but probably remain high enough to erode bottom sediment along the channels. Littoral drift near the inlet was generally toward the inlet, whereas further from the inlet the pattern is irregular.

A thorough description of the type of studies conducted and their methodologies is included, but this report does not contain substantial amounts of data.

Ritter, J. R. and Brown, W. M., III, 1971, Turbidity and suspended-sediment transport in the Russian River Basin, California: U.S. Geological Survey Open-File Report 72-316, p. 100.

The Russian River in north coastal California is persistently turbid. To determine the source of the turbidity and the rate of sediment transport in the basin, a network of sampling stations was established in February 1964 along the river, on some of its tributaries, and near Lake Pillsbury in the upper Eel River basin.

Turbidity and concentration of suspended sediment, expressed in milligrams per liter, were highly correlative ($r>0.90$) at almost every sampling station. The correlation differed for each station and varied slightly each year. From correlations between turbidity and the size of particles in suspension it is concluded that a concentration of particles finer than sand produces a higher turbidity than does an equal concentration of sand. Most of the persistence of turbidity seemed to be produced by particles finer than sand carried in suspension.

Ritter, J. R., 1973, Bolinas Lagoon, Marin County, California, a summary of sedimentation and hydrology, 1967-69, with a section on fluorescent-tracer study of sediment movement (section by W. M. Brown III): U.S. Geological Survey Water-Resources Investigation 19-73, p. 80.

Sedimentation in Bolinas Lagoon presently averages about 16- acre-feet per year. Depositional rates based on sediment budget studies, topographic maps, and geological evidence indicate that the lagoon would fill 0.5 to 1.0 foot in the next 50 years and would fill to the highest high water level in 340 to 650 years.

Studies from 1967 to 1969 indicated that approximately 80 acre-feet of sediment was transported into and 86 acre-feet was transported out of Bolinas Lagoon annually by tidal flows. Cliff erosion west of the inlet and littoral drift provided the principal sources of the sediment transported into the lagoon by floodtides. Winds and streamflow brought additional sediment. Measurements of tidal flows and suspended-sediment discharge in the lagoon inlet showed that:(1) most of the suspended sediment is sand, (2) the average velocity was as much as 4.9 feet per second, (3) instantaneous suspended-sediment discharge reached rates as large as 11,600 tons per day on an ebbtide, (4) tidal flows ranged from 180 to 2,800 acre-feet, and (5) corresponding suspended-sediment discharge ranged from 3 to 1,200 tons.

Ritter, J. R., 1973, Sand transport by the Eel River and its effect on nearby beaches: U.S. Geological Survey Open-File Report [73-236], p. 17.

The Eel River basin has one of the largest sediment yields per unit area in the world. Sand composes about 25 percent of the total sediment transported by the river into its estuary. The annual sand load averaged about 4,600,000 tons for the 58 year period of 1911-1914 and 1917-1970.

Most of this sand probably enters the ocean, some is deposited in the estuary, and the amount furnished to nearby beaches probably is small. Of the sand and finer sediment debouched by the Eel River into the ocean, the major part is scattered over the continental margin, some is lost to the Eel Canyon, and some is deposited offshore near the Eel River mouth. An analysis of the mineralogy and textural parameters of river and beach sands was performed to determine the sources of the nearby beach sands. The Eel River probably supplies most of the sand found along the beaches between Centerville Beach and the entrance to Humboldt Bay. The Mad and Little Rivers probably supply most of the sand found along the beaches between the entrance to Humboldt Bay and Moonstone Beach.

Schlocker, J., 1974, Geology of the San Francisco North quadrangle, California: U.S. Geological Survey Professional Paper 782, p. 109.

An extensive description of the deposits of the San Francisco North quadrangle is given. Two 1:24,000 scale, color maps are included on: (1) the geology, and (2) bedrock surfaces and landslide localities with a table of probable causes for landsliding. Sediment grain size and petrology of beach sands are used to locate the source of beaches along the Pacific shore of San Francisco. The probable sources of the beach sand and the related onshore dunes are the poorly consolidated Pliocene (5 to 2 million years old) and Pleistocene (2 million to 10,000 years old) Merced Formation, the younger formations along the shore to the south, and the sands of the continental shelf. The sands of the continental shelf probably were deposited by the ancestral Sacramento-San Joaquin River, during the Wisconsin Glaciation (about 85,000 to 7,000 years ago), when sea level was lower.

Smith, R. E., Herndon, R. E., and Harmon, D. D., 1979, Physical and chemical properties of San Francisco Bay waters, 1969-1976: U.S. Geological Survey Open-File Report 79-511, p. 607.

Basic data on the physical and chemical properties of San Francisco Bay waters were collected on 76 cruises over the period 1969 to 1976 at about six-week intervals at 36 stations. The stations were located along the axis of the Bay from Calaveras Point in South San Francisco Bay to the town of Rio Vista on the Sacramento River. On most of the cruises vertical profiles of the water properties were taken at 12 of the 36 stations. The samples were analyzed for physical and chemical characteristics including: salinity, temperature, light transmission, and suspended-particulate weight. The results of these analyses and the analytical methods used are documented in this report.

Thompson, J. K., 1981, Sediment grain-size distribution in San Francisco Bay, California: January, February, and August 1973: U.S. Geological Survey Open-File Report 81-1332, p. 34.

Sediment grain size data for San Francisco Bay are presented for Van Veen grab samples taken at 43 stations in January and February 1973 and at 42 of the same stations in August 1973. Mean and median grain size, sorting, skewness, kurtosis, and size-class percentages and ratios are presented for each station.

The coarsest sediment in the study area, 0.25 mm mean diameter, is found at the opening to the bay where more than 95 percent of the bed material is sand size. Stations with a over 50 percent sand-size particles are located: (1) west (seaward) of the Golden Gate, (2) in the central Bay, (3) in the constriction near Point San Pablo, and (4) at the confluence of the Sacramento and San Joaquin Rivers.

The seasonal changes in grain size were minimal, with greater variation occurring in the extremities of the bays.

U.S. Geological Survey, 1953, Floods of 1950 in southwestern Oregon and northwestern California: U.S. Geological Survey Water-Supply Paper 1137-E, p. 413-503.

Continuous rains through most of October 1950, culminating in heavy rains October 27-30, caused the streams of southwestern Oregon and northwestern California to rise rapidly to high peaks. Flood-affected coastal areas in California included the Smith, Klamath, Mad, and Eel river basins.

This report includes stream gaging data for the Smith and Trinity Rivers, historical data for the Smith and Klamath rivers, and precipitation data for Crescent City.

U.S. Geological Survey, 1960, Compilation of records of surface waters of the United States through September 1950, part 11-A, Pacific slope basins in California, except Central Valley: U.S. Geological Survey Water-Supply Paper 1315-B.

This volume presents monthly and yearly summaries of streamflow and reservoir data collected before September 1950 by the U.S. Geological Survey in Pacific slope basins except the Central

Valley basin before September 1950. Included with these data are some records furnished by other Federal, State, and private agencies.

The data presented for most of the gaging stations comprise a description of the station, tables of monthly discharge and runoff, and a yearly summary table. The station description gives the location of the gaging station, drainage area, supplemental records available (for some stations), types and datums of gages, average discharge, extremes of discharge, general remarks concerning the data, and a credit statement when records were furnished by another agency. Results of miscellaneous discharge measurements and, in general, stage records have been excluded. Bar charts showing the period of record covered by each gaging station and a map of the area showing the location of each station are also presented. The original data were published, usually annually, in U.S. Geological Survey Water-Supply Papers.

U.S. Geological Survey, 1962, Summary of floods in the United States during 1955: U.S. Geological Survey Water-Supply Paper 1455-B, p. 69-143.

A destructive series of floods occurred in the Western States in December 1955 and continued on into January 1956, covering California (with the exception of about the southern one-fourth) the western part of Nevada, the southwestern part of Oregon, and west-central Idaho.

The floods described in this report are given in chronological order. The data presented include: (1) a description of the storm, the flood, and flood damage; (2) a map of the flood area showing the location of flood-determination points and for some floods the location of precipitation stations or isohyets; and (3) rainfall data and flood-peak stages and discharges of the affected streams.

Floods affecting northern California, some of the most intense ever recorded, began with a series of intense rain on December 16, 1955. Stream stages and discharges during the floods of 1955 and the maximum previously known flood are given for the Pajaro, Salinas, Russian, Eel, Klamath rivers.

U.S. Geological Survey, 1963, Summary of floods in the United States during 1958: U.S. Geological Survey Water-Supply Paper 1660-B, p. 97.

A series of storms from January 23 to February 16 brought large amounts of precipitation to northern California and produced damaging floods, particularly in the Lower Sacramento Valley. The most intense rainfalls were associated with the frontal passage of April 2-3. In San Francisco, 0.96 inches of rain fell in an hour, the greatest hourly intensity recorded there since the maximum of 1.07 inches in 1912.

A second series of storms moved southeastward across California and caused almost continuous precipitation over most of the State from April 29 to May 7, with the greatest concentration in the central part of the State. Precipitation totals of more than 10 inches were not uncommon, and several stations recorded daily amounts of more than 5 inches. Rain swollen streams overflowed throughout central California, and the peak of many of the small streams exceeded those of the floods of December 1955. High tides contributed to the high stages on many of the coastal streams.

U.S. Geological Survey, 1964, Summary of floods in the United States during 1956: U.S. Geological Survey Water-Supply Paper 1530, p. 85.

In California the rains associated with the disastrous floods of December 1955 to January 1956 in the Far Western States ceased on January 27. Then a severe storm moving southeast from the north Pacific Ocean struck northern and central California on February 23. All coastal basins north of San Francisco Bay and the entire Sacramento Valley were affected by the storm. Precipitation totals of more than 15 inches from February 19 to 23 were not uncommon. Many Weather Bureau precipitation stations received more than 6 inches of rainfall in 24 hours. At

Gasquet Ranger Station 8.50 inches of rain was recorded in 1 day.

Peak discharges for the 1956 flood and for the maximum recorded flood are given for the gaging stations nearest the ocean for four coastal rivers in northern California: the Mattole, the Eel, the Klamath, and the Smith.

U.S. Geological Survey, 1964, Compilation of records of surface waters of the United States, October 1950 to September 1960, part 11, Pacific slope basins in California: U.S. Geological Survey Water-Supply Paper 1735.

This report presents a summary of records of stream discharge and reservoir contents collected from October 1950 to September 1960 by the U.S. Geological Survey. These records are supplemented by data from other agencies. Results of miscellaneous discharge measurements and, in general, stage records have been excluded.

The data presented for most of the gaging stations comprise a description of the station, a table of monthly discharge in cubic feet per second, a table of monthly discharge in acre-feet and a yearly summary table. The station description gives the name of the river basin, the station number and name, the location, drainage area, records available, types and datums of gages, average discharge, extremes of discharge, general remarks concerning the data, and a credit statement if records were furnished by another agency.

The original data were published annually in U.S. Geological Survey Water-Supply Papers.

U.S. Geological Survey, 1970, Surface water supply of the United States 1961-65, part 11, Pacific slope basins in California, vol. 2, basins from the Arroyo Grande to Oregon State line except Central Valley.: U.S. Geological Survey Water-Supply Paper 1929.

The data in this report generally comprise a description of the gaging station and tabulations of daily and monthly figures from October 1961 to September 1965. The description of the station gives the location, drainage area, records available, type and history of gages, average discharge, extremes of discharge, general remarks, and notations on revisions of the previously published record. For gaging stations on streams or canals a table showing the daily discharge and monthly and yearly discharge is given. For gaging stations on lakes and reservoirs a monthly summary table of stage and contents or a table showing the daily contents is given. Tables of daily mean gage heights are included for some streamflow and reservoir stations. This report does not include sediment data.

U.S. Geological Survey, 1971, Index of surface-water records to September 30, 1970- Part 11, Pacific slope basins in California: U.S. Geological Survey Circular 661, p. 53.

This report lists, by basin, streamflow and reservoir stations in the Pacific slope basins in California that have data published in reports of the Geological Survey for periods through September 30, 1970. Drainage area, station number, and period of record are given for each station. An alphabetical list of streams, lakes, and reservoirs in California is given at the end of this circular.

U.S. Geological Survey, 1976, Surface water supply of the United States 1966-70, part 11, Pacific slope basins in California, vol. 2, basins from the Arroyo Grande to Oregon State line except Central Valley.: U.S. Geological Survey Water-Supply Paper 2129.

The data in this report generally comprise a description of the gaging station and tabulations of daily and monthly figures from October 1966 to September 1970. The description of the station gives the location, drainage area, records available, type and history of gages, average discharge, extremes of discharge, general remarks, and notations on revisions of the previously published record. For gaging stations on streams or canals a table showing the daily discharge and monthly and yearly discharge is given. For gaging stations on lakes and reservoirs a monthly summary

table of stage and contents or a table showing the daily contents is given. Tables of daily mean gage heights are included for some streamflow and reservoir stations. This report does not include sediment data.

U.S. Geological Survey, 1978, Reports for California by the Geological Survey Water-Resources Division: Water-Resources Report, p. 145.

This bibliography presents a listing, by author, of about 1500 reports on the water resources of California prepared and released by the Water-Resources from 1898 to December 1977. Reports are indexed by hydrologic area, county, and subject. The subject index is divided into three general categories-- ground water, surface water, and water resources. These general subjects are subdivided into 30 to 60 more specific categories.

U.S. Geological Survey, Quality of surface waters of the United States, published yearly 1941 to 1970, part 11, Pacific slope basins in California: U.S. Geological Survey Water-Supply Papers, p. 300-700.

The U.S. Geological Survey has published annual records of chemical quality, water temperature, and suspended sediment since 1941. These records were published annually in U.S. Geological Survey Water-Supply Papers. These papers describe the location of sampling stations and the station's drainage area, period of record, extremes of dissolved solids, hardness, specific conductance, temperature, sediment discharge, and other pertinent data. Records of discharge of the streams at or near the sampling station are included in most tables. Sediment grain- size data was collected on selected streams.

U.S. Geological Survey, Water resources data for California- published yearly 1971 to 1974, part 1, surface-water records, Colorado River basin, southern Great basin, and Pacific slope basins excluding Central Valley: available through National Technical Information Service, p. 500.

Part 1 of water-resources data for California presents surface- water records of streamflow or reservoir storage at gaging stations, partial-record stations, and miscellaneous sites. Daily and monthly mean discharges are given in this report. This is one of two-part data report the U.S. Geological Survey published yearly between 1971 and 1974 on the hydrology of California. The companion report is water-resources data for California, part 2, water-quality records.

U.S. Geological Survey, Water resources data for California- published yearly 1971 to 1974, part 2, water-quality records: available through National Technical Information Service, p. 600.

Part 2 of water-resources data for California includes records of data for the chemical, physical, and biological characteristics of surface and ground water. Sediment-discharge data are also included in this report. This is one of a two-part data report the U.S. Geological Survey published yearly between 1971 and 1974 on the hydrology of California. The companion report is water-resources data for California, part 1, surface-water records.

U.S. Geological Survey, Water resources data for California- published yearly 1975 to 1982, volume 2, Pacific slope basins from Arroyo Grande to Oregon State line except Central Valley: U.S. Geological Survey Water-Data Reports CA-75-2 to CA-82-2, p. 500.

Volume 2 of water-resources data for California consists of record of stage, discharge, and water quality of streams and wells; stage, contents, and water quality in lakes and reservoirs; and water levels in wells. This volume, published yearly since 1975, presents data for Pacific slope basins in California except the Central Valley. Sediment-discharge data is included in this volume.

Waananen, A. O., 1971, Floods of December in central and southern California in Summary of floods in the United States during 1966: U.S. Geological Survey Water-Supply Paper 1870-D, p. D78-D91.

Rains of December 1966 caused flooding in coastal basins in Monterey Bay and south past the Mexican border. Peak discharges and stages and the maximum previously recorded flood are given for rivers in the Big Sur, Carmel, Salinas, and Pajaro river basins.

Waananen, A. O. and Crippen, J. R., 1977, Magnitude and frequency of floods in California: U.S. Geological Survey Water-Resources Investigation 77-21, p. 96.

The magnitude and frequency of floods at both gaged and ungaged drainage areas in California, for any recurrence interval from 2 to 100 years, can be estimated using the method presented. Equations relating flood magnitudes of selected frequency to basin characteristics such as drainage area, precipitation, and altitude were developed for six regions in the State. The correct variables to plug into the equation for each of the six regions are given in a table. The regression equations were developed for streams that have natural flow or flows not substantially affected by storage. Also included are informative tables of maximum recorded discharges and of basin characteristics.

Wahl, K. C., Crippen, J. R., and Knott, J. M., 1980, Floods of January and February 1980 in California: U.S. Geological Survey Open-File Report 80-1005, p. 52.

The storms of January-February 1980 caused significant flooding over most of California. The storm of mid-January covered the entire State, but most of the flooding was caused by runoff from the Sierra Nevada and the Sierra foothills; subsequent storms primarily affected southern California and coastal areas northward to San Francisco. This report includes a summary of peak discharges at selected stream-gaging stations for the peak flows of 1980 and the previous maximum peak flows. The data in this report is preliminary; final discharge data is published in the annual series "Water Resources Data for California". No sediment data is included for central and northern California.

Wehmiller, J. F., Kennedy, G. L., and Lajoie, K. R., 1977, Amino acid racemization age estimates for Pleistocene marine deposits in the Eureka-Fields landing area, Humboldt County, California: U.S. Geological Survey Open-File Report 77-517, p. 25.

Amino acid enantiomeric (D/L) ratios in fossil Saxidomus, a thick-shelled aragonitic clam, were used to estimate the age of sedimentary deposits at four localities in the Eureka - Fields Landing area of the Humboldt Bay region, California. This method yields age estimates of 180,000 to 280,000 years for exposed and slightly deformed bay and estuarine deposits.

Willis, B., 1898, Photograph of Slate Springs, about 55 miles southeast of Monterey, Monterey County, California: U.S. Geological Survey Photographic Library Photograph no. 101, Denver, Colorado.

This 1898 photograph shows the coastline near Slate Springs, which is about 55 miles southeast of Monterey. The photograph, taken looking towards the north, shows a rocky beach and offshore sea stacks.

Willis, B., 1898, Photograph of Slate Springs, about 55 miles southeast of Monterey, Monterey County, California: U.S. Geological Survey Photographic Library Photograph no. 102, Denver, Colorado.

This 1898 photograph shows the coastline near Slate Springs, which is about 55 miles southeast of Monterey. The photograph, taken looking towards the south, shows a rocky beach and offshore sea stacks.

Willis, B., 1898, Photograph of Slate Springs and coastal aspects in the vicinity, looking southeast, 55 miles southeast of Monterey: U.S. Geological Survey Photographic Library Photograph no. 103, Denver, Colorado.

A view, looking southeast, of the 1898 coastline in the vicinity of Slate Springs, about 55 miles southeast of Monterey. This photograph was taken from an elevation of a few hundred feet above sea level.

Willis, B., 1898, Photograph taken 65 miles southeast of Monterey, between Slate Springs and Gamboa Point, Monterey, California: U.S. Geological Survey Photographic Library Photograph no. 105, Denver, Colorado.

This 1898 photograph of the coastline was taken about 65 miles southeast of Monterey between Slate Springs and Gamboa Point. The view, looking north from an elevation of a few hundred feet above sea level, includes rocky headlands and offshore sea stacks.

Willis, B., 1898, Photograph taken 65 miles southeast of Monterey between Slate Springs and Gamboa Point, Monterey County, California: U.S. Geological Survey Photographic Library Photograph no. 106, Denver, Colorado.

This 1898 photograph of the coastline was taken about 65 miles southeast of Monterey between Slate Springs and Gamboa Point. The view, looking south from an elevation of a few hundred feet above sea level, includes rocky headlands and offshore sea stacks.

Wilson, A. and and, others, 1967, River discharge to the sea from the shores of the conterminous United States, Alaska, and Puerto Rico- a contribution to the International Hydrological Decade: U.S. Geological Survey Hydrologic Investigation Atlas HA-282, scale 1:500,000, 1 sheet.

River discharge from large coastal regions to the oceans is shown in this 1:500,000 scale map of the conterminous United States. The coastal regions are about the size of central and northern California combined.

Wood, B. D., 1913, Gazetteer of surface waters of California, part 3, Pacific Coast and Great Basin streams: U.S. Geological Survey Water-Supply Paper 297, p. 244.

Even though written in 1913, this report contains useful information on surface water in California. Information about lakes and streams, for the most part based on topographic maps, is listed in alphabetical order. Information is given about a stream's source, course, length, principal tributaries, drainage area, and destination. Information is given about a lake's inlets, outlets, elevation, and a short description.

A complete list of the gaging stations maintained on streams in the Great Basin and the streams tributary to the Pacific Ocean from 1888 to July 1, 1912 is also presented.

Wright, R. H., 1971, Map showing locations of samples dated by radiocarbon methods in the San Francisco Bay region: U.S. Geological Survey Miscellaneous Field Studies Map MF-317.

46 sites, encompassing a total of 76 C14 dates, are plotted on a 1:500,000 scale map of the San Francisco Bay region. Information about the sites location, the C14 dates, and the source of data are also given in a text section. Data from locations in the vicinity of the coast include: (1) the Bodega Bay area, and (2) coastal terraces in San Mateo and Santa Cruz Counties.

Young, L. E. and Cruff, R. W., 1967, Magnitude and frequency of floods in the United States, part 11, Pacific slope basins in California, vol. 1, coastal basins south of the Klamath River basin and Central Valley drainage from the west: U.S. Geological Survey Water-Supply Paper 1685, p. 272.

This report presents a method for determining the probable magnitude of floods with recurrence intervals between 1.2 and 50 years for any stream, gaged or ungaged, in the study area. The study area includes streams in California that drain into the ocean south of the Klamath River basin. The area was divided into two regions of differing flood-frequency characteristics. A multiple-regression analysis found that the hydrologic basin characteristics having the most significant effect on the flood magnitude were drainage area, mean annual precipitation, and altitude. Coefficients for the multiple-regression equation are given for the two regions.

A table compiling all the available annual-maximum flood- peak data in the study area is also included in the report.

Young, L. E. and Cruff, R. W., 1967, Magnitude and frequency of floods in the United States, part 11, Pacific slope basins in California, vol. 2, Klamath and Smith river basins and Central Valley drainage from the east: U.S. Geological Survey Water- Supply Paper 1686, p. 308.

This report presents a method for determining the probable magnitude of floods of any recurrence interval between 1.2 and 50 years for any stream, gaged or ungaged, in the study area. The study area includes the Klamath and Smith river basins plus the small streams between them that drain into the Pacific Ocean.

A multiple-regression analysis found that the hydrologic basin characteristics having the most significant effect on the flood magnitude were drainage area, mean annual precipitation, and altitude. California coastal streams in and north of the Klamath basin use the same coefficients in the regression equation.

A table compiling all the available annual maximum flood peaks in the study area is also included in the report.

AERIAL PHOTOGRAPHY OF THE COASTLINE

The U.S. Geological Survey has been taking aerial photographs of the coastline of central and northern California since 1940. Photographs are black-and-white stereo pairs with 60 percent overlap in the direction of flight and 30 percent overlap perpendicular to the direction of flight. Unless otherwise noted, the focal length of the camera is six inches and the photograph size is nine inches square. Photographs can be obtained through any National Cartographic Information Center (NCIC) office. There are seven USGS NCIC offices and many State affiliate NCIC offices. The USGS NCIC office in California is:

Western Mapping Center - NCIC
U. S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

U.S. Geological Survey Aerial Photography of the Coastline of Central and Northern California

Coastline Flown						
From (southern border)	To (northern border)	Date	Scale	Flight Direction	Flight Number	Notes
Piedras Blancas Point San Luis Obispo Co. Lat. 35°40′	Sunset Beach State Park Monterey Co. Lat. 36°50′	1972	1:80,000	N-S	GS-VDDI-1	
San Simeon Point San Luis Obispo Co. Lat. 35°40′	Partington Point Monterey Co. Lat. 36°10′	1973	1:80,000	N-S	GS-VDDI-2	
San Simeon Beach San Luis Obispo Co. Lat. 35°30′	Cape San Martin Monterey Co. Lat. 35°50′	1976	1:80,000	N-S	GS-VEGI-3	
Notley's Landing Monterey Co. Lat. 36°20′	Half Moon Bay San Mateo Co. Lat. 37°30′	1968	1:30,000	N-S	GS-VBZK	
Lopez Point Monterey Co. Lat. 36°00′	Carmel Bay Monterey Co. Lat. 36°30′	1953 1954	1:37,400	N-S	GS-YH	
Castroville Monterey Co. Lat. 36°45′	Greyhound Rock Santa Cruz Co. Lat. 37°05′	1952	1:23,600	E-W	GS-WL	
Watsonville Santa Cruz Co. Lat. 36°50′	Guala Point Sonoma Co. Lat. 38°45′	1970	1:80,000	N-S	GS-VCMI	

Coastline Flown						
From (southern border)	To (northern border)	Date	Scale	Flight Direction	Flight Number	Notes
Greyhound Rock Santa Cruz Co. Lat. 37°05′	Pescadero Point San Mateo Co. Lat. 37°15′	1953	1:23,600	E-W	GS-XY	
Pescadero Point San Mateo Co. Lat. 37°15′	Half Moon Bay San Mateo Co. Lat. 37°30′	1948	1:23,600	E-W	GS-HR	
Half Moon Bay San Mateo Co. Lat. 37°30′	Muir Beach Marin Co. Lat. 37°50′	1946	1:23,600	E-W	GS-CP	
Presidio Fort San Francisco Co. Lat. 37°50′	Bodega Bay Marin Co. Lat. 38°15′	1952	1:23,000	N-S	GS-UX	
Pescadaro Point San Mateo Co. Lat. 37°15′	Half Moon Bay San Mateo Co. Lat. 37°30′	1960	1:30,000	E-W	GS-VACY	
Half Moon Bay San Mateo Co. Lat. 37°30′	Fort Barry Marin Co. Lat. 37°50′	1956	1:30,000	N-S	GS-VLX	
Half Moon Bay San Mateo Co. Lat. 37°30′	Muir Beach Marin Co. Lat. 37°50′	1968	1:30,000	N-S	GS-VBZJ	
Stinson Beach Marin Co. Lat. 37°50′	Anchor Bay Mendocino Co. Lat. 38°50′	1971	1:30,000	N-S	GS-VCUN	
Bolinas Bay Marin Co. Lat. 37°55′	Bodega Bay Marin Co. Lat. 38°15′	1976	1:80,000	N-S	GS-VEGH	

Coastline Flown						
From (southern border)	To (northern border)	Date	Scale	Flight Direction	Flight Number	Notes
Fort Ross Sonoma Co. Lat. 38°30′	Gualala Point Sonoma Co. Lat. 38°45′	1942	1:27,200	E-W	GS-AI	
Gualala Point Sonoma Co. Lat. 38°45′	Fort Bragg Mendocino Co. Lat. 39°30′	1959	1:49,000	E-W	GS-VQV	
Gualala Point Sonoma Co. Lat. 38°45′	Point Arena Mendocino Co. Lat. 38°55′	1956	1:48,000	E-W	GS-CBW	
Gualala Point Sonoma Co. Lat. 38°45′	Bear Harbor Mendocino Co. Lat. 39°55′	1976	1:80,000	N-S	GS-VEEX	
Fort Bragg Sonoma Co. Lat. 39°30′	Mistake Point Sonoma Co. Lat. 39°50′	1948	1:43,150	E-W	GS-EE	5.2" focal length
Fort Bragg Mendocino Co. Lat. 39°30′	Point Delgada Humboldt Co. Lat. 40°00′	1948	1:28,400	N-S	GS-ED	
Fort Bragg Mendocino Co. Lat. 39°30′	Cape Vizcano Mendocino Co. Lat. 39°45′	1964	1:34,000	N-S	GS-VBAG	
Fort Bragg Mendocino Co. Lat. 39°30′	Cape Vizcano Mendocino Co. Lat. 39°45′	1964	1:17,000	N-S	GS-S-VBAG	12" focal length, 9"x18" image
Bell Point Mendocino Co. Lat. 39°40′	Eel River Humboldt Co. Lat. 40°35′	1968	1:34,000	N-S	GS-VBZX	

Coastline Flown						
From (southern border)	To (northern border)	Date	Scale	Flight Direction	Flight Number	Notes
Cape Mendocino Humboldt Co. Lat. 40°25′	Humboldt Bay Humboldt Co. Lat. 40°50′	1940	1:34,000	E-W	GS-R	5.2" focal length
Cape Mendocino Humboldt Co. Lat. 40°25′	Crannel Humboldt Co. Lat. 41°05′	1956	1:37,400	N-S	GS-VLI	
Eel River Humboldt Co. Lat. 40°35′	Crannel Humboldt Co. Lat. 41°05′	1972	1:30,000	N-S	GS-VCZP	
Point Delgada Humboldt Co. Lat. 40°00′	Prairie Creek State Park Humboldt Co. Lat. 41°25′	1980	1:80,000	N-S	GS-VEZF	
McKinleyville Humboldt Co. Lat. 40°55′	Oregon Border Del Norte Co. Lat. 42°00′	1964	1:30,000 1:36,000	N-S	GS-VAXK	
McKinleyville Humboldt Co. Lat. 40°55′	Oregon Border Del Norte Co. Lat. 42°00′	1964	1:15,000 1:18,000	N-S	GS-S-VAXK	12" focal length, 9"x18" image
False Klamath Cove Del Norte Co. Lat. 41°35′	Oregon Border Del Norte Co. Lat. 42°00′	1955	1:23,600	N-S	GS-VIU	
Prairie Creek Humboldt Co. Lat. 41°25′	Sister Rocks Del Norte Co. Lat. 41°40′	1978	1:80,000	N-S	GS-VEMA	

INDEX

Publications are indexed by county, inland-to-offshore position, and subject. Each publication is indexed at least once in each of these three categories and more than once when its scope warrants indexing in additional categories. Because some publications pertain to a broad area covering several counties, a regional subdivision is included in addition to the 10 counties in the county category. The bulk of publications indexed as regional are water resources reports which give information for the entire study area. Publications including information from more than three counties and attempting to find relationships applying to large areas are also indexed as regional. The three subdivisions under the inland-to-offshore position category are offshore, coastal, and inland. The dividing lines between offshore-coastal and coastal-inland indexing are the seaward edge of the surf zone and about one-mile inland from the coast, respectively. The subject category has four subdivisions; hydrology, geologic record, geomorphology, and sediments. Publications indexed under hydrology contain flow information for streams, lagoons, estuaries, and coastal waters. A geologic record indexing was given to publications that contain information on geologic deposits and structures. Geomorphology indexing was given to publications which describe the lands form or processes that alter its form. Included in this subdivision are publications containing information on river cross-sections, processes such as landslides and mudflows, and historical photographs of the coastline which can be used to document coastal erosion. The last subdivision in the subject index is sediments. Sediments indexing was given to publications with any information on grain-size or mineralogy of loose sediments and on quantities of sediment transported by streams, lagoons, estuaries, and coastal waters. Publications with detailed information on erodible cliff sediments are also included in this subdivision.

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Arnold, R., ca. 1904, Photograph of north of the mouth of Waddell Creek, looking south, Santa Cruz County,
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