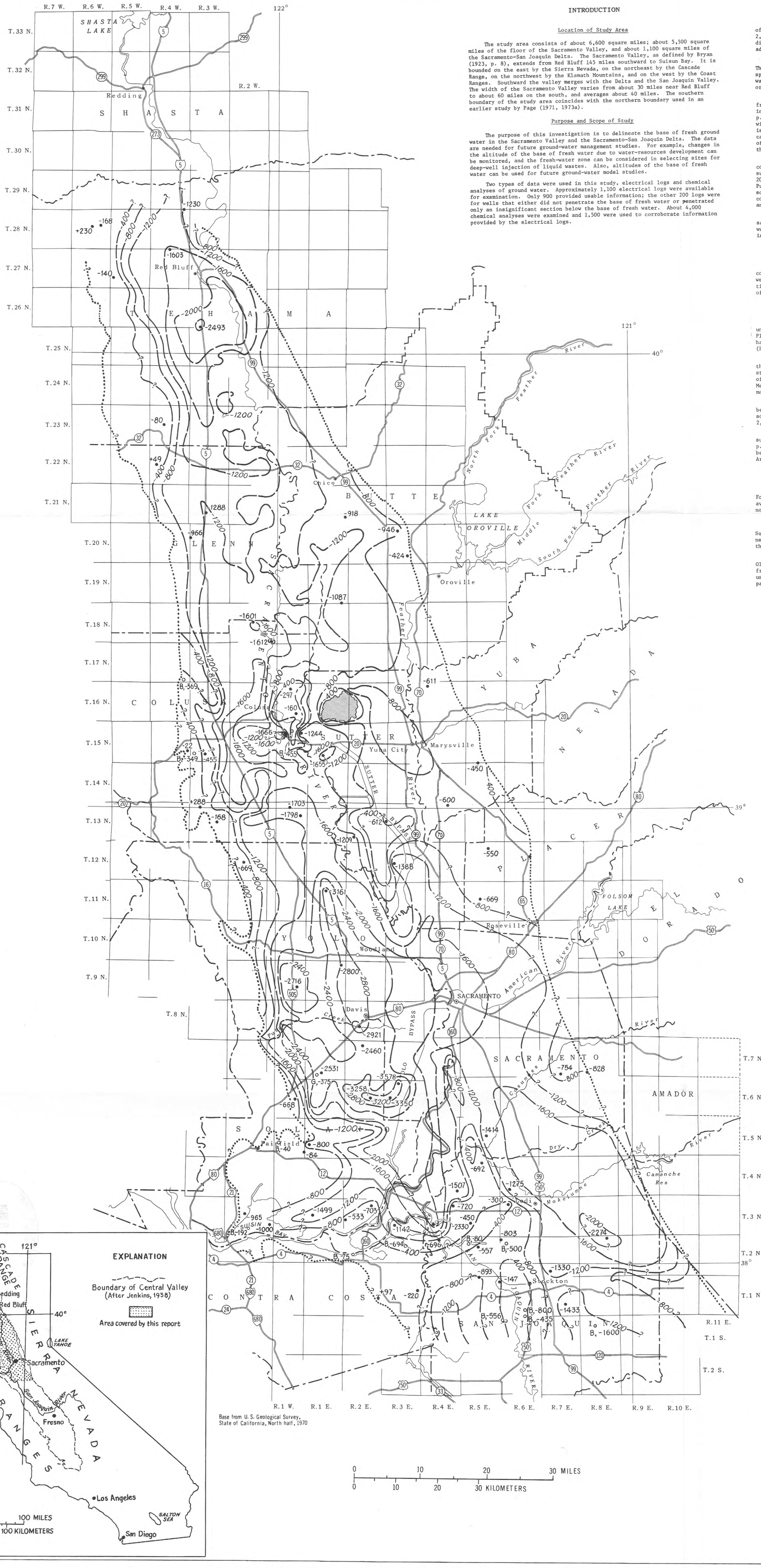
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
CALIFORNIA DEPARTMENT OF WATER RESOURCES

(200)
WRI
no. 40-73

WRI 40-73
OPEN FILE REPORT



INTRODUCTION

Location of Study Area

The study area consists of about 6,600 square miles; about 5,500 square miles of the floor of the Sacramento Valley, and about 1,100 square miles of the Sacramento-San Joaquin Delta. The Sacramento Valley, as defined by Bryan (1923, p. 8), extends from Red Bluff 145 miles southward to Suisun Bay. It is bounded on the east by the Sierra Nevada, on the northeast by the Cascade Range, on the northwest by the Klamath Mountains, and on the west by the Coast Ranges. Southward the valley merges with the Delta and the San Joaquin Valley. The width of the Sacramento Valley varies from about 30 miles near Red Bluff to about 60 miles on the south, and averages about 40 miles. The southern boundary of the study area coincides with the northern boundary used in an earlier study by Page (1971, 1973a).

Purpose and Scope of Study

The purpose of this investigation is to delineate the base of fresh ground water in the Sacramento Valley and the Sacramento-San Joaquin Delta. The data are needed for future ground-water management studies. For example, changes in the altitude of the base of fresh water due to water-resources development can be monitored, and the fresh-water zone can be considered in selecting sites for deep-well injection of liquid wastes. Also, altitudes of the base of fresh water can be used for future ground-water model studies.

Two types of data were used in this study, electrical logs and chemical analyses of ground water. Approximately 1,100 electrical logs were available for examination. Only 900 provided usable information; the other 200 logs were for wells that either did not penetrate the base of fresh water or penetrated only an insignificant section below the base of fresh water. About 4,000 chemical analyses were examined and 1,500 were used to corroborate information provided by the electrical logs.

Definitions

Fresh water, as used in this report, is water with a specific conductance of less than 3,000 μmhos/cm (micromhos per centimeter) at 25°C. This is about 2,000 mg/l (milligrams per liter) dissolved solids. A relationship between dissolved solids and specific conductance exists. The following equation adapted from Hem (1970, p. 99) can be used to approximate the relationship:

Specific conductance x 0.65 ≈ dissolved solids, in milligrams per liter.

The factor of 0.65 is reasonable for approximation of dissolved solids from specific conductance. In practice, the value of the factor for individual water samples ranges from about 0.50 to about 1.00, dependent on ionic species or combinations of species in solution.

Water with a specific conductance less than 3,000 μmhos is considered fresh in this study for several reasons. First, this limiting value was used in previous ground-water studies in California (Olmsted and Davis, 1961, p. 134-136, pl. 5; Page, 1971, 1973a). Second, this assumption is consistent with criteria established by the [U.S.] Federal Water Pollution Control Administration (1968, table IV-3) for irrigation water. Finally, 3,000 μmhos/cm can be picked with comparative ease on most available electrical logs because of the magnitude and character of the self-potential and resistivity curves in this range of specific conductance.

Salty or saline water, as used in this report, is water with a specific conductance greater than 3,000 μmhos/cm. In addition, salty water contains sufficient chloride as sodium chloride to taste salty to most people--more than 200 to 300 mg/l of chloride, according to Richter and MacLean (1939) and U.S. Public Health Service (1962, p. 32-34)--or contains at least this amount of sodium chloride by analysis. Saline water contains other dissolved mineral constituents and is based either on specific conductance or on chemical analysis.

The base of fresh water is defined as that depth below which only salty or saline water is present. In parts of the valley, bodies of salty or saline water overlie useful bodies of fresh water. A discussion of those conditions is presented later in this report.

Acknowledgments

Collection of data and completion of the study was made possible by the cooperation of public agencies, private companies, and individuals. Electrical well logs and other relevant data were furnished by the U.S. Bureau of Reclamation, the California Department of Water Resources, and the California Division of Oil and Gas (with permission of owners).

CONFIGURATION OF THE BASE OF FRESH GROUND WATER

Fresh ground water in the study area is contained almost exclusively in unconsolidated or poorly consolidated continental and volcanic deposits of Pliocene to Holocene age (Olmsted and Davis, 1961, p. 34-117). The deposits have a maximum thickness of about 3,600 feet, but generally are much thinner (Page, 1973b).

The surface of the base of fresh water is uneven and generally reflects the configuration of continental and volcanic deposits. Deeper geologic structures such as faults and gas reservoirs are rarely reflected in the shape of the base. Along the east margin of the valley, the basement complex of Mesozoic age delineates the lower limit of fresh water. Along the west margin, marine bedrock of Eocene age or older probably delineates the lower limit.

The minimum estimated altitude of the base of fresh water is 3,578 feet below mean sea level at a point between Walnut Grove and Davis about 15 miles southwest of Sacramento. In general, the base of fresh water is less than 2,000 feet below mean sea level.

In several parts of the valley, saline water zones are found near land surface. Some of these zones, described by Olmsted and Davis (1961, p. 135-136), can be divided into two groups based on knowledge of what lies beneath them. One group of shallow saline water zones overlies fresh water. Areas in this group include:

Tps. 3 and 4 N., Rs. 3, 4, and 5 E.
Tps. 6 and 7 N., R. 4 E.
Tps. 8 and 9 N., R. 4 E.
T. 14 N., R. 1 W.

For the second group of shallow saline water zones, inadequate information is available about what type of water underlies the shallow zone. Two of the more notable areas are located as follows:

Tps. 12 and 13 N., R. 2 E.
T. 12 N., R. 6 E.

Sutter Buttes, a volcanic plug, is also surrounded by saline water that occurs near land surface and slopes into the valley, reflecting the configuration of the underlying marine rocks.

The configuration shown on the map generally substantiates the work of Olmsted and Davis (1961, pl. 5). Variations between the two maps result mainly from the availability of more data in 1973 and the difference in intervals used to contour the data. Contours on the base of fresh water in the central part of the delta are based on poor control and are considered tentative.

SELECTED REFERENCES

Alger, R. P., [no date], Interpretation of electric logs in fresh water wells in unconsolidated formations: Schlumberger Well Surveying Corp., 25 p.
Bowen, O. E., Jr., ed., 1962, Geologic guide to the oil and gas fields of northern California: California Div. Mines and Geology Bull. 181, 412 p.
Bryan, F. L., 1950, Application of electric logging to water well problems: Schlumberger Well Surveying Corp., 5 p. [reprinted from Water Well Jour., Jan.-Feb., 1950, v. 4, no. 1].
Bryan, Kirk, 1923, Geology and ground-water resources of the Sacramento Valley, California: U.S. Geol. Survey Water-Supply Paper 495, 285 p.
_____1924, Report on proposed sites for a salt-water barrier in the lower reaches of Sacramento and San Joaquin Rivers, California: U.S. Geol. Survey open-file rept., 12 p.
California Department of Public Works, Division of Water Resources, 1931, Sacramento River Basin: California Dept. Public Works, Div. Water Resources Bull. 26, 578 p.
California Department of Water Resources, 1960, Northeastern Counties investigation: California Dept. Water Resources Bull. 58, 312 p.
_____1967, San Joaquin County ground water investigation: California Dept. Water Resources Bull. 146, 177 p.
_____1971, Hydrologic data, 1969: California Dept. Water Resources Bull. 130-169, v. 2, 531 p.
California Division of Mines, 1960a, Geologic map of California, Ukiah sheet: California Dept. Nat. Resources, 2 sheets.
_____1960b, Geologic map of California, Westwood sheet: California Dept. Nat. Resources, 2 sheets.
California Division of Mines and Geology, 1962a, Geologic map of California, Chico sheet: California Dept. Conserv., 2 sheets.
_____1962b, Geologic map of California, Redding sheet: California Dept. Conserv., 2 sheets.
_____1963, Geologic map of California, Santa Rosa sheet: California Dept. Conserv., 2 sheets.
_____1965, Geologic map of California, Sacramento sheet: California Dept. Conserv., 2 sheets.
_____1966, Geologic map of California, San Jose sheet: California Dept. Conserv., 2 sheets.
California Division of Oil and Gas, 1964, Exploratory wells drilled outside of oil and gas fields in California to December 31, 1963: California Div. Oil and Gas, 320 p.
_____1969, California oil and gas fields, supplemental maps and data sheets: California Div. Oil and Gas, 183 p.
California State Water Resources Board, 1952, Sutter-Yuba Counties investigation: California State Water Resources Board Bull. 6, 174 p.
Chandler, A. E., 1901, Water storage on Cache Creek, California: U.S. Geol. Survey Water-Supply Paper 45, 48 p.
Davis, G. H., and Olmsted, F. H., 1952, Geologic features and ground-water storage capacity of the Sutter-Yuba area, California: California Water Resources Board Bull. 6, app. B, p. 89-104.
Davis, G. H., and Poland, J. F., 1957, Ground-water conditions in the Mendota-Huron area, Fresno and Kings Counties, California: U.S. Geol. Survey Water-Supply Paper 1360-G, p. 409-588.
Guyod, Hubert, 1944, Electrical well logging: Halliburton Oil Well Cementing Pub., 103 p.
Hackel, Otto, 1966, Summary of the geology of the Great Valley, *in* Geology of northern California: California Div. Mines and Geology Bull. 190, p. 217-238.
Hart, E. W., 1966, Economic mineral deposits of the Great Valley, *in* Geology of northern California: California Div. Mines and Geology Bull. 190, p. 249-252.
Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water [2d ed.]: U.S. Geol. Survey Water-Supply Paper 1473, 363 p.
Jenkins, O. P., ed., 1943, Geologic formations and economic development of the oil and gas fields of California: California Div. Mines Bull. 118, 773 p.
_____1938, Geomorphic map of California: California Div. of Mines.
Mitten, H. T., 1971, Ground-water pumpage in parts of Yolo, Sacramento, Solano, Sutter, Colusa, and Napa Counties, California, 1966-68: U.S. Geol. Survey open-file rept., 4 p.
Olmsted, F. H., and Davis, G. H., 1961, Geologic features and ground-water storage capacity of the Sacramento Valley, California: U.S. Geol. Survey Water-Supply Paper 1497, 241 p.
Page, R. W., 1971, Base of fresh ground water (approximately 3,000 micromhos) in the San Joaquin Valley, California: U.S. Geol. Survey open-file rept., 13 p.
_____1973a, Base of fresh ground water (approximately 3,000 micromhos) in the San Joaquin Valley, California: U.S. Geol. Survey Hydrol. Inv. Atlas HA-489.
_____1973b, Base and thickness of the post-Eocene continental deposits in the Sacramento Valley, California: U.S. Geol. Survey Water-Resources Inv. 45-73 (in preparation).
Poland, J. F., Davis, G. H., Olmsted, F. H., and Kunkel, Fred, 1949, Ground-water storage capacity of the Sacramento Valley, California, appendix D, *in* Water Resources of California: California State Water Resources Board Bull. 1, 648 p. (1951).
Richter, C. P., and MacLean, A., 1939, Salt taste threshold of humans: Am. Jour. Physiol., v. 126, p. 1-6.
Schlumberger Well Surveying Corporation, 1958, Introduction to Schlumberger well logging: Schlumberger Well Surveying Corp., Doc. 8, 176 p.
Smith, M. B., 1964, Map showing distribution and configuration of basement rocks in California, north half, south half: U.S. Geol. Survey Oil and Gas Inv. Map OM-215.
Thomasson, H. G., Jr., Olmsted, F. H., and LeRoux, E. F., 1960, Geology, water resources and usable ground-water storage capacity of part of Solano County, California: U.S. Geol. Survey Water-Supply Paper 1464, 693 p.
[U.S.] Federal Water Pollution Control Administration, 1968, Water quality criteria: Rept. of Natl. Tech. Advisory Comm. to Secretary of Interior, Washington, D.C., 243 p.
U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

For additional information write to:
District Chief, Water Resources Division
U.S. Geological Survey
345 Middlefield Road
Menlo Park, Calif. 94025

Base from U. S. Geological Survey, State of California, North half, 1970

0 10 20 30 MILES
0 10 20 30 KILOMETERS

EXPLANATION

-220
Well
Well selected to show base of fresh water with specific conductance generally less than 3,000 micromhos per centimeter. Number is altitude of base of fresh water, in feet above (+) or below (-) mean sea level.

B,-80
Supplemental wells
Selected wells in which base of fresh water could not be delineated. 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. The number indicates altitude, in feet below (-) mean sea level.

?—1200
Contour
Contour on base of fresh water with specific conductance generally less than 3,000 micromhos per centimeter. Queried where data are inconclusive. Contour interval 400 feet. Datum is mean sea level.

Boundary
Approximate line where fresh water is in contact with bedrock or basement complex. Beyond the western boundary, water extends to marine rocks of Eocene or Cretaceous age (after California Division of Mines, 1960a, and California Division of Mines and Geology, 1963). Beyond the eastern boundary, water extends to basement complex (after Smith, 1964). Queried where data are inconclusive.

Sutter Buttes
Marine sediments surrounding igneous core.

BASE OF FRESH GROUND WATER—APPROXIMATELY 3,000 MICROMHOS—IN THE SACRAMENTO VALLEY AND SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA

By
C. F. Berkstresser, Jr.

December, 1973

MENLO PARK, CALIFORNIA