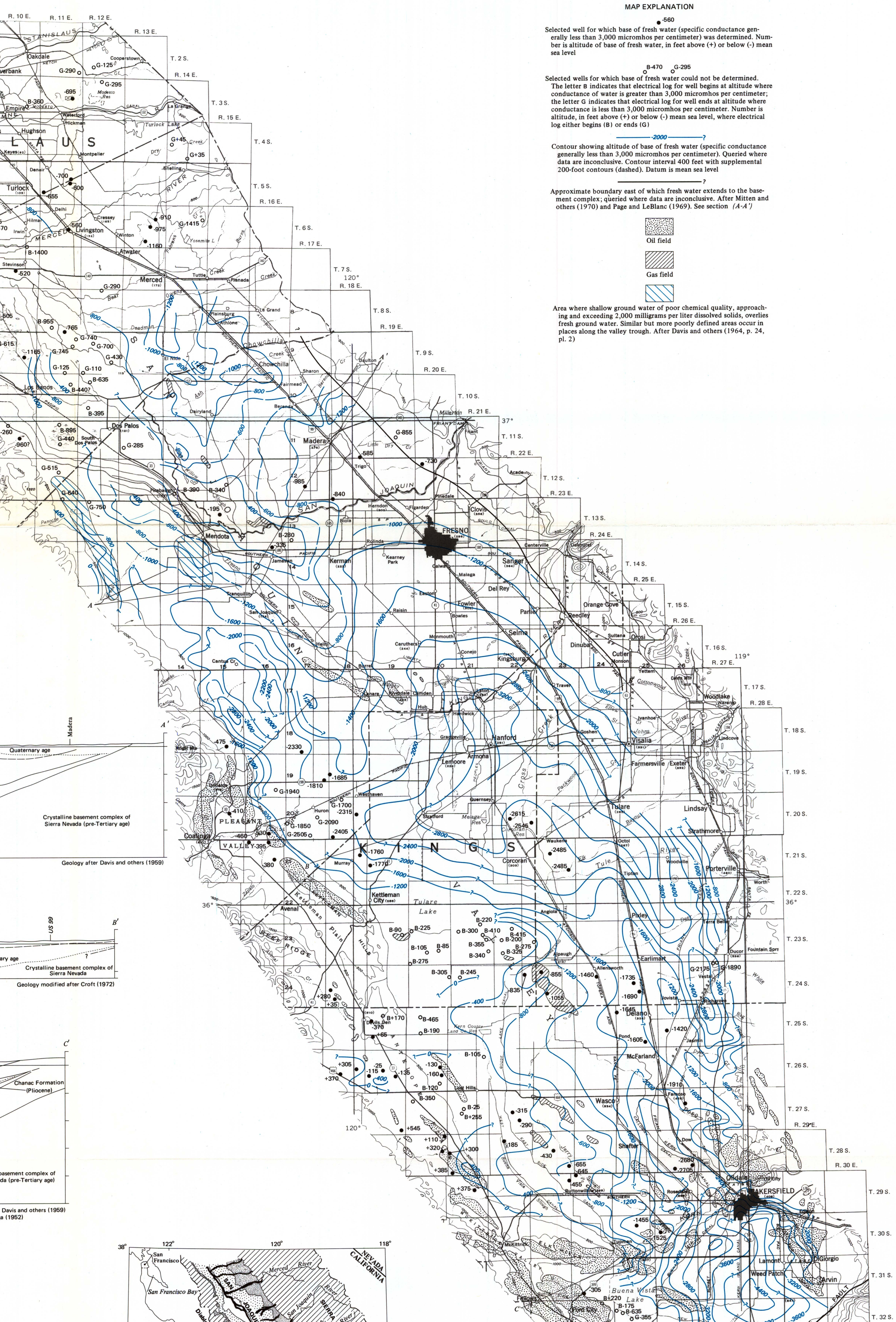
Prepared in cooperation with the
CALIFORNIA DEPARTMENT OF WATER RESOURCES



MAP EXPLANATION

-560

Selected well for which base of fresh water (specific conductance generally less than 3,000 micromhos per centimeter) was determined. Number is altitude of base of fresh water, in feet above (+) or below (-) mean sea level

B-470 G-295

Selected wells for which base of fresh water could not be determined. The letter B indicates that electrical log for well begins at altitude where conductance of water is greater than 3,000 micromhos per centimeter; the letter G indicates that electrical log for well ends at altitude where conductance is less than 3,000 micromhos per centimeter. Number is altitude, in feet above (+) or below (-) mean sea level, where electrical log either begins (B) or ends (G)

-2000 ?

Contour showing altitude of base of fresh water (specific conductance generally less than 3,000 micromhos per centimeter). Queried where data are inconclusive. Contour interval 400 feet with supplemental 200-foot contours (dashed). Datum is mean sea level

?

Approximate boundary east of which fresh water extends to the basement complex; queried where data are inconclusive. After Mitten and others (1970) and Page and LeBlanc (1969). See section *(A-A')*

Oil field

Gas field

Area where shallow ground water of poor chemical quality, approaching and exceeding 2,000 milligrams per liter dissolved solids, overlies fresh ground water. Similar but more poorly defined areas occur in places along the valley trough. After Davis and others (1964, p. 24, pl. 2)

Base map from U.S. Geological Survey, State of California, North and South half, 1963, 1:500,000

SCALE 1:500 000

CONTOUR INTERVAL 500 FEET
DATUM IS MEAN SEA LEVEL

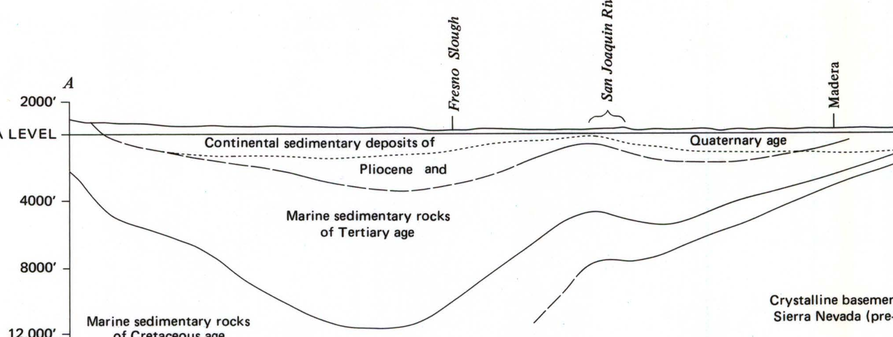
MAP SHOWING ALTITUDE OF THE BASE OF FRESH GROUND WATER

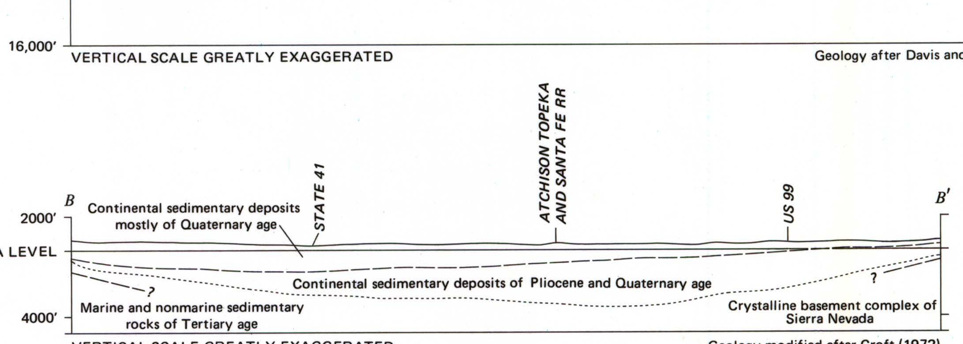
SECTION EXPLANATION

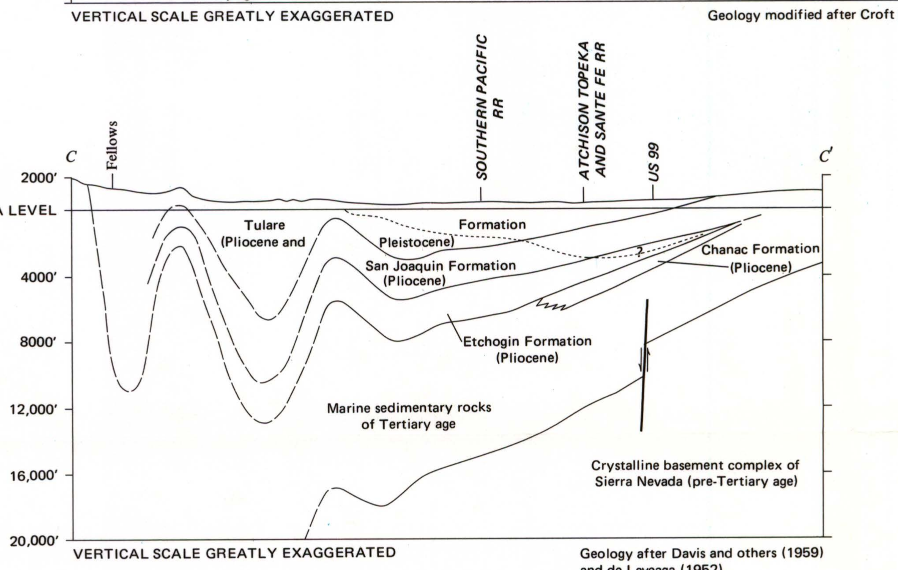
Stratigraphic unit contact
Dashed where approximately located. Queried where evidence is inconclusive

Approximate base of water with specific conductance less than 3,000 micromhos per centimeter
Queried where evidence is inconclusive

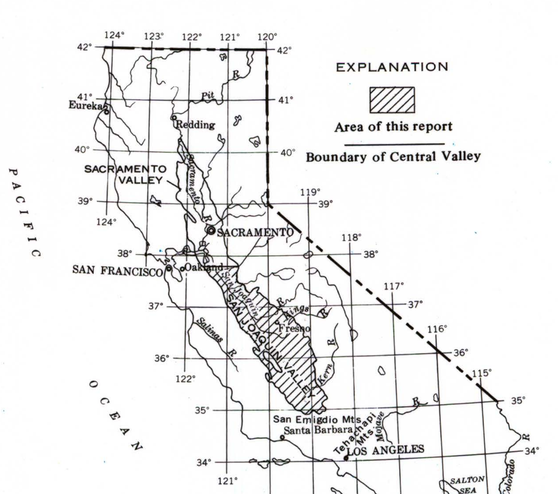
Fault
Arrows indicate direction of relative movement



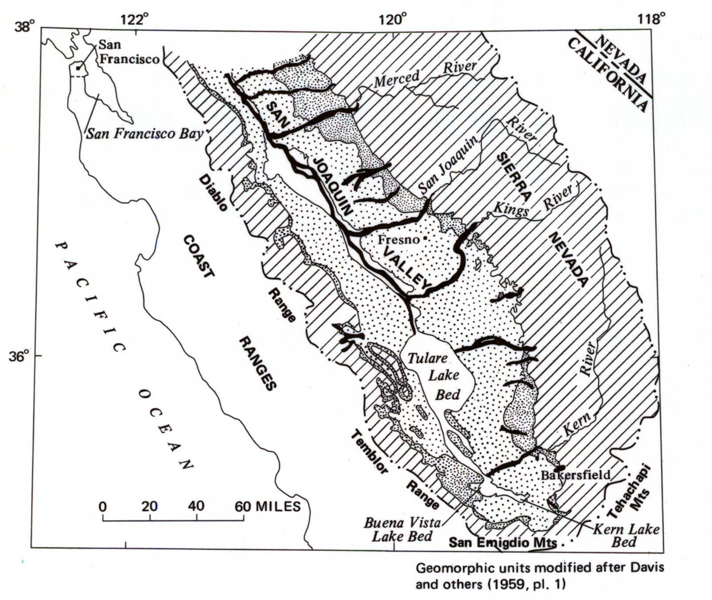




GENERALIZED GEOLOGIC SECTIONS



INDEX MAP OF CALIFORNIA SHOWING AREA COVERED BY THIS REPORT



Geomorphic units modified after Davis and others (1959, pl. 1)

GEOMORPHIC MAP OF PART OF THE SAN JOAQUIN VALLEY

EXPLANATION

Overflow lands and lake bottoms
River flood plains and channels
Low alluvial plains and fans
Consolidated rocks (Valley boundary)
Dissected uplands
Drainage boundary

LOCATION AND GENERAL FEATURES

The Central Valley of California consists of the San Joaquin and the Sacramento Valleys (index map). The San Joaquin Valley, forming the southern two-thirds of the Central Valley, is a broad structural trough bordered on the east by the Sierra Nevada, and on the west by the Diablo and the Temblor Ranges, which are parts of the Coast Ranges (geomorphic map). The valley extends 250 miles southeastward from the confluence of the San Joaquin and the Sacramento Rivers to the Tehachapi and the San Emigdio Mountains. The width of the valley ranges from 25 miles near the Kern River to 55 miles near the Kings River and averages about 35 miles. The study area, the southern eight-ninths of the San Joaquin Valley, includes about 10,000 square miles of the valley floor.

The warm climate, rich soil, and extensive irrigation make the San Joaquin Valley the largest single agricultural area in the State and one of the most productive agricultural areas in the country. Water from wells makes up the sole irrigation-water supply for about half the irrigated land within the valley, and is a supplemental supply for another quarter of the irrigated areas (Poland and Evenson, 1966, p. 242). Ground water also supplies nearly all the municipal, industrial, and domestic needs for the area.

PURPOSE AND SCOPE

Widespread pumping of ground water in the San Joaquin Valley began about 1900, and since 1940 pumpage has increased at an accelerated rate. In response to the heavy withdrawal of ground water, water levels have declined rapidly beneath extensive areas of the valley. Consequently, it becomes necessary to delineate the base of fresh ground water so that changes in thickness of the fresh-water zone can be monitored, and limiting depths of water wells can be determined. In turn, those data will be useful in determining favorable areas for ground-water storage, and areas and depths for waste-water disposal wells.

Because other agencies and the U.S. Geological Survey have collected a vast amount of well log and other data, most of the information in this report was assembled from existing files. However, for areas where data were scanty, a few hundred additional electrical logs were collected to supplement the available information.

Using that information, the base of fresh water was determined from electrical logs of wells, chemical analyses of water from wells, and from data included in numerous hydrologic and geologic reports. The most important sources of data were the electrical logs of wells drilled for oil and gas. In all, about 3,000 electrical logs were used to interpret ground-water salinity.

DEFINITION OF FRESH GROUND WATER

For the purpose of this study, fresh water is defined as that water having a maximum specific conductance of 3,000 μmhos/cm (micromhos per centimeter), about 2,000 mg/l (milligrams per liter) dissolved solids. The value of 3,000 μmhos/cm was chosen because it was used as the criterion for mapping the base of fresh water in the Sacramento Valley (Olmsted and Davis, 1961, pl. 5), and because the Federal Water Pollution Control Administration (1968, table IV-3) considered 2,000 mg/l to be a limiting dissolved-solids content for the irrigation of most crops. In addition, two recent reports (Mitten, LeBlanc, and Bertoldi, 1970, pl. 3, and Page and LeBlanc, 1969, pl. 17), show contour maps of the base of fresh water (2,000 mg/l dissolved solids) for local areas. Because in places saline water overlies fresh water, the base of fresh water is here defined as that depth below which only saline water is available.

ACKNOWLEDGMENTS

The collection of data and successful completion of the investigation for this report were made possible by the cooperation of public agencies, private companies, and individuals. Special thanks are given to A.N. Turcan, Jr., of the Geological Survey and R.P. Alger of Schlumberger Limited, who gave valuable advice on techniques of interpretation. Electrical well logs and relevant data were furnished by the U.S. Bureau of Reclamation, California Department of Water Resources, commercial blueprint firms, several oil companies in the Bakersfield area, and the California Division of Oil and Gas, with permission of well owners.

FRESH GROUND-WATER BODY AND BASE OF FRESH GROUND WATER

The body of fresh ground water in the San Joaquin Valley is contained in principally unconsolidated continental deposits of Pliocene to Holocene age that extend to depth ranging from less than 100 to more than 3,500 feet (base of fresh-water map and sections A-A', B-B', and C-C'). Locally at considerable depth, and along the eastern boundary of the valley at shallower depth, the base of fresh ground water occurs in more consolidated marine and continental sedimentary rocks of Tertiary age, and in marine rocks, also of Tertiary age. However, near Bakersfield and Terra Bella, fresh water-bearing sands occur within and between oil-bearing sands (Barnes, 1966, p. 39–41; Crowder, 1952, p. 17; Diepenbrock, 1933, p. 26; Kaseline, 1940–41, p. 17; Park, 1965, p. 19; Park, Weddle, and Barnes, 1963, p. 32–35; Shea, 1964, p. 37; and Weddle, 1958, p. 56; 1961, p. 16)—consequently, for those areas, the base of fresh water was either contoured using data above the first reported oil zone or not contoured at all. In places along the western side of the valley, the base of fresh water also occurs in marine and continental sedimentary rocks (Miller, Green, and Davis, 1971, p. E40–E41, figs. 14–15, pls. 3–4). Finally, in addition to occurring in sedimentary rocks and deposits, the base occurs locally in the igneous and metamorphic rocks of pre-Tertiary age of the Sierra Nevada.

The configuration of the base of fresh water in places reflects the underlying geologic structure. For example, the base of fresh water reflects the structures of the thick Tertiary basin underlying the southern part of the valley as well as part of the structure of the syncline that underlies an area just north and south of Tulare Lake bed (Hoots, Bear, and Kleinpel, 1954, pl. 5). Furthermore, it reflects the underlying anticlinal structure in some of the oil and gas fields in the valley, such as those near Mendota, Helm, and Riverdale (map and section A-A') (Frame, 1950; Hunter, 1952, 1954, and 1956). In other places, however, particularly along the eastern side of the valley, the base transgresses the structure (map and sections A-A' and B-B'). The base also transgresses some of the structural features along the western side of the valley, including an area where it transgresses the major confining bed in the valley.

Ground water occurs under both confined (artesian) and unconfined (water table) conditions in the San Joaquin Valley. The degree of confinement varies widely because of the heterogeneity of the continental deposits. In the large alluvial fans on the eastern side of the valley, the ground water is unconfined. The most extensive confined aquifer is the major aquifer system overlain by the Corcoran Clay Member of the Pliocene and Pleistocene Tulare Formation, a member which underlies more than 5,000 square miles in the valley (the diatomaceous clay described by Davis, Green, and Olmsted, 1959, pl. 14)—the Corcoran Clay Member itself is considered to be of Pleistocene age (Croft and Gordon, 1968, p. 22). In most places in the valley, the base of fresh water lies well below the Corcoran, but in an extensive area along the western side of the valley in T. 23 S., R. 19 E., 20 E., 21 E., and part of 22 E.; in T. 24 S., R. 20 E., 21 E., and part of 22 E.; in T. 25 S., R. 21 E.; and probably in T. 26 S. and parts of R. 21 E. and 22 E., it overlies the Corcoran.

In order to properly evaluate the salinity, dissolved solids content, of a water from resistivity data it is necessary to know the water type. Some of the water types common to the eastern and western sides of the valley are shown on the graphs. For example, for a resistivity of 3.3 ohm meters, about 3,000 μmhos/cm, sodium chloride type water from the western side has a dissolved-solids content of about 1,800 mg/l; whereas, for the same resistivity, sodium calcium or calcium sodium chloride type water has a dissolved-solids content of about 2,250 mg/l. Furthermore, as a water becomes more saline, and therefore less resistive, the difference in dissolved-solids content between two types of water having the same resistivity generally becomes larger (see graphs).

The salinity of the water directly beneath the base of fresh water generally increases gradually with depth, but in some places, such as in T. 3 S., R. 6 E., it increases rapidly. Data from reports of the California Department of Conservation, Division of Oil and Gas, and data from logs of deep wells indicate that the base of fresh water is underlain by nearly everywhere by a basal, saline-water body of a sodium chloride water type. Because very few wells yield water from near the base of fresh water, it is not known what type of water occurs there, but probably in most areas it is a mixture between the local directly overlying water type and the underlying sodium chloride water.

In addition to being underlain nearly everywhere by a saline water body, the fresh water body is locally overlain by water containing a dissolved-solids content that approaches and exceeds 2,000 mg/l (Davis, Lofgren, and Mack, 1964, p. 24, pl. 2). Some of those areas are shown on the base of fresh-water map. Mack (1969, p. 2535–2536) suggests that a markedly drier trend in the climate within the last 600,000 years is primarily responsible for the observed vertical changes in concentration.

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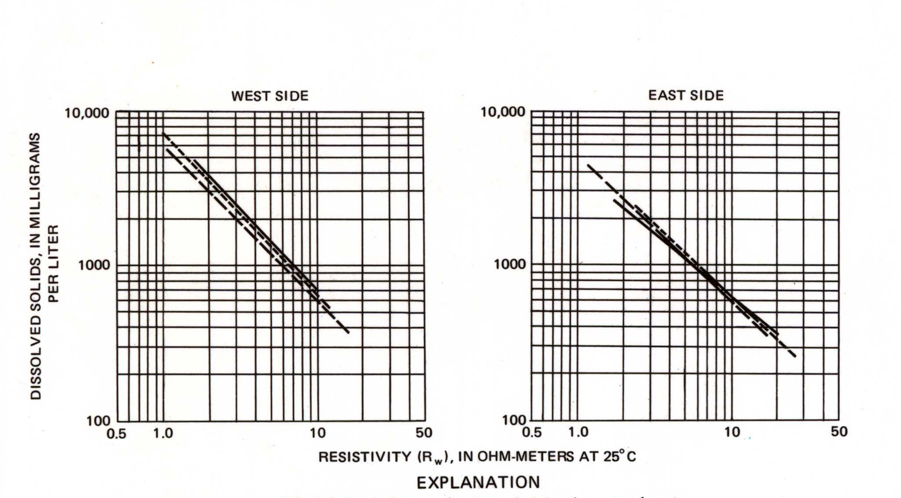

EXPLANATION

Selected chemical types of water underlying the east and west sides of the San Joaquin Valley

EAST SIDE

Sodium chloride | Sodium calcium, calcium sodium bicarbonate | Sodium bicarbonate

WEST SIDE

Sodium chloride | Sodium calcium, calcium sodium sulfate | Sodium sulfate

GRAPH SHOWING RELATION BETWEEN RESISTIVITY AND DISSOLVED SOLIDS FOR SIX WATER TYPES

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—W72395

BASE OF FRESH GROUND WATER (APPROXIMATELY 3,000 MICROMHOS) IN THE SAN JOAQUIN VALLEY, CALIFORNIA

By
R. W. Page

1973

For sale by U.S. Geological Survey, price 75 cents