MASTER

RESOURCE ASSESSMENT OF LOW- AND MODERATE-TEMPERATURE GEOTHERMAL WATERS IN CALISTOGA, NAPA COUNTY, CALIFORNIA

Report of the Second Year, 1979-80 of the U.S. Department of Energy-California State-Coupled Program

for

Reservoir Assessment and Confirmation

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ABSTRACT

The California Division of Mines and Geology (CDMG), under contract to the U.S. Department of Energy (DOE), has performed, under its second year geothermal contract (1979-80), Phase I statewide assessment studies and Phase II site specific assessment studies. Phase I studies included updating and completing the USGS GEOTHERM File for California and compiling all data needed for a California Geothermal Resources Map. Phase II studies included a program to assess the geothermal resource at Calistoga, Napa County, California. The Calistoga effort was comprised of a series of studies involving different disciplines, including geologic, hydrologic, geochemical and geophysical studies.

The Calistoga geothermal area is relatively large and contains a considerable shallow, moderate temperature geothermal resource with the extent not known until now. Additionally, CDMG's findings indicate that the area along the southwest side of the main geothermal area is either a deep seated source of heat or a deep seated hydrogeothermal resource and thus the geothermal area may be much larger than was previously believed. The area containing near surface geothermal resources, determined by CDMG, is 5.79 square miles and the vertical section of sediments containing geothermal fluids above 25°C, and serving as the major part of the reservoir, averages 280 feet deep. The maximum recorded temperature is 135°C and the maximum estimated temperature is 140°C. A drilling program, still to be completed, has been designed by CDMG to confirm what has been done and to provide information as to the volume, quality, mix, and thermal energy of the geothermal fluids available for use.

INTRODUCTION

This report presents the results of the investigations performed under the terms of the second year contract (1970-80) between the U.S. Department of Energy (DOE) and the California Division of Mines ane Geology (CDMG) under the State Coupled Program. As explained in the report for the first year of this program (Martin and others, 1980, p. 2), there are two operationally distinct technical phases in the program. Phase I involves the compilation, verification, and dissemination of existing data, as well as use of this data to produce state geothermal maps and related publications and to assess regional and local geothermal areas. Phase II involves site specific studies in which new data are generated by geophysical surveys and drilling operations. The data are used to quantitatively assess the resource potential of a given geothermal reservoir.

The main efforts in the second year were divided between Phase I and Phase II studies. Phase I studies included updating the USGS GEOTHERM file and compilation and submittal of the data for the low and moderate temperature geothermal resources map of California. Phase II studies included an intensive study of the low and moderate temperature geothermal resources of the Calistoga area in Napa County, California.

Phase I work for the GEOTHERM file was concerned mainly with adding data to, and deleting data from, and making corrections on each of the original 966 records in the file, as well as inserting newly found data on previously unrecorded wells and springs. Deletions for elemination of duplicate entries were approximately equal to new entries. Complete data were developed and sent to National Oceanic and Atmospheric Administration (NOAA) for publication of a 1:750,000 scale Geothermal Resources Map of California showing the distribution of the known low and moderate temperature geothermal resources within the State. A lithographer's proof of the final map was reviewed and returned with corrections to NOAA in late June 1980. Copies of this map will abe available to the public from the Division of Mines and Geology in early 1981.

For Phase II studies of low and moderate temperature geothermal resources, under the second year contract, the Calistoga area in the upper Napa Valley was chosen. The Calistoga groundwater and geothermal area is unique in having (a) a long history of development and use as a geothermal resource (first by Indians and then by early settlers, for domistic use, space heating, and spas); (b) high and sometimes artesian groundwater, and (c), surprisingly, a shortage of potable ground water for domestic use. This last factor, and a proposal to remedy the situation by using geothermal heat to remove deleterious salts from poor quality water obtained from a local aquifer, was partly instrumental in focusing CDMG's attention on the area. Subsequently, it was decided by the local electorate that the water from the state water project should be imported to satisfy the domestic water need. However, the extensiveness of the geothermal resource in the area, the many potentials for its use, its ease of access and a good local source of manpower continues to make the resource attractive for a priority Phase II study by CDMG.

The purpose of this study is to provide new insight into the extent of the geothermal resource--its areal extent has never been determined--and its quality, and to gain an understanding of the geologic factors that control its occurrence. This report outlines the steps taken to accomplish this end and presents the results obtained to date. Included are studies of the history of the resource, the geology of the area, geophysical studies, geochemical sampling and temperature testing for 206 wells in the area, and a map showing the seismicity of the nearby region.

Still to be completed as part of the 1979-80 project are the drilling, sampling, and testing of up to six geothermal test holes ranging in depth from 400 to 990 feet. Upon completion of the drilling and testing program, a final supplement will be prepared to present interpretation of all the data obtained. Results from a separately funded study, based on geochemical sampling, not only for the newly completed test holes, but also for wells tested throughout the area, will be released in a separate report (Majmundar, work in progress). Maps, together with the other interpretive data, are expected to provide a new and concise picture, not only of the extent and potential of the hot and cold water aquifers, but also of the subsurface geologic stratigraphy and structure--the controlling elements for the aquifers and their contained waters.

The present report presents a wealth of new geophysical information developed by CDMG in its Calistoga studies. Studies using resistivity, seismic refraction, gravity, magnetic and chemical methods are described, as are the good correlations obtained by comparing the resistivity results with those from a shallow hole temperature study made in the area northwest of the center of Calistoga. The best overall results obtained, by far, are those from use of the resistivity method and, in fact, it has been possible to determine the subsurface higher temperature areas directly using resistivity. It should be pointed out that one of the studies included, the geochemical analyses, is not called for under terms of the 1979-80 contract but is presented only as a complimentary study to those funded by DOE.

Because geologic and hydrologic data from drilling operations are not yet available, the conclusions presented in this report are necessarily identified as being preliminary in nature. In addition, some types of data, as mentioned above, cannot be finalized until the drilling and testing operations are complete. The final supplementary report will contain all of the data from drilling, complete with interpretations, and is expected to be available during the first quarter of 1981.

PHASE I STUDIES

SUMMARY OF PHASE I ACTIVITIES (FY 1979-80)

Phase I work during Fiscal Year 1979-80 consisted of two major projects: (1) the updating of the California records in the U.S. Geological Survey's GEOTHERM file (a computer data bank listing data for all known thermal springs and wells in California) and (2) the compilation of a map that shows the distribution of known geothermal resources in California. The former task is ongoing whereas the latter was completed during 1979-80.

Updating of the GEOTHERM File

The U.S. Geological Survey's computer file GEOTHERM was substantially updated during Fiscal Year 1979-80. At the beginning of the year, the file contained 966 records of thermal wells and thermal springs. Initially, these records were compared with the CDMG Jenning's file of thermal wells and springs for mutual completeness. Many of the GEOTHERM records lacked chemical analyses; project staff abstracted chemical data from the literature for as many of these records as possible. The literature search mainly included various USGS and California Department of Water Resources reports as well as the chemical records at the Los Angeles Office of the Department of Water Resources. This search also revealed dozens of new thermal wells and thermal springs.

At the end of June 1980, the first complete updating of the file was nearly finished. Emphasis was made on adding data to, deleting data from, and making corrections on each of the original 966 records, and on inserting records for the newly found wells and springs. Many of the 966 records were deleted from the file because of duplications or because they were not considered truly thermal. The number of deletions was approximately equal to the number of new records added to the file.

Another purpose of updating the file was to ensure that the file contained records of all the thermal wells and thermal springs shown on the public geothermal map, described below. People who desire more detailed information on particular wells or springs than is given on this map (for example, a chemical analysis) will, in most cases, find it in the GEOTHERM file. The file will also be used as a basic source of data for the technical geothermal map, that is to be compiled in FY 1980-81.

Public Geothermal Map

The major accomplishment in Phase I activities during 1979-80 was the compilation of a map (scale 1:750,000) that shows the distribution of known geothermal resources in California. The map is intended for use by both the general public and technical community. A proof of the map was reviewed in late June, 1980, was approved with minor changes to be made by NOAA, and is expected to go to the printer in late 1980. Printed copies will probably be available to the public in January 1981.

Specifically, the map shows the locations of thermal springs and thermal wells, areas underlain or possibly underlain by thermal water (>20°C) suitable for direct-heat applications, KGRA's, points of measured heat flow, and cultural and geographic data. A table lists the location, and, where available, the temperature, rate of flow, total dissolved solids, and well depth for each well and spring. Notes on the map highlight geothermal phenomena and applications at many localities throughout the state. The data for the wells and springs were drawn exclusively from the three sources discussed above: the Jenning's file (a part of CDMG Bulletin 201, in press), the GEOTHERM file, and our literature search during the fiscal year.

PHASE II STUDIES, CALISTOGA AREA

PHASE II STUDIES, CALISTOGA AREA - METHODOLOGY

At the outset of CDMG's Calistoga geothermal investigation, it was decided that, in order to provide a resource assessment for the area, information would have to be gathered on the following: (a) the areal extent of the hot water reservoir; (b) the depth and configuration of the reservoir, including the configuration of geologic boundaries and barriers; (c) flow rates and yield for the geothermal fluids within the reservoir and, if possible, for individual aquifers within the area; (d) locations and depths where the hottest water is to be found; and (e) quality of the thermal waters and problems to be expected from use of those waters.

As with any complex research project, a logical first step is to perform a search of the literature. Although much information was available concerning thermal waters in the area, no delineation of the resource could be made without developing abundant new data.

Areal Extent

One of the best ways to determine the areal extent of the hot water in a geothermal area that contains a multitude of wells is to canvass the well owners and to measure temperatures and sample waters from the wells. Geothermal gradients and total depth temperatures obtained from certain of the wells can also provide some of the needed information to help determine vertical as well as lateral reservoir configuration, and where the hottest water can be found. Chemistry of the water can provide information on maximum temperatures of mixed water. For these reasons, a program was established early to systematically sample and run temperature tests on the wells throughout the Calistoga area. This work was performed with the cooperation of the California Division of Oil and Gas. Chemical analyses of the water samples were performed by CDMG and by University of Utah Research Institute (UURI). The intensive use of the electrical resistivity technique was originally planned to help delineate the boundaries of the reservoir, however, delays in delivery of the new resistivity equipment that had been ordered, precluded part of the intended use of this technique for this purpose.

Depth and Configuration of Reservoir

Several techniques were planned for use in the program to develop a picture of the subsurface configuration. These included detailed geologic mapping to supplement existing maps, gravity studies, resistivity studies, seismic studies, and to a lesser extent, magnetic studies. Information from these methods was used, in addition to information about the subsurface gained from the survey of existing water wells, to develop profiles to show depths to basement and to different horizons within the reservoir. Pertinent information from water wells was necessarily sketchy because of a lack of good drill logs and other data relative to the wells.

The CDMG drilling program was designed, in part, to develop substantiating information for the reservoir configuration developed through the methods outlined above. Two sets of proposed drill hole locations, those in the Tubbs Lane-Bennett Lane vicinity, and those along Greenwood Avenue, were chosen to provide checks on the geophysical profile alignments and to provide correlative alignments of the wells themselves that would substantiate basement configuraton. In addition, these drill holes are expected to provide detailed information on the stratigraphy within the reservoir and on the basement rock itself.

Flow Rates and Reservoir Capacity

At the beginning of CDMG's Calistoga studies, it was expected that documentation on flow rates and draw down in the geothermal reservoir, information essential to development of a quantitative estimate of reservoir capacity, would become available from two sources. These included (1) testing of one or more existing wells in cooperation with the owner/operator and (2) drilling and testing by CDMG of a series of test holes at strategic locations within the reservoir area. As of the date of this report, it has not been possible for CDMG to gain the cooperation of an owner of an appropriate existing well to procede with the necessary testing. The primary reason has been that such testing would severely interfere with the owner's normal operation of the wells. The result is that CDMG will have to depend very heavily on its own still-to-be-completed drilling program for data on flow rates, draw downs, and specific yield to provide data with which to estimate quantitative reservoir capacity. Another aspect of this problem lies with the presence (or absence) of water barriers within the reservoir proper. A separately funded geochemical study of the Calistoga area is being carried on by CDMG concurrently with this study and preliminary results so far show the probable presence of one or more major fault controlled water barriers within the alluviated part of the valley. The feasibility of using geochemical techniques to show fault controlled partitioning of different water types was recognized early in CDMG's study and plans were made for its use. Significant results are expected to be available in time for use in making the final assessment of this area.

Locations and Depths of Hottest Waters

One of the main objectives of the program to visit and systematically sample the existing wells throughout the Calistoga area, was to obtain temperature information, including a temperature profile for each well wherever possible. These temperature data, together with geothermometry based on geochemical techniques, were two of the main methods planned to provide the temperature picture, including maximum temperatures for the reservoir area in and around Calistoga. The other technique that was planned to provide a major contribution to temperature information was resistivity. An extremely strong correlation between the measured occurrence of hot water and areas interpreted as being hot based upon resistivity has proven the use of the resistivity technique. Contouring of the temperatures to be found at different depths in the reservoir area and in outlining the periphery of the hot water zone provide two of the major elements needed in reservoir assessment.

Quality of Thermal Waters-Problems

At the outset of CDMG's studies in the Calistoga area, it was recognized that deleterious chemical constituents were present in harmful quantities in at least part of the hot waters to be found within the reservoir. These constituents, when present in quantity, can result in a host of problems ranging from scaling of pipes and water handling equipment, to detrimental effects on agricultural plant growth. Chemical analysis of the samples collected from wells of various depths throughout the reservoir area was seen as a most logical and useful method to obtain the needed data; however, because mixing of water from different levels in an existing well is an ever-present problem, it was planned to carefully sample water from each interval as encountered during the drilling of CDMG's test wells. The sites of the proposed wells are strategically located to provide a cross section of the valley and also to provide samples from special locations known to have waters with unique characteristics. The samples taken from CDMG's test wells during drilling are thus expected to provide, by far, the most exact data available on water quality and to pinpoint the location of sources of problem waters, both vertically and horizontally within the reservoir area.

In summary, the Division of Mines and Geology program for resource assessment at Calistoga was planned using a variety of techniques. One that was considered essential was to collect and study data gathered from a survey of the existing water and thermal wells. The purpose was to provide information on the areal extent and vertical distribution of hot waters and to provide chemical data for geothermometry, water quality, and related problems, and also to provide information on partitioning and source areas for different types of subsurface water--a potential key to reservoir limits and to fault controlled barriers within the reservoir. Geophysical and geological techniques planned and used included: the resistivity technique to locate and delimit hot and chemically variable waters and also geologic structure; seismic, magnetic, and mapping techniques to delineate geologic unit occurrence and subsurface structure, and microacoustics to attempt to locate areas of high subsurface thermal activity. To complete the assessment, it was considered essential to obtain first hand flow data and accurate information on the temperature, stratigraphy, and water chemistry at specific depths. To accomplish this, the CDMG drilling program was planned. All but the drilling program and attendant studies have now been completed and so far results have proven the success of the resource assessment program as planned. An addendum to this report will be submitted to present the results of the drilling program.

HISTORICAL USE OF THE MODERATE-TEMPERATURE GEOTHERMAL RESOURCE

In this day of awakening interest in alternate energy sources, moderate-temperature geothermal resource areas are coming under scrutiny. One technique helpful in evaluating a potential resource area is to study the historical use of the "hot water: in the area. Fairly good historical documentation is available for Calistoga, California. Researching the literature and interviewing local residents of Calistoga has brought to light the use of the moderate-temperature geothermal resource there.

The Indian-Spanish Period of Use

According to all historical sources and local lore, the Indians residing in the Upper Napa Valley were the first to utilize the hot springs and steaming mud at the present site at Calistoga. In a fanciful drawing, labeled "Calistoga in primitive times", found in the 1871 "Handbook of the Calistoga Springs", several Indians are shown relaxing about the hot springs. Two or three are apparently partaking of a natural steam bath.

How long the Indians had been coming to the springs to "bathe away aches and pains" is not clear. Beard (1979, p. 12) reports that the Napa Valley has been continuously inhabited by man for 4,000 years and probably longer.

Studies of two nearby Lake County archaeological sites have placed ancient man there approximately 10,000 - 12,000 years ago (Beard, 1979, p. 9).

When Spanish explorers and friars pushed into the Upper Napa Valley in 1823 looking to extend their line of missions up California, probably several thousand Indians were encamped throughout the valley and foothills, mostly along streams and rivers. The Spanish termed the Indians "Guapos", later anglicized to "Wappo" by immigrating Americans. The Wappo lands encompassed the lower Napa River Valley to lower Clear Lake and to the area now known as "The Geysers".

A permanent Wappo village had one or two sweat houses. A daily bath in the sweat house was common practice for the Wappo men. The sweat house served as a combination health spa, men's club, and ceremonial center (Beard, 1979, p. 46). It has long been assumed that the Wappo practiced their daily sweat bath ritural utilizing the natural resources available at the hot springs.

The Spanish "discovered" a number of hot springs and probably some small geysers grouped several hundred feet to the south and east of a small, isolated volcanic tuff knoll. They called the place "Aqua Caliente". In a succession of names, the surrounding area was called the Aqua Caliente District, Hot Springs, Calistoga Springs and eventually, Calistoga. The meadow containing the hot springs was often called the Springs Ground.

The Spanish friars chose to establish their twenty-first and last mission approximately 30 miles south of Aqua Caliente. Nothing seems to be recorded about the springs at Calistoga until the date 1857.

Arrival of the American Settlers

The American, George C. Yount, settled in the upper Napa Valley in 1831 and was endowed with a Spanish grant of land in 1836 from General Mariano Guadalupe Vallejo at Petaluma-Sonoma. Dr. Edward Turner Bale was awarded a land grant from General Vallejo in 1841. Dr. Bale's grant included present day St. Helena and extended northwestward to encompass the present day Calistoga City limits and all the valley lands out to the foothills that enclose the upper Napa Valley.

The American ownership of two large tracts of land in this area attracted early American immigrants who wanted their own small farms, and Yount and Bale were glad to sell portions of their grants to the immigrants for profit. As a result, in the late 1830's and early 1840's the Upper Napa Valley began to acquire new settlers.

"The Saratoga of the Pacific"

In 1857, Samuel Brannan, reportedly California's first millionaire, began buying up portions of the Springs Ground. By 1859, he had acquired nearly 2,000 acres of upper valley property including all the Springs Ground. He set out to build a health resort to rival the famed Saratoga Hot Springs of New York State.

A popular story of the times relates how the resort became known as Calistoga. According to the story, Sam Brannan, while slightly "under the influence", meant to say that he was going to build the Saratoga of California, But instead said, "Calistoga of Sarafornia". The Name "Calistoga" had appeal and was adopted.

In the fall of 1862, Brannan declared his fabulous resort open at a gala party of some 3,000 people. The grounds included a large hotel, stables, racetrack, 25 neat little cottages for guests, dance pavilion, store, bath houses, steam rooms, mud baths, laundry, swimming pool, an observatory placed atop the volcanic tuff knoll (dubbed Mount Lincoln, by Brannan), and even an aviary. A grand place it was by any standards.

I.C. Adams, in a passage (1946, p. 6) explaining how the bath houses were built at the hot springs, makes a very interesting observation about the consequences of drilling wells at a later date in the area:

Before there were any geysers here, there were many individual springs and streams of hot water from which on cool days, steam could be seen rising; but since the drilling of the geysers this is practically a thing of the past as it seems the surface pressure has been taken off and this has done away with the smaller emanations. Over some of the little individual springs lattice houses were built which were approximately eight by ten feet in size, with seats running lengthwise on the inside upon which patrons could sit while partaking of the water if they so desired.

One house was about a hundred feet from the entrance gate and another was at the upper end of the grounds and was known as the "Chicken-Broth Spring". It was so named because the water tasted like weak chicken broth, especially if a pinch of salt and a dash of pepper were added.

Writing in 1881, the anonymous author of "History of Napa and Lake Counties" (1881, p. 347) records some temperatures at the famed Calistoga Springs:

> Several years ago a well was bored directly in front of the hotel, and at the depth of seventy feet rock was struck which prevented further progress, and water stood in this well at the uniform temperature of one hundred and eighty-five degrees. There was a Russian steam bath formed by having the bath-room erected immediately over a spring which had a temperature of one hundred and ninety-five degrees, with apparatus for letting steam come up into the room. There are a host of springs there, each differing from the others in some peculiarity.

From the "Handbook of Calistoga and the Geysers" (1871, p. 11) comes this quantitative record of temperatures at the Calistoga Springs:

> There are baths of all temperatures, dozens of them, from cold to scalding hot, by which last, eggs are boiled and combining medicinal virtues applicable to every ill that flesh is heir to.

And still another record of early temperatures at the springs comes from Waring (1915, p. 108):

> The observed temperatures of the principal springs range from 126 to 173 and their flows from about one-fourth gallon to 5 gallons per minute. The hottest spring which yields about 1 gallon a minute, appears to be the most strongly mineralized, though its mineralization is only slightly perceptible to the taste.

At Brannan's resort, one could spend the day strolling the grounds, partaking of mud or steam baths, and preparing lunch in special cooking houses utilizing the natural steaming waters from the springs. It has been reported that bathing towels were also sterilized in the waters of the hottest springs, thus providing a "natural boiling laundry".

It appears that at least one of the small cottages built for guests was at one time heated by piped hot water from the springs. It seems more than likely that this was attempted some years after Sam Brannan lost ownership of the resort.

Brannan lavishly landscaped his resort with palms, hardwoods, flowers, cactii, etc. Some of these plants and trees still are growing today in Calistoga. However, Brannan reportedly had to bring in "fresh" soil for some of his gardens because of the high concentrations of "toxic minerals" in the soil around the springs. This may be the earliest record of the high concentrations of boron evident in some of the geothermal waters at Calistoga today.

The Decay and Revival of Calistoga as a Resort

Sam Brannan was going broke by 1873. Resorts closer to the San Francisco area were becoming more popular. He leased the once magnificent resort to George Schonewald, but the economic situation worsened. In 1875, the

Sacramento Savings Bank ordered all of Brannan's property in Calistoga sold. Leland Stanford, who once considered siting his university at Calistoga, but instead chose Palo Alto because it was closer to the Bay Area, retained the main resort and several of the guest cottages. Then began a long succession of managers of the resort and a gradual decline and decay of the facilities hastened by several fires that destroyed some of the buildings.

Mr. A.C. Tichenor became proprietor of the property in 1880 ("History of Napa and Lake Counties", 1881, p. 349). He erected a steam whistle and had "some machinery in motion, operated by the steam of one of the springs". He also placed some sort of gas collecting device over one of the springs and attached a lighted burner. The burning gas was called "carburetted hydrogen" (methane?). Mr. Tichenor also claimed the waters of the springs were laden with gold. Through a "secret process" he added some gold to the water and was supposed to be able to recover six times the original amount of gold.

In 1911, Jacques Pacheteau became proprietor of the resort and bought all of Leland Stanford's interest in 1919. The Pacheteau family built up the grounds and improved the resort. Although no longer owned by the Pacheteau family, the resort thrives today as Pacheteau's Original Hot Springs, Inc.

In approximately 1922, Charley Nance bought a lot on the southern edge of the original Springs Ground and started the second mud bath spa in Calistoga (Adams, 1946, p. 19). The operation still thrives today as Nance's Hot Springs, located on Lincoln Avenue.

Other motels/spas have been built through the years in Calistoga. Some are still operating today; some closed and became low-income apartment complexes. There are presently four mud-bath spas in Calistoga (Buck, 1980). There are approximately four or five more establishments that offer hot mineral water baths, jacuzzi baths, heated swimming pools, and massages. Today, Calistoga offers more types of hot mineral water "treatments" and more facilities than any other "hot springs" resort area in California.

History of Well-Drilling and Geyser Wells

The first geysering hot water well at Calistoga was drilled on Sam Brannan's resort ground (now Pacheteau's Original Hot Springs) probably in the late 1860's. Bancroft's "Tourists' Guide" (1871) provides the following account of the drilling:

> A well was bored at this place preparatory to the erection of a bath-house, to the depth of sixty-five feet, when the boring instruments were blown out with tremendous force high into the air, as if some unseen power beneath was resenting intrusion of mortals upon his domain. The workmen ran for their lives and could not be induced to resume operations on any terms. An attempt was made to pump water from this well, and after a few strokes a violent stream was blown out of the well ten or fifteen feet high. If the pumping were stopped the blowing would stop also, but was renewed afresh as often as the pumping was resumed. The water being cold at the top, seemed to hold in abeyance the steam and intensely hot water below; the action of the pump relieved the superincumbent pressure when the hot water below rushed out.

Adams (1946, p. 30) surmises that "this well was left to its own devices as it were, as nothing was ever done with it. The probabilities are that it was filled with debris at the time and forgotten."

The date when the second geysering well was drilled is uncertain, but it was in existence before 1916. A local resident of Calistoga relates that, when she moved to Calistoga as a young lady of eight years in 1916, there were two geysering wells, one at the Ephriam Light winery and one out on Tubbs Lane owned by Mr. Bhegnasco. She recalls having the impression that the Light well was drilled about two years prior to her arrival and that the Bhegnasco well was drilled perhaps only one year or less before her move to Calistoga.

Ephriam Light bought the stable building from Sam Brannan's decayed resort and turned it into a neat winery. Adams (1946, p. 30) relates the happenstances of drilling a well on the property:

> Mr. Ephriam Light, knowing that his property was situated on the edge of the hot-water land, thought that by boring a well he could get hot water which would be available at all times and with which he could wash the barrels and tanks as they needed it without having to build a fire each time, so he hired a local well-driller--Mr. Strubel--to drill a well for him.
>
> At a depth of one hundred fifty feet hot water was struck and the drilling was stopped. Shortly after this his son Edward who lived close by, heard a loud swishing noise one night and running out saw hot water and steam being shot high into the air. It would seem that the drilling had been stopped just before the area of hot water was struck and that the plug between where the drilling stopped and where the lake of boiling

water is had been blown out which allowed the hot water and steam to shoot out. For a time one could set one's watch by the intervals at which the spouting occurred but it changed quite frequently. at first it would shoot every day or so and finally got down to about an hour or so.

The geyser caused a terrific stir about the area. Benches were set up for the people who came to sit and wait for the eruption. A few years later the well was capped.

The stable-converted-to-winery still stands in Calistoga today on Grant Street, but it is no longer used as a winery. The present occupant is the Napa Valley Springs Mineral Water Company. The company commercially bottles mineral water from a "hot water" well on the property (not the original geysering well).

Allen and Day (1927, p. 98-99) write that by 1924 thirteen geyser wells had been drilled in Calistoga and all but three were capped so that the water could be utilized. Other wells that didn't geyser have been drilled into the geothermal zone, also. An unpublished map (Koenig and Anderson, 1970) shows the location of 76 "hot water" wells in Calistoga.

Many of the "hot water" wells drilled in Calistoga were flowing or artesian wells. Today approximately ten wells are openly discharging at the surface. Many of the artesian wells have been capped. Three spectacular flowing wells are on the Pacheteau's Original Hot Springs property. These wells flow at a pressure of 80 psi, and it is reported that two of them flowing together can discharge 250,000 gallons of 100°C water in approximately 8 hours. These wells are approximately 160-180 feet deep and were drilled around 1920. Apparently these wells have flowed at the same volume since they were drilled.

The three wells are controlled by gate valves at the well heads. The water is directed into holding tanks for cooling before it is used in the swimming pool, mineral baths, mud baths, etc. In addition, the resort has put their geothermal resource to a clever practical use: to dry bath towels and linens after washing, two large commercial clothes dryers are employed. The heat is supplied by geothermal well water circulating about the large drying drums.

The geothermal wells at "Pacheteau's" have provided some "hair-raising" moments throughout the years. Adams (1946, p. 30) provides the following account:

> In 1928 the boiling water geyser on the Springs Ground next to the Pacheteaus Bath-house ran amuck and was finally brought under control by the Calistoga Fire Department after it had "shot" for several days continuously. It not only damaged the nearby bath-house but drained other wells in the vicinity. This incident had its start when A.H. Word, a local well-driller reached a depth of one hundred fifty feet while boring a well for Mrs. Pacheteau. Suddenly tools and equipment went hurtling through the air propelled by a force which was estimated to be about one thousand pounds to the square foot. For days the frantic efforts of the people failed, as they attempted to "cap" the geyser. After much publicity in bay-area papers, the Springs Ground was the goal of thousands of motorists for several days. Finally it was the Fire Department that solved the problem. They pumped cold water into the well fast enough to cool it off thus allowing workmen to cap the pipe and to put a concrete packing around it.

Approximately eight years ago, a similar incident occurred. There was an old abandoned open well in the driveway in front of the bath house at "Pacheteau's". Some of the waste water from the mineral baths had been allowed to drain into this well for years. Apparently over the years some debris had been dropped down the well, also. One night, this well erupted with a vengeance belching forth cans, bottles, and sundry debris. The local Fire Department was prevailed upon again to quench the eruption, and the well was capped and buried.

"Old Faithful Geyser of California"

There remains only one uncapped geysering water well in Calistoga today. That one is the old Bhegnasco well at the corner of Tubbs Lane and Myrtledale Road which apparently has always remained open since it was drilled circa 1915(?). The well erupts on a somewhat regular basis on the average of every 40 minutes (Rinehart, 1972) and has long been both a point of interest and a tourist attraction. It is now called the "Old Faithful Geyser of California". The grounds around the geyser have been moderately well maintained, the result of which is a small park-like setting for tourists awaiting the eruption. The eruption lasts sometimes as long as three minutes. It has been reported that the discharge during the eruption is 4,000 gal/min, sometimes shooting to a height of sixty feet or higher.

A local resident related how he had been baptized at the geyser in 1942. Apparently others had been baptized there also. He remembered that in the 1940's weddings were occasionally performed at the geyser site.

Disappearance of the Springs

In the "Handbook of Calistoga and the Geysers" (1871, p. 4), the author describes the abundance of hot springs on the old Springs Ground:

> There are upwards of a hundred within an area of about sixty acres...in winter when a slight frost tips the glades with silver, the boiling springs send up clouds of vapor as from a hundred steam engines...

Waring in 1915 (p. 108) writes:

> Four main springs rise at the base of a knoll of buff-colored tuffaceous material at the northern border of the meadow land, and a few pools and seepages of hot water appear in the meadow itself...about 400 yards west from the springs, a dug well supplies warm water for tub baths...warm water is also obtained in several other wells near by and there is one strongly flowing artesian well.

If both authors are to be believed, the old Springs ground was beginning to dry up by 1915. The meadow lands are apparently completely dry at the surface today, except for some discharge flowing from the artesian wells at "Pacheteau's". A large mobile home park and a glider airport are situated on a large portion of the original hot spring-laden meadow land.

Bottled Mineral Water

Guests at Sam Brannan's Calistoga Hot Springs would not only bathe and steam themselves, but also drink the spring waters in hopes of curing a malady or simply improving their constitutions. Today, bottling the mineral water at Calistoga is a thriving business; there are three commercial mineral water bottling companies operating in town. It is reported that a fourth bottling company, with its works located in Santa Rosa, obtains some of its water from the "Pacheteau's" wells.

The largest in sales volume and the longest in business is the Calistoga Mineral Water Company on First Street. A well was put down on this site in 1920, and the temperature of the water was reported to be 212°F. In 1924, the first bottles of mineral water were produced, and the company has remained in business ever since.

Prior to 1975, the Napa Valley Springs Mineral Water Company was only a small weekend business. After that date, the company stepped up to full production and now puts out its product in gallon plastic jugs. Their production well was probably drilled about 1920, also.

The Crystal Geyser Water Company, located on Washington Avenue, drilled their production well in 1978. After testing the water and ensuring the presence of a large enough supply, a bottling plant was erected at the site. According to the company, they now rank third in total mineral water sales in

California. First in sales in California is the French import "Perrier". Second is the California Mineral Water Company.

The volume of water pumped from the moderate-temperature geothermal resource for mineral water bottling purposes is unknown. Because of the competitive nature of the mineral water business, the bottling companies guard their production figures. However, it may be assumed, since the popularity of Calistoga's mineral waters is great, that a relative large volume of "hot water" is removed from the resource annually.

Recent Use of the Geothermal Resource

Through the years, a few enterprising individuals attempted to utilize the geothermal resource at Calistoga for home heating. According to a long-time Calistogan, these heating systems generally had to be abandoned when, in a few years, the water pipes would be choked full of mineral deposits. There have been successes in recent years.

There are at least two private residences totally heated by utilizing hot water from a well. One house, built in the late 1950's to early 1960's, simply has copper pipes built into the concrete foundation through which the geothermal waters circulate, heating the whole house from the floor up. The other house has an elaborate custom-made heat exchanger system whereby the heat from mineral laden waters is transferred to a system containing fresh water. This eliminates the mineral deposit problem that plagued early heating systems.

There is one motel/spa in Calistoga that heats its entire complex from a geothermal well. The hot waters circulate through a space-heating system in each of the units.

There may be as many as 20-25 residences that are using water from a "hot well" directly as a domestic hot water supply in Calistoga. Approximately 10-12 residences are utilizing their "hot wells" for heating swimming pools, private mineral water baths, jacuzzi-type spas, etc.

In the mid 1950's, a moderate size greenhouse was built and heated with two geothermal wells. This business is still operating today on Tubbs Lane. Another greenhouse complex, which used two geothermal wells as a heat source, was started in the early 1960's in the same general area, but the economics of the plant business apparently forced the abandonment of this operation in the late 1960's.

Very recently, there has been a renewed interest on the part of some Calistogans to utilize the geothermal resource as an alternate energy source. A few new homes have been built with a geothermal well designed into their system as a potential auxiliary heating supply for some domestic needs. There is much interest in converting some older residences to geothermal heating, also. An estimated two to five wells are currently drilled annually in Calistoga with the explicit goal of tapping the geothermal resource.

The Resource Development's Effect on the "Hot Water" Table

It is obvious that the "hot water" table has lowered about the original Springs Ground since the development of the geothermal resource there. The history suggests that the springs dried up sometime between 1910-1920, probably at least in part due to the drilling of the first deeper (150-190 feet) water wells in Calistoga. It is now generally believed by townspeople and local well drillers that a well must abe drilled over 100 feet to reach the resource in this area.

Even though the "hot water" table has deepened around Pacheteau's, it may not have lowered very much in nearby areas. It was reported that shallow excavations (dug in the early 1960's to 8-10 feet deep) in the vicinity of Tubbs Lane and Bennett Lane became so hot that the soil was nearly "too hot to touch", even when no water flowed into the excavations.

Despite moderately heavy commercial and domestic development of the resource over the years, some geysering and flowing wells drilled around 1920 are still producing at what appears to be nearly their original volume.

Although geothermal wells have been drilled elsewhere in Calistoga, none seem to have been able to produce as much hot water as the wells at Pacheteau's. Therefore, the largest volume of the resource may be in this area, although exploratory drilling may prove this conclusion wrong.

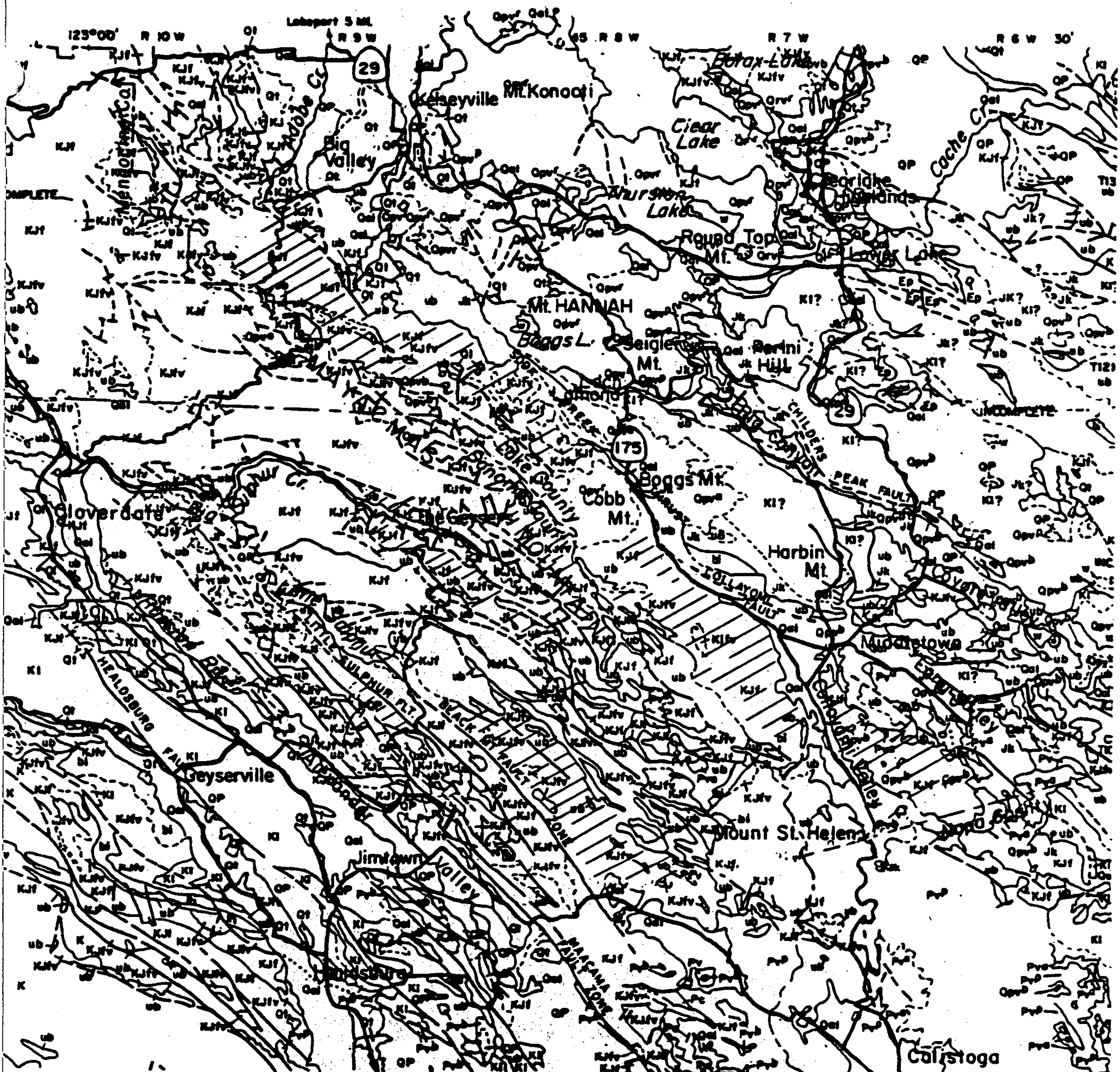
The literature suggests that the temperature of the resource may not have changed much in at least the last 120 years (that is, boiling water is still available from the resource).

GENERAL GEOLOGY

The geologic formations within or near the Calistoga Geothermal Project Area have been studied and mapped by Johnson (1940), Carter (1943), Weaver (1949), Taliaferro (1951), Kunkel and Upson (1960), Koenig (1961, 1963), Blake and others (1971), and lastly by fox and others (1973). Regional studies were limited to providing insight into structural and lithologic controls of geothermal waters. Thus, the brief description of the geologic formations, history, and water bearing properties contained within this report has, for the most part, been abstracted from published works.

The Calistoga area lies within the southern end of the Mayacmas Mountains. The geologic framework for the Mayacmas Mountains is characterized by a series of northwest-trending folded and faulted blocks and thrust plates (Figure 1). The mountains are typically broken into a corresponding series of northwest-trending ridges and valleys.

In the Mayacmas Mountains, the Great Valley sequence of Jurassic to Cretaceous marine miogeosynclinal sedimentary rocks and underlying igneous rocks are in thrust fault contact with, and overlie the rocks of, the eugeosynclinal Franciscan assemblage of similar age. Also present in this zone are: Marine sedimentary rocks of Tertiary age, southeast of Clear Lake; the Sonoma Volcanics, of Pliocene age, near and south of Mount St. Helena; and numerous scattered exposures of non-marine sedimentary rocks of Pliocene to Holocene age.



EXPLANATION

CENOZOIC

- QUATERNARY – Pleistocene
  - Qal — Alluvium
  - Qt — Quaternary terrace deposits
  - QP — Plio-Pleistocene nonmarine
- TERTIARY – Eocene
  - E — Eocene marine
- TERTIARY – Paleocene
  - Ep — Paleocene marine

JURASSIC CRETACEOUS – Great Valley ?

- K — Undivided Cretaceous marine
- Ku — Upper Cretaceous marine
- Kl — Lower Cretaceous marine
- Jk — Knoxville Formation

MESOZOIC – JURASSIC CRETACEOUS

SEDIMENTARY AND METASEDIMENTARY ROCKS

- KJf / KJfs (KJfs-Melange)
- KJfv — Franciscan volcanic and metavolcanic rocks
- gr — Mesozoic granitic rocks: gr^a-granite and adamellite; gr^g-granodiorite gr^t-tonalite and diorite
- bi — Mesozoic basic intrusive rocks
- ub — Mesozoic ultrabasic intrusive rocks

IGNEOUS AND META-IGNEOUS ROCKS

CENOZOIC – QUATERNARY – Pleistocene

- Quaternary and/or Pliocene cinder cones
- Qpv — Pleistocene volcanic: Qpv^r-rhyolite; Qpv^a-andesite; Qpv^b-basalt; Qpv^p-pyroclastic rocks

CENOZOIC – TERTIARY – Pliocene

- Pv — Pliocene volcanic: Pv^r-rhyolite; Pv^a-andesite; Pv^b-basalt; Pv^p-pyroclastic rocks

N

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5 0 5 10 Km.

SCALE

FIGURE I:

REGIONAL GEOLOGY

Geologic map of the Geysers-Calistoga Geothermal Resource Area, Lake, Mendocino, Napa, and Sonoma Counties in California. (Adapted from California Division of Mines and Geology Special Report 122.)

Franciscan Assemblage

Rock units, assigned to the Franciscan assemblage by Blake and others (1971), occur in major portions of the Mayacmas Mountains. The Franciscan assemblage contains an abundance of sheared rock characterized by high clay content and low permeability. Areas where these rocks are exposed in the Mayacmas Mountains have large numbers of landslides. The entire assemblage can be divided into three major rock units that are separated by faulting into three thrust plates. The unit that is most unstable and that apparently extends beneath the Sonoma Volcanic rocks and other younger rocks in the Calistoga area, is exposed over major parts of the area to the northwest. This unit is the sheared shale and sandstone (KJfs) of Blake and others (1971) which contains resistant masses of hard rocks of several lithologic types. Most of the sheared rock in the Franciscan assemblage, together with masses of shattered sandstone, is assigned to this unit. The term "melange" has been applied to Franciscan rocks of similar characteristics by Hsu (1969).

A melange unit generally consists of a highly sheared lustrous gray to black shale matrix containing abundant hard, resistant blocks of metagraywacke sandstone, chert, greenstone, serpentinite, and metamorphic rock. The blocks range in size from less than 1 foot (30 cm) to greater than 5 miles (8 km) in length. They make up a highly variable proportion of the entire unit.

The second of the three subdivisions of the Franciscan rocks, and the most stable for engineering purposes, consists principally of metagraywacke sandstone with lesser amounts of other metamorphic constituents, including metagreenstone and metachert. This unit is characterized by blueschist minerals, such as glaucophane, lawsonite, and jadeitic pyroxene. The main outcrop area lies to the northwest of Calistoga near Geyserville and Jimtown.

The third Franciscan unit has widespread outcrops in the Mayacmas Mountains, particularly west and north of the present study area. it consists predominantly of graywacke-type sandstone and shale with minor greenstone, limestone, and chert and some lenses of conglomerate. The sandstone ranges from massive to thin bedded, but the rock is frequently shattered and commonly veined with laumontite and is subject to landslide activity.

The base of the Franciscan assemblage has not been recognized and no older formations are exposed. It is probable that the Franciscan rocks were deposited upon a thin oceanic crust and were tectonically emplaced in their present position as the Pacific plate slid beneath the North American continental plate.

Several rock types occur as discrete masses within the Frnaciscan units, and their presence can often serve as an indication of the melange-like character of the unit within which they occur. They include high grade metamorphic rocks such as glaucophane schist, eclogite, and amphibolite; blocks of graywacke and metagraywacke sandstone; chert and metachert; greenstone, serpentinite, and silica-carbonate rock. Many of the high-grade metamorphic rock inclusions occur in blocks less than 100 feet (30 m) long. The three most important rock types are greenstone, serpentinite, and silica-carbonate rock.

Greenstone: These altered mafic submarine volcanic rocks include gray to greenish-gray spilitic basalts in the form of pillow lavas, massive flow rock, tuffs, and breccias. In many parts of the area, they occur as discrete masses no more than a few hundred feet thick, but McNitt (1968) has estimated a thickness of 7,000 feet for the massive pile that trends northwestward for several miles from the vicinity of the Geysers Resort. In some places, these rocks contain minor amounts of fossiliferous limestone; in others, the greenstone contains incipient blueschist minerals or is reconstituted to blueschist. Landslide activity, although not as prevalent as in some other rock units, does occur in the larger greenstone outcrop areas.

Serpentinite, including relatively fresh ultramafic masses "intrudes" the lower or melange unit of the Franciscan assemblage and occurs as sheets, lenses, and; irregular shaped masses, both within and along the boundaries of the unit. Depending on the degree of internal shearing and alteration, serpentinite can present foundation problems for well drilling and for other engineered structures.

Silica-carbonate rock, a product of the hydrothermal alteration of serpentinite, can be relatively hard and strong. It most often occurs in blocks and masses associated with serpentinite and is often associated with the occurrence of mercury deposits.

Although the Franciscan assemblage comprises the bedrock within the Calistoga study area, actual outcrops of Franciscan rocks occur as small isolated exposures, confined to the north and northeastern margins of the valley. Typically, these outcrops are comprised of graywacke or greenstone, although an extensive body of serpentinite is exposed northwest of Kimball Reservoir.

Chemical analyses of the serpentinized intrusions (Bailey, Irwin, and Jones, 1964) indicate that the rock is composed of almost equal parts of silica and magnesium but also contains residual amounts of other rock-forming minerals. Analyses of the sandstones and shales of the Franciscan assemblage (Bailey, Irwin, and Jones, 1964) indicate that silica and aluminum are the dominant constituents, followed by iron, magnesium, and calcium, respectively. Except where fractured or deeply weathered, the ultramafic rocks and the Franciscan rocks are poorly permeable and yield water of poor quality.

Great Valley Sequence

the Jurassic and Cretaceous Great Valley sequence consists mainly of well-bedded sandstone and shale, massive shale and siltstone or mudstone with minor sandstone, and conglomerate lenses and beds. Swe and Dickinson (1970), in their studies centered in the Lower Lake quadrangle have described 35,000 feet of clastic sedimentary strata, ranging in age from Late Jurassic to Late Cretaceous, as belonging to the Great Valley sequence. They have divided the entire sequence stratigraphically into four main segments, three of which, although broken by faults, are apparently conformable successions of strata. The fourth consists of several segments of similar age each bounded entirely by faults. None of these rocks crop out in the immediate Calistoga vicinity.

Ultramafic rocks, largely pyroxenite and serpentinite, basaltic pillow lavas and breccias, quartz diorite, diorite, gabbro, and diabase are present locally at the base of the Great Valley sequence. These rocks are in fault contact with the Franciscan rocks.

Logs of wells and pump-test information supplied by drillers, pump companies, and land owners indicate that the consolidated sedimentary rocks of Cretaceous age, rocks of the Franciscan assemblage and the ultramafic rocks generally yield small quantities of water to wells. However, significantly larger quantities of water may be obtained from highly fractured or deeply weathered zones. Well-test information from 36 wells drilled into these rocks show an average yield of 19 gpm (gallons per minute) with most wells yielding 10 gpm or less. Most of the well tests for which both yield and drawdown information are available, show a specific capacity less than or equal to 0.1 gallon per minute per foot of drawdown (Faye, 1973, p. 14).

Sonoma Volcanics

Tertiary volcanic rocks are exposed on the surface over all of the marginal area of the Napa Valley. These rocks are composed almost entirely of material of volcanic origin, and are considered to constitute a part of the Sonoma Volcanics of upper Pliocene age.

The Sonoma volcanics constitute a thick and highly variable series of volcanic rocks including andesite, basalt, and minor rhyolite flows with interbedded and discontinuous layers of tuff, tuff breccia, agglomerate and scoria.

Tuff, by far the most common and widely distributed rock in the Sonoma Volcanics, is a fragmental rock made up entirely of volcanic material. Enormous quantities of volcanic ash were showered on the area and accumulated under various conditions. Most of these tuffs appear to be massive and were deposited on the irregular surface of the land. Locally, however, some of them are definitely waterworked, apparently shallow lake deposits. Tuffs formed this way are often soft and usually fine grained and light both in color and weight, but coarse varieties are common and, in some places, these appear to be more a kind of agglomerate, containing angular particles of lava, mostly andesite and basalt. Ordinarily, the massive tuff contains numerous pumice fragments, which vary in size from very small grains to fragments up to an inch or more in length. The majority of the tuff is white in color, but gray and buff colored varieties are common, and in some localities the gray and white tuffs occur interbedded (Johnston, 1948).

the tuffs are separated at a number of horizons by lava flows, which are either basaltic or andesitic in composition. These lavas usually occur as dense, heavy, very fine-grained rocks, but are commonly scoriaceous, have vesicles which may or may not be filled, and may be porphyritic in nature. Flow banding is commonly present and columnar jointing occurs locally. The lava flows are much more resistant to weathering and erosion than the tuffs, and they commonly crop out in steep cliffs and form caps on many of the ridges.

A number of lenses of sediments, composed almost entirely of volcanic material, none of which are either thick or extensive, are found locally. These sediments are composed of loosely consolidated sands, gravels, and conglomerates, most of which were probably deposited in streams or shallow lakes, while others represent erosion intervals between periods of volcanism.

Redeposited, water-laid pyroclastic materials, diatomite, silt, sand and gravel are exposed in roadcuts along the Silverado Trail east and southeast of St. Helena. In the vicinity of Calistoga, prominent bodies of rhyolite and rhyolitic tuff have been altered by hydrothermal processes to a hard, dense, fine-grained rock. Thin-section and X-ray diffraction analyses indicate that the altered rhyolitic rocks now consist primarily of quartz and kaolinitic and montmorillonitic clays.

Well-test information from 140 wells tapping the Sonoma Volcanics show an average yield of 32 gpm and an average specific capacity of 0.6 gallon per minute per foot of drawdown (Faye, 1973).

Alluvium

In this report, deposits described as alluvium include the older alluvium, terrace deposits, older alluvial-fan deposits, and younger alluvium as mapped and described by Kunkel and Upson (1960) and Fox and others (1973).

The older alluvium of Napa Valley is composed of lenticular deposits of unconsolidated and poorly sorted clay, silt, sand, and gravel. Where exposed at the surface, it is predominantly a reddish-brown color and exhibits cross-bedding. The material is unconsolidated but somewhat compacted, and some lenses of gravel are cemented. The sand and gravel fragments are composed mainly of andesitic debris, but they include chert.

Terrace deposits include numerous isolated bodies of unconsolidated clay, sand, gravel, and cobbles that cap hilltops and benches or border the base of steep hills and mountain slopes. All these bodies are thin and of small extent. Locally, they conceal the older formations on which they lie unconformably. Some are remnants of former river-channel or flood-plain deposits, some may be marine terrace deposits, and some are older alluvial fan deposits. They occur at several altitudes above present sea level and present stream grades. They range in thickness form 0 to 15 feet, except for the older alluvial fan deposits which may be considerably thicker. No fossils have been found in these deposits, but their stratigraphic positon indicates an age from late Pleistocene to Holocene. They may be equivalent in part to the older alluvium. These deposits are unconsolidated. Although in most places they contain a large proportion of sand and gravel, they are mainly non-waterbearing, because generally they are thin and occur above the water table. Where these deposits overlie either the Huichica or the Glen Ellen formation, the coarse gravel of the terrace deposits may easily be mistaken for gravel interbedded with the underlying formations, and a false impression of the water-bearing character of the underlying formations may be inferred. Because these deposits are mainly non-water-bearing, they have been mapped only where they are relatively thick or where they obscure the nature of the underlying formations (Kunkel and Upson, 1960).

The younger alluvium consists of interbedded unconsolidated gravel, sand, silt, clay, and peat in beds comprising channel, flood-plain, and alluvial fan deposits. These deposits overlie or overlap all other formations in the

Napa Valley. They were deposited by the streams, much as we see them today, in valleys cut by streams graded to a lower position of sea level thought to correspond with a late Pleistocene glacial stage (Upson, 1949, Louderback, 1951). Hence, the younger alluvium may be in part late Pleistocene, but for the most part it is considered to be recent (Holocene) because deposition is continuing (Kunkel and Upson, 1960).

The floor of the Napa Valley consists of channel deposits and flood-plain deposits composed predominantly of well-sorted gravels and sand interbedded with silts. This material is not well exposed in section; and for the most part is indistinguishable from the older alluvium. However, typically, these deposits are less than 30 feet thick.

The yield of wells tapping the alluvium ranges from about 50 gpm to about 3,000 gpm depending on the number and thickness of gravel and sand lenses penetrated at the particular well. Well-test information supplied by drillers, pump companies, and land owners for 100 wells perforated in the alluvium indicate that this unit is by far the best aquifer in the project area. The average yield of these 100 wells is about 220 gpm, and the average specific capacity is about 10 gallons per minute per foot of drawdown (Faye, 1973).

Geologic Structure

The geologic structure for much of the Mayacmas Mountains area is characterized by the northwest trends of the outcrop patterns of the Jurassic and Cretaceous rocks and of the fault zones that separate them into tilted and folded blocks or plates of strata. The area north of Calistoga is essentially bisected by a major thrust fault zone called the Soda Creek thrust by Swe and Dickinson (1970). This zone, which apparently follows a line of serpentinite outcrops trending northwestward, marks the line of separation between the outcrop areas of the Great Valley sequence on the northeast and the Franciscan assemblage on the southwest.

Swe and Dickinson (1970) postulated that, together with overthrust Eocene and Paleocene strata, the Great Valley sequence forms a thrust complex that rests structurally upon the Franciscan assemblage along the Soda Creek thrust, and is overlain unconformably by late Cenozoic strata. A number of subsidiary thrusts, that are discordant to the bedding, divide both the Great Valley sequence and the Franciscan assemblage into three or more successive thrust plates or slices.

Emplacement by regional thrust faulting of the Great Valley sequence and early Tertiary rocks above the Franciscan assemblage was probably complete by Oligocene time, after which the entire complex, including the thrust faults themselves, were folded and cut by faults during later Cenozoic deformations. The late Tertiary-early Quaternary oregeny, which probably produced most of this folding and faulting, also brought with it the volcanism that produced the Sonoma Volcanics and the Clear Lake lavas. Mount St. Helena itself is built up of a series of folded flows and beds and is not a former major volcanic vent. The fact that the maximum dip of beds in the vicinity does not usually exceed 20 degrees indicates that oregenic activity in that area was relatively mild in post-Sonoma Volcanics time.

Folding and erosion have exposed the Soda Creek thrust and underlying Franciscan rocks along the Soda Creek anticline outside the Calistoga area on the north. Of the several subsidiary thrusts or other faults known to have sizable displacements within the Great Valley sequence, most prominent is the Collayomi fault. This fault may be associated with the Soda Creek thrust which separates the Great Valley and Franciscan rocks.

The more important fault zones associated with the Franciscan assemblage outcrop area include (1) the complex fault zone along Big Sulphur Creek to the northwest; (2) the Little Sulphur fault and Black Mountain fault zone that bound the Little Sulphur graben along Little Sulphur Creek; and (3) the Maacama and Chianti fault zones. Gealey (1951) estimates that the Sonoma volcanic rocks have been downdropped by nearly 2,100 feet (700 m) by the combined action along the Maacama and adjacent Chianti fault zones that border the Mayacmas Mountains on the southwest. These facts would tend to agree, at least in part, with the concept expressed by McNitt (1968) that the Mayacmas Mountains are a large complex horst bounded by faults.

Local Folding

As mentioned above, the folding that has affected the Franciscan rocks is difficult to document in the Calistoga area due to lack of outcrops and reliable attitudes. That folding and faulting have occurred in the Franciscan rocks is evidenced by sharp attitude changes within short distances and near vertical to vertical bedding.

The rocks of the Sonoma Volcanics that cover most of the Franciscan rocks south of Mt. St. Helena were gently folded and faulted by compressional forces from the northeast or southwest after their deposition. Broad, parallel synclines and anticlines transgress across the area in a northwest-southeast direction and, in general, the topography follows these folds. Thus, Napa Valley is a broad, asymmetric syncline plunging to the southeast and the large mass of overthrust Franciscan rocks exposed to the southwest of Napa Valley comprises the crest of an anticline. Gentle dips in the range of 10 to 30 degrees are the most common within the Sonoma Volcanics, although steep dips and tight folds have been documented (Johnston, 1948, p. 32).,

Local Faulting

The pre-Pliocene (pre-Sonoma Volcanics) faults that occur within the Franciscan Formation, although contemporaneous with major folding, are poorly exposed within the study area. Major northwest trending fault zones in Franciscan rocks have been mapped to the northwest of Napa Valley (Fox and others, 1973), but the overlying Tertiary volcanic rocks and Quaternary alluvium mask any pre-Sonoma faulting that may be present within the Napa Valley.

The Sonoma Volcanics show some evidence of Pliocene and post Pliocene faulting. Mapping by Fox and others (1973) has shown the occurrence of two short length faults north of the town of Calistoga, as well as some relatively large, both in length and possible displacement, faults occurring 3 to 5 miles south and southeast of Calistoga. The faults all appear to be of normal displacement.

A major structural feature with a strong local effect is the large northwest trending thrust; along which Franciscan rocks have been overthrust upon Sonoma Volcanic rocks at a relatively shallow angle of 20 to 30 degrees. This thrust is the major feature of the western limb of the Napa Valley syncline. The eastern terminus of this thrust, in all probability, is coincident with the current axial plane of the Napa Valley and may result in a major structural discontinuity underlying the Napa Valley.

GEOPHYSICAL INVESTIGATIONS

Geophysical surveys were undertaken by the Division of Mines and Geology in the Calistoga area in order to provide additional information concerning the geology as related to the hot water resource. Parts of two aeromagnetic surveys and a reconnaissance gravity survey were already available in the area. Therefore, the Divison's geophysical work consisted for the most part of relatively detailed ground magnetic, gravity, electrical resistivity, and seismic refraction surveys. A discussion of each of these surveys and their interpretation follows.

Magnetic Surveys

Purpose

Measurements of the earth's magnetic field are often useful for determining structural trends and details of the geology including the location of possible faults in geothermal areas. Magnetic "lows" in some geothermal areas have been attributed to the alteration of magnetite in rocks by hydrothermal fluids (Studt, 1963); magnetic data have also been used to help locate possible geothermal heat sources (Goldstein and others, 1978, p. 32).

U.S. Geological Survey aeromagnetic maps are available in the Calistoga area (U.S. Geological Survey, 1973, 1974). These maps are most useful for studying the regional geology. For more local detail, however, ground magnetometer data were obtained in the area. The ground data also served to aid in interpretation of the airborne magnetic anomalies.

Aeromagnetic Data

Plate 2 is an aeromagnetic map of the Calistoga 15 minute quadrangle compiled from U.S. Geological Survey open-file maps (1973, 1974). Overall, the map is characterized by northwest aeromagnetic anomaly trends in the Calistoga area. The largest magnetic anomalies (up to 200-300 gammas in amplitude) are associated with exposures of serpentinite in the Franciscan basement rocks located south and east of Mt. St. Helena, and in the southeastern corner of the map area. The rocks of the Sonoma Volcanics, in general, evidently have only a minor effect on the aeromagnetic map in the Calistoga area. The reason for this is evident in Table 1, which shows that the Tertiary volcanic rocks generally have low values of magnetic susceptibility in comparison with serpentinite. A possible exception to this is andesite flow rocks that often exhibit reverse magnetic polarity and cause prominent magnetic anomalies in the southwestern part of the map sheet (Chapman and Chase, 1977).

Table 1. Magnetic susceptibility, density, data, and lithology of rock samples from Calistoga, Napa County, California. Measurements by Paul V. Anderson.

Sample Number	Geologic Formation	Geologic Map Unit#1	Rock Type	Susceptibility (10^{-6} emu/cm^3)	Specific Gravity
CRV-1	Sonoma Volcanics	Tsa	andesitic tuff breccia	354	1.96
CRV-2	" "	Tsr	rhyolitic ash flow breccia	17	1.89
CRV-3	" "	Tsr	tuff	219	2.19
CRV-4	" "	Tsr	rhyolitic tuff breccia	10	2.02
CRV-5	" "	Tsag	andesite	22	2.02
CRV-6	" "	Tsa	rhyolite	10	2.32
CRV-7	" "	Tsa	tuff	11	1.95
CRV-8	" "	Tsa	altered flow rock	23	2.38
CRV-9	" "	Tsr	rhyolitic tuff breccia	10	2.14
CRV-10	" "	Tsr	altered rock flow	10	2.25
CRV-11	" "	Tsa	rhyolitic tuff	10	1.99
CRV-12	" "	Tst or Tsr?	altered rhyolitic tuff	10	2.37
CRV-13	" "	Tst	tuff	10	1.97
CRV-14	" "	Tsr	rhyolitic tuff breccia	80	1.88
CRV-15	" "	Tsr	andesitic tuff breccia	554	2.21
CRV-16	" "	Tsr	rholitic tuff	154	2.18
CRV-17	" "	Tst	pumicitic ash flow tuff	78	1.83
CRV-18	" "	Tsa	andesite	46	2.40
CRV-19	" "	Tsr	flow-banded rhyolite	314	2.21
CRV-20	" "	Tsa	porphyritic andesite	23	2.42
CRV-21	" "	Tst	rhyolite	320	2.18
CRV-22	" "	Tst	tuff	286	2.18
CRV-23	" "	Tst	tuff	331	2.19
CRV-24	" "	Tst	tuff breccia	297	2.30
CRV-25	" "	Tst	tuff	51	1.60
CRV-26	" "	Tst	tuff	67	1.56
CRV-27	" "	Tst	tuff	23	1.51
CRV-28	" "	Tst	tuff	11	1.66
CRV-29	" "	Tst	tuff	46	1.35
CRF-1	Franciscan Assemblage	Tsa *2	greenstone	349	2.67
CRF-2	" "	KJfs	graywacke	10	2.56
CRF-3	" "	KJfs	"high grade metamorphic rock(glaucophane schist?)	51	2.99
CRF-4	" "	sp	serpentinite	1860	2.29

*1. The geologic map units are from Fox and others (1973).

*2. Sample CRF-1 was from a small greenstone outcrop characteristic of the Franciscan Assemblage. The outcrop was not shown on the geologic map by Fox and others (1973) probably because the outcrop was too small for adequate mapping.

Near Calistoga, the general aeromagnetic pattern consists of several subparallel, northwest-trending, positive and negative anomalies including: (1) a positive anomaly approximately parallel to Napa Valley but located at a distance of about 1 1/2 miles to the southwest; (2) a negative anomaly, the axis of which is located near the southwestern side of Napa Valley; this anomaly extends to the northwest through Knight's Valley; and (3) a small (in amplitude) positive anomaly that extends southeastward along the northeastern side of the valley from the large magnetic "high" just south of Mt. St. Helena.

The positive anomaly located southwest of Napa Valley near Calistoga decreases in amplitude toward the northwest. Near the latitude of Calistoga, the trend of this anomaly apparently turns westward. Near the southeastern corner of the map, this anomaly is associated with outcrops of serpentinite. Thus, the northwestern continuation of this anomaly suggests the possible presence of some serpentinite in the subsurface in this direction. Similarly, the small positive magnetic anomaly on the northeastern side of the valley may represent a small amount of serpentinite in the subsurface in this area as well. Alternatively, the latter anomaly could represent Franciscan greenstone which crops out in this area in several places, although this rock usually does not have a very high magnetic susceptibility (Table 1).

Equipment and Field Procedure for Ground Survey

Ground magnetometer traverses were obtained in the Calistoga area by means of an EGG - Geometrics proton-precession magnetometer, model 816, that has a sensitivity of one gamma. A total of 15 ground lines were run (Plates 2 and 3). Most stations were spaced at intervals of 100 feet, usually estimated by pacing, but the station spacings on some lines were from 200 to 500 feet. Plate 3 shows the location of 13 of the 15 magnetometer lines. The location of two additional reconnaissance lines are shown on Plate 2. The ground magnetometer lines total about 18.5 miles in length.

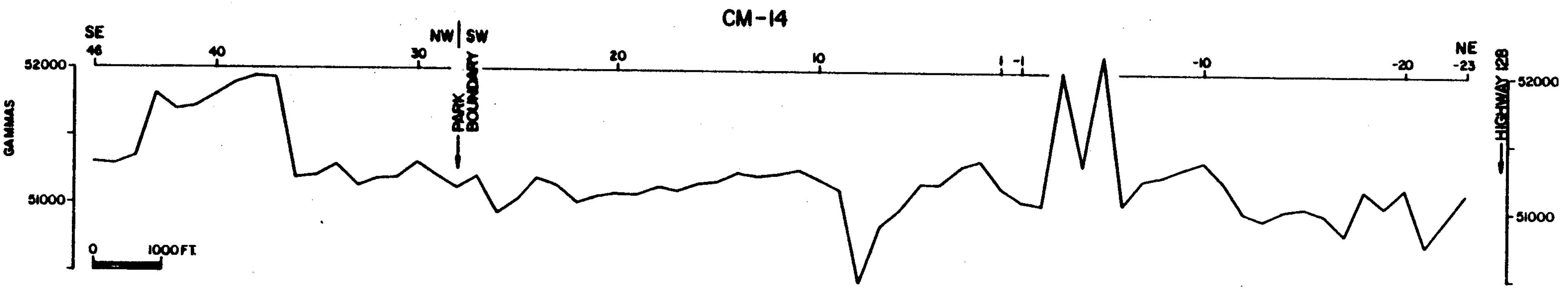
Ground Magnetic Data

Ground magnetic data were plotted both in profile and plan map form (Plate 3). On Plate 3, the data are contoured at intervals of 50 and 100 gammas. The regional magnetic gradient, which is about 10 gammas per mile, increasing to the northeast, has not been removed from these data. In general, on magnetic profiles that cross Napa Valley (CM4, CM5, CM7, CM12, and CM13), except for line CM13, the magnetic values tend to rise gradually toward the northeast at a much faster rate than the normal gradient. This is shown on Plate 3 and is in general agreement with the aeromagnetic map (Plate 2).

Near the southwest end of profiles CM4 and CM7, there is also a slight rise in the magnetic levels, resulting in a small magnetic "low" centered near Myrtledale Road on both of these lines. This magnetic "low" is near the Old Faithful (California) geyser on profile CM4, and could be related to the geothermal field, but it may actually represent a regional low between positive anomalies located to the southwest and the northeast as shown on the aeromagnetic map (Plate 2). Alternatively, the small magnetic gradients on the southwestern sides of the negative anomalies on profiles CM4 and CM7 (values increasing toward the southwest) could represent changes in rock types in the valley. Within the valley area, the profiles usually show only relatively small magnetic anomalies. Some of the very local, high frequency, magnetic anomalies are probably caused by man-made sources, such as pipes and culverts. Others of these smaller anomalies could be caused by relatively magnetic volcanic rocks or by small masses of serpentinite or possibly greenstone in the underlying basement rocks.

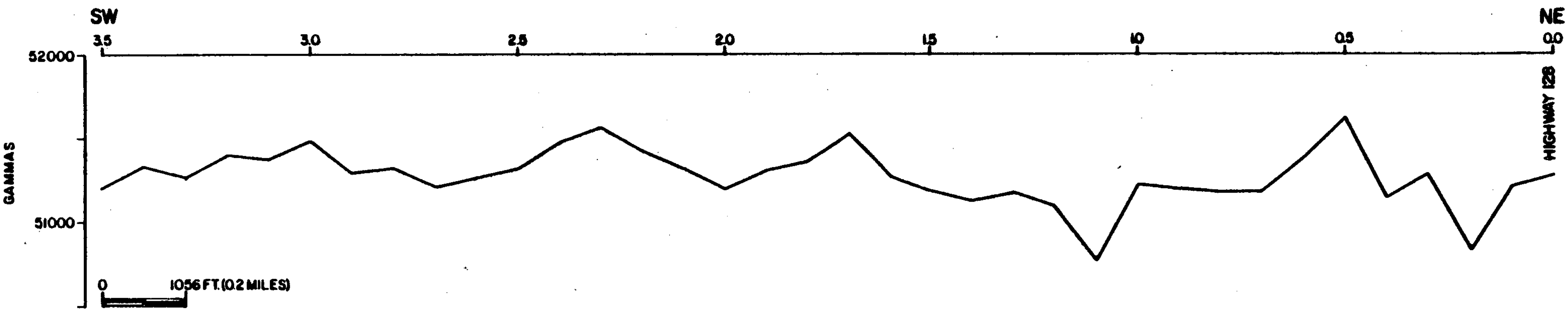
The magnetic "highs" located near the northeastern ends of lines CM2 and CM5 evidently represent the flanks of the large positive anomaly shown on the aeromagnetic map south of Mt. St. Helena, which evidently is caused by serpentinite. The relatively large local dipole anomaly (about 1500 gammas peak to peak) near the middle of line CM2 may be caused by a magnetic volcanic rock or by serpentinite in the basement rocks. The small southeastward trending positive anomaly (300 gamma contour) that crosses lines CM7, CM11, and CM12, evidently corresponds to the small positive aeromagnetic anomaly located along the northeastern side of the Napa Valley in this area.

Line CM14 (Figure 2) was run along a trail up Ritchie Creek and line CM15 (Figure 3) traversed the Diamond Mountain Road in order to investigate the positive aeromagnetic anomaly shown on Plate 2 in this area. These lines show somewhat erratic magnetic values, with small to moderate local anomalies. The sharpness of these anomalies suggests near-surface sources for the most part. These sources could be within the Sonoma Volcanics or within the Franciscan basement rocks if they are not deeply buried. The local anomalies on both of these profiles are evidently superimposed on very broad positive magnetic anomalies with amplitudes of about 200 to 300 gammas that appear to correspond to the positive aeromagnetic anomaly. These broad positive anomalies could originate in the basement rocks, and might represent the cumulative effect of a number of small masses of serpentinite. The small amplitude of the anomalies appears to preclude the presence of only one or a few large masses of serpentinite, however. Alternatively, the anomalies could represent the cumulative effect of a number of andesite flows within the Sonoma Volcanics, or possibly a buried igneous intrusive rock mass within the basement rocks in this area.



GROUND MAGNETIC PROFILE CM-14
CALISTOGA AREA
NAPA COUNTY, CALIFORNIA
BY
LES YOUNGS

FIGURE 2



GROUND MAGNETIC PROFILE CM-15
CALISTOGA AREA
NAPA COUNTY, CALIFORNIA

BY
L. G. YOUNGS

FIGURE 3

Conclusions

The largest magnetic anomalies in the Calistoga area are evidently caused primarily by serpentinite, although smaller magnetic anomalies may be caused by relatively magnetic units within the Sonoma Volcanics or by greenstone in the Franciscan rocks. Anomalies within the Napa Valley are almost all small and indicate that there is little serpentinite in the basement rocks in this area. There is little evidence in the magnetic data to indicate faults within or near the geothermal area. This may mean that magnetic units are not offset in the valley, but it does not mean that faults are not present.

A low amplitude negative anomaly near the geothermal area in the northwestern end of the valley could be related to the geothermal zone, and could reflect a zone of hydrothermally altered rocks, but it is more likely that this apparent negative anomaly is a part of a regional magnetic low.

The broad positive magnetic anomaly that appears to correspond in part to the large negative gravity anomaly south of Calistoga may have in part the same cause as the gravity anomaly. However, serpentinite is probably not the cause of either of the anomalies. An igneous intrusive mass could be the cause of both anomalies, but there are other equally plausible possible causes.

Gravity Survey

Purpose

Gravity measurements are often used to supplement other geophysical data in geothermal areas both to aid the study of the regional geology and to provide information on local structure that may be related to geothermal reservoirs. In some areas, such as at The Geysers in northern California, gravity measurements have also revealed the presence of the possible heat source for the geothermal phenomenon (Chapman, 1975).

Regional gravity measurements and a Bouguer anomaly map were available in the area (Chapman and Bishop, 1974). Additional gravity measurements were made during this study both to provide more regional information and to investigate the geothermal area near Calistoga in greater detail.

Equipment and Field Procedure

Gravity measurements were made in the Calsitoga area using La Coste and Romberg geodetic gravity meter G-129. For the regional survey, readings were made at elevation points from U.S. Geological Survey 7 1/2 minute maps. A few station elevations were also obtained by interpolation of the 40-foot topographic map contours. For the detailed lines in Napa Valley, elevation points were obtained by surveying. All readings were referenced to a gravity base station in Calistoga (Chapman, 1966, p. 43). A total of about 190 new gravity stations were obtained during the survey.

Gravity data

All the gravity data were reduced to complete Bouguer anomalies using a reduction density of $2.67 g/cm^3$. Terrain corrections were made out to a radius of 166.7 km. Plate 4 is a regional map at a scale of 1:62,500 showing gravity data contoured at an interval of 2 milligals (mgal). Plate 5 is a local map showing gravity data near Calistoga contoured at an interval of 0.5 mgal where possible.

One of the major features on Plate 4 is a prominent northwest-trending negative gravity anomaly, the axis of which is located about 1 to 1 1/2 miles southwest of the southwest edge of the valley near Calistoga. In this area, the anomaly is located principally over exposures of the Sonoma Volcanics. South of Calistoga, this anomaly has a maximum amplitude of about 15 mgal. To the southeast (off the map), the anomaly may continue down Napa Valley at a reduced amplitude (Chapman and Bishop, 1974). This part of the anomaly at least may be associated with sedimentary and volcanic deposits within the valley.

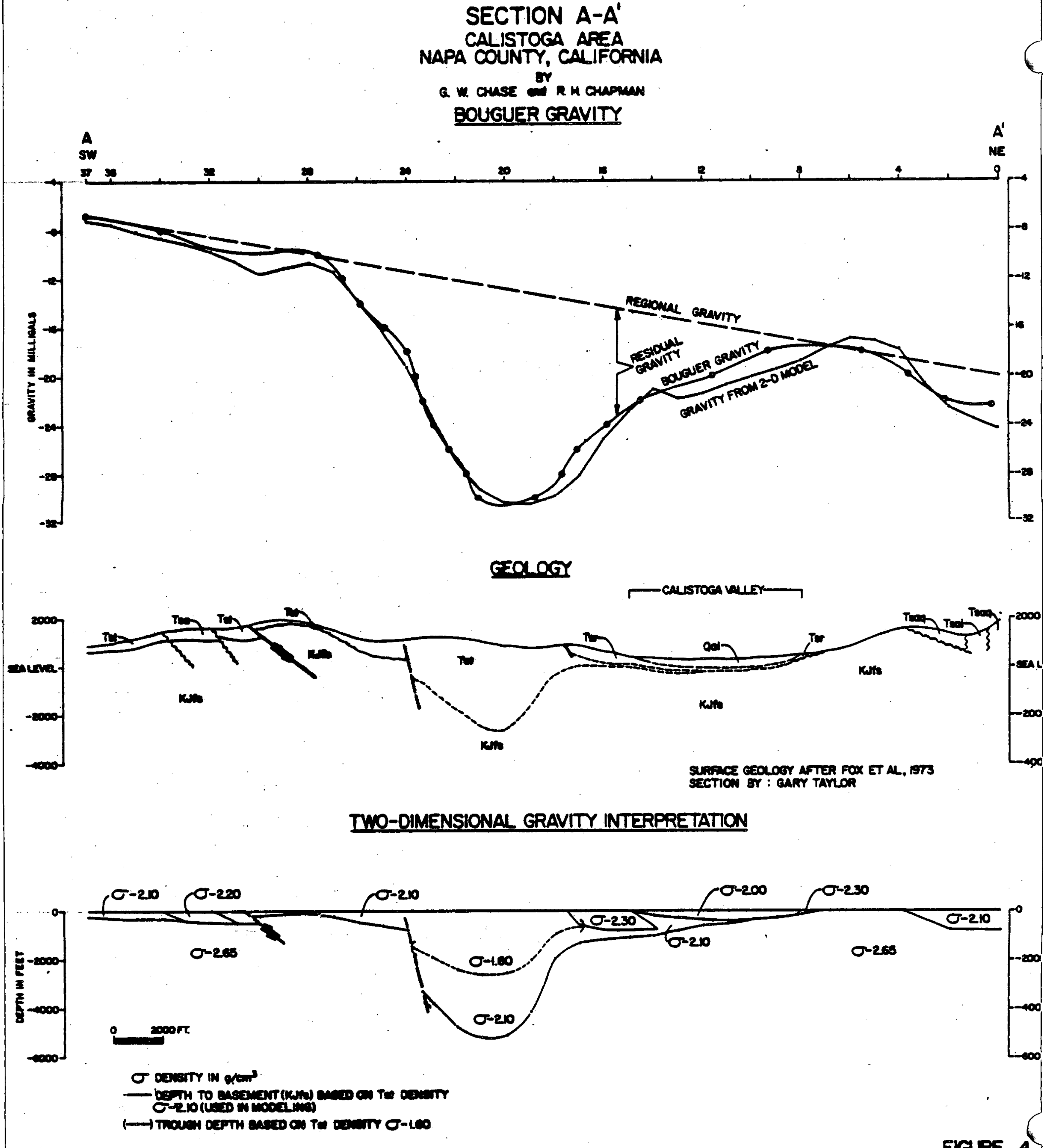
Because of the prominent negative anomaly discussed above, Napa Valley near Calistoga is characterized in general by a moderately-steep gravity gradient, with gravity values increasing toward the northeast. Northeast of Napa Valley, an irregular pattern of negative and positive anomalies is present over the Sonoma Volcanic rocks and Franciscan basement rocks exposed in this area.

Interpretation of Data

Regional Anomalies. Overall, gravity values decrease generally throughout the Calistoga area toward the northeast, reflecting the regional gravity gradient in this part of the Coast Ranges. This regional gradient has not been removed from the gravity data in Plates 4 and 5, but this has only a minor effect on the interpretation of the local anomalies. Locally, however, the gravity data in the Calistoga area apparently are strongly affected by the thicknesses of the younger, less dense Sonoma Volcanics and sediments that overlie the Franciscan basement rocks and by other density variations as well.

Plate 4 shows that the large negative gravity anomaly, centered south of Calistoga, tends to dominate the gravity field in the Calistoga area. Residual anomalies from trend surface analyses of the gravity data (not shown) suggest that the main anomalous mass is located chiefly in a northwest-trending zone about one mile wide, approximately between the Mark West Springs Road on the northwest and the Diamond Mountain Road on the southeast. The cause of this anomaly is puzzling. The anomaly could be caused by a relatively deep basin or a structure such as a graben or caldera filled with Sonoma Volcanics. The average measured density of 29 samples of Sonoma Volcanics is $2.04 g/cm^3$ (Table 1). This value yields a density contrast of about $0.6 g/cm^3$ with Franciscan basement rocks (average density of about $2.65 g/cm^3$). Assuming this density contrast, a two-dimensional analysis (A-A, Plate 4 and Figure 4) indicates that a graben or syncline with thickness of about 5000 feet of these rocks would be required to satisfy the anomaly. This thickness of volcanic rocks seems to be unreasonably large considering the geology of the area. Even if the average density of the volcanic rocks is less than $2.0 g/cm^3$, any reasonable value of the density requires what appears to be an excessive thickness of these rocks.

Other possible causes for the negative anomaly include: (1) a thick mass of serpentinite in the Franciscan basement rocks, (2) an extensive zone of extremely altered rocks in the basement, (3) a underlying intrusive mass within the basement consisting of either glassy or partially molten rocks, or (4) some combination of the above. Serpentinite has a relatively low density (Table 1), but if this is the cause of the anomaly, a large magnetic anomaly should also characterize this area. In fact, there is a positive magnetic anomaly of a few tens of gammas shown on the aeromagnetic map (Plate 2) in part of this area. However, ground magnetometer lines CM14 and CM15 (Figures 2 and 3) that cross this aeromagnetic anomaly show a very broad anomaly with a possible maximum amplitude of only 200-300 gammas. Therefore, serpentinite probably is not the cause of the gravity anomaly. If altered basement rocks



SECTION A-A'
CALISTOGA AREA
NAPA COUNTY, CALIFORNIA
BY
G. W. CHASE and R. H. CHAPMAN
BOUGUER GRAVITY
A
SW
A'
NE
GRAVITY IN MILLIGALS
REGIONAL GRAVITY
RESIDUAL GRAVITY
BOUGUER GRAVITY
GRAVITY FROM 2-D MODEL
GEOLOGY
CALISTOGA VALLEY
SEA LEVEL
KJfs
Qal
Tsr
SURFACE GEOLOGY AFTER FOX ET AL, 1973
SECTION BY : GARY TAYLOR
TWO-DIMENSIONAL GRAVITY INTERPRETATION
DEPTH IN FEET
σ-2.10
σ-2.20
σ-2.00
σ-2.30
σ-2.65
σ-1.80
0 2000 FT.
σ DENSITY IN g/cm³
DEPTH TO BASEMENT (KJfs) BASED ON Tsr DENSITY σ-2.10 (USED IN MODELING)
(----) TROUGH DEPTH BASED ON Tsr DENSITY σ-1.80

FIGURE 4

are the cause of the anomaly, the volume of these rocks required is so large that the hypothesis also appears to be unlikely.

It is possible that an elongate intrusive mass (3 above) could be the cause of the negative gravity anomaly, or at least that part of it south of Calistoga. This mass could possibly explain the small associated magnetic anomaly as well, and might serve as the source of heat for the geothermal phenomena in Napa Valley near Calistoga. However, our analysis of the anomaly indicates that the top of such an intrusive mass probably would be no deeper than two or three thousand feet. Any such hot intrusive mass at this shallow depth probably would result in extensive geothermal activity in the area immediately over the anomaly, but these effects evidently are lacking here, although we have no subsurface temperature measurements or thermal gradient measurements for evidence. Thus, the cause of the anomaly is puzzling. None of the possible alternative hypotheses seems to fit perfectly with other observed data.

<u>Local Anomalies</u>. Plate 5 is a detailed contour map of Bouguer gravity anomalies in the vicinity of Calistoga. The southern half of this map is dominated by the negative gravity anomaly south of Calistoga and the southward decreasing values of gravity related to this feature. Relatively local features include two positive anomalies, one centered on the northeastern side of the valley north of Calistoga (-16.5 contour) and one in the northwestern end of the valley (-16 contour). These anomalies are

probably caused by near-surface Franciscan rocks that include greenstone, at least in the area north and northwest of Calistoga. Two small negative anomaly closures with an overall northwest trend are present near the central part of the valley. These small negative anomalies may reflect the thickness of alluvium or some other relatively low density rock unit in the valley.

The gravity profiles on Greenwood Avenue and Tubbs Lane are shown on Plates 7 and 8 and discussed briefly in the section entitled "Comparison of geophysical traverses on Greenwood Avenue and on Tubbs Lane".

Conclusions

The results of the gravity study in the Calistoga area have revealed a possible structure or low-density mass southwest of Calistoga. Although the cause of the anomaly is uncertain, if a graben or caldera is present, this structure could include reservoirs that might serve as sources of additional hot water. Alternatively, if a heat source is present, the area that may be underlain by the geothermal resource might also be of substantially larger size than known at the present time.

Gravity data within Napa Valley reflect the thicknesses of sedimentary and volcanic rock units above Franciscan basement rocks and indicate the presence of some dipping contacts, some of which could be faults. For example, see Plates 7, 8, and 9. Small negative anomalies near and southeast of the Old Faithful geyser could be associated with the geothermal field, or they could represent the thickness of valley fill in this area.

Seismic Refraction Survey

Purpose

Seismic refraction lines were run in the Calistoga area for the following reasons: (1) to determine, if possible, the depth of Franciscan "basement" rock in the valley, (2) to investigate rock types and structure in the area, and (3) to determine, if possible, whether some of the apparent resistivity anomaly boundaries or zones of low resistivity might represent fault zones.

Equipment and Field Procedure

A 12 channel EGG-Nimbus enhancement seismograph, model 1210, was used for the seismic refraction survey. The source of energy was a 400 pound free-falling weight that was dropped a distance of about 4 feet onto a steel plate on the ground. Two cable lengths were used, 550 feet and 1100 feet, with geophone spacing of 50 feet and 100 feet, respectively. The weight was dropped at each end of the geophone cable, and frequently also at an offset distance of about 550 feet from each end in order to obtain data from greater depths.

The locations of the four seismic refraction lines are given in Plate 6. The total length of seismic refraction lines surveyed is approximately 11,350 feet. The locations and lengths of the four refraction lines are listed below:

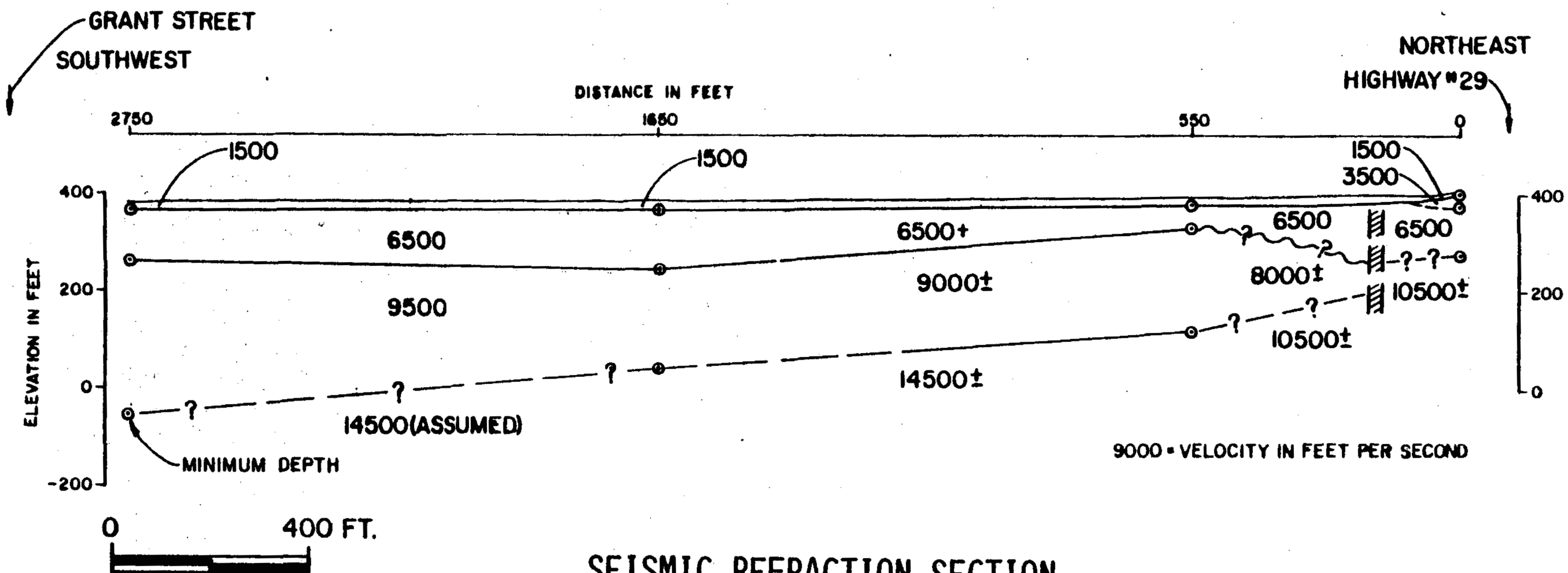
Line No.	Location	Length of Line in Feet
S1	Greenwood Avenue	7200 (segment between 5500 and 6300 not done).
S2	Mora Avenue	2750
S3	Silverado Trail	1100
S4	Grant Street (east of Greenwood Avenue)	1100

Interpretation of Data

Seismic velocities. The seismic refraction lines (Figures 5-7 and Plate 7) show four basic ranges in velocity that probably represent different rock units. The layers representing these velocity ranges are listed below:

Layer	Velocity Range in feet per second (fps)	Thickness in feet
1	1000-1500	5-20
2	6000-6500	50-250
3	8000-9500	0-450
4	12,000-14,500	-----

SEISMIC SECTION S-2 (MORA AVENUE)



SEISMIC REFRACTION SECTION
CALISTOGA AREA

ELEVATION IN FEET

RELIABLE DATA

POOR DATA

VERY POOR DATA

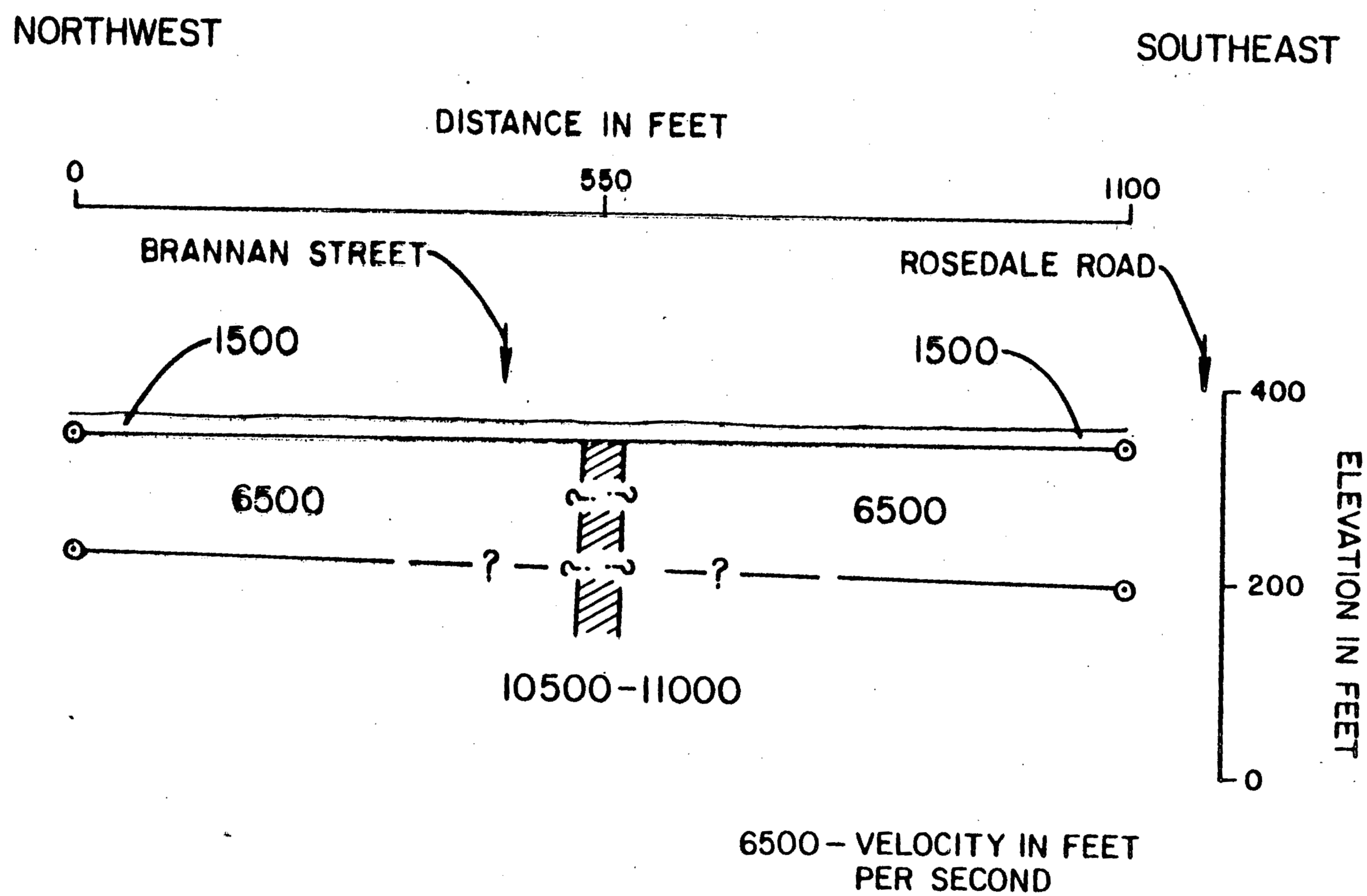
POSSIBLE FAULTING

INDETERMINATE BOUNDARY

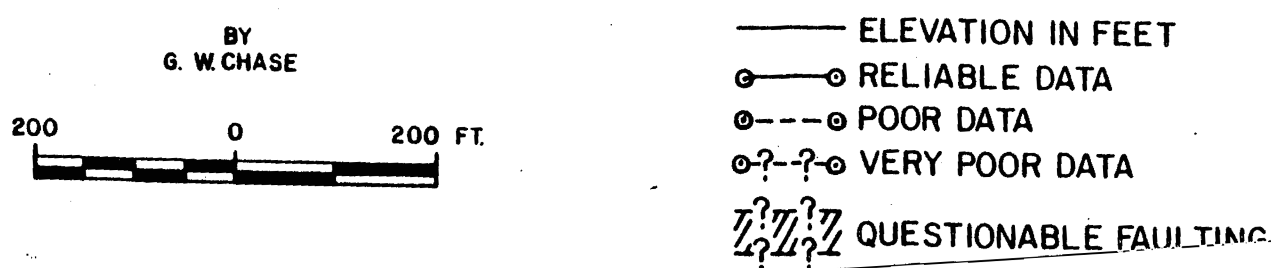
BY
G. W. CHASE

FIGURE 5

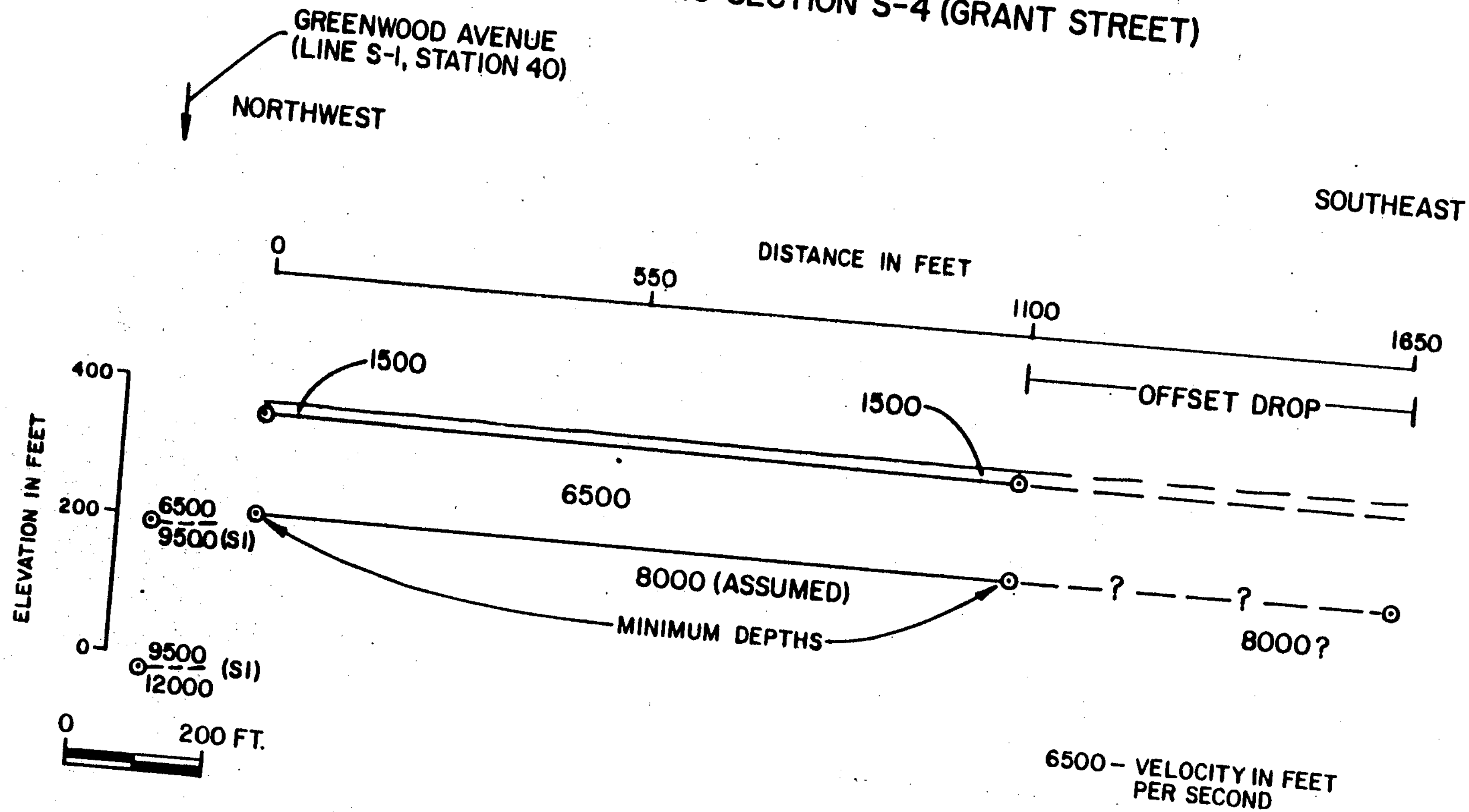
SEISMIC SECTION S-3 (SILVERADO TRAIL)



SEISMIC REFRACTION SECTION
CALISTOGA AREA



SEISMIC SECTION S-4 (GRANT STREET)



SEISMIC REFRACTION SECTION
CALISTOGA AREA

——— ELEVATION IN FEET
⊙——⊙ RELIABLE DATA
⊙---⊙ POOR DATA
⊙-?-?⊙ VERY POOR DATA

BY
G. W. CHASE

FIGURE 7

The 1000-1500 fps and 6000-6500 fps layers are found consistently in the upper part of the sections on all the lines. The 8000-9500 fps layer is found on most, but not all of the lines. The 12,000-14,500 fps layer is found on some of the lines, especially near the northeastern edge of the valley where the unit is apparently at a relatively shallow depth.

At this time, we have insufficient information to identify the rock types associated with all of the characteristic velocities. Layer 1 (1000-1500 fps) is probably near-surface overburden, above the water table. Layers 2 (6000-6500 fps) and 3 (8000-9500 fps) have not been identified. However, Layer 2 could be associated with the water table, although the velocity is somewhat high for this. Layer 3 could be highly fractured Franciscan rocks (greenstone or graywacke) or possibly Tertiary volcanic rocks. Layer 4 (12,000-14,500 fps) probably represents relatively dense Franciscan basement rock, probably greenstone or metagraywacke or both. Plate 7 shows the interpretive section for seismic line S1, Figures 5-7 show the sections for seismic lines 2, 3, and 4.

Line S1. Seismic line S1 (Plate 7) trends northeast along Greenwood Avenue and consists of a number of 550 and 1100 feet seismic spreads. Near the northeastern end of the line, layer 4 velocities (probable Franciscan basement rocks) were determined to be at depth of about 60 feet. The seismic interface marking the top of this velocity layer dips toward the southwest; beyond a distance of about 2200 feet (Plate 7), the interface becomes increasingly difficult to map accurately. On the south end of the line, south of Blossom Creek, the highest seismic velocity observed (10,500 fps) is intermediate between velocity layers 3 and 4, and it is possible that this represents a rock type not encountered in the rest of the area surveyed. Layer 2 (6000-6500 fps) is present all along the section, including the area south of Blossom Creek, but this unit is irregular in thickness. Layer 3 (8000-9500 fps) is found in the section south of the 2200 feet mark, and this layer also varies in thickness irregularly. This unit may not be present south of Blossom Creek unless it is represented by the 7300 fps unit mapped here.

In the vicinity of Blossom Creek, there is apparently a discontinuity in the seismic section near the gap in the seismic line in this area. The correlation of the seismic units across the discontinuity is not clear; it is possible that this discontinuity represents a fault zone. Additional evidence for this possible fault zone is shown by an abrupt change in the magnesium (Mg) and bicarbonate (HCO_3) concentrations measured in water from wells in the area (Figure 16). These concentrations are both much higher southwest of a northwest-trending zone that passes near the seismic discontinuity.

On the northeastern end of the section, between the 800 and 1400 foot marks (Plate 7), a low-velocity zone (about 9000 fps) is present in seismic layer 4. There is also a fairly steep southward slope of the velocity discontinuity on the top of layer 4 in this area that is near a steep gravity gradient. It is possible that this low velocity zone represents a fault zone, but this is uncertain.

Line S2. Seismic line 2 (Figure 5) trends northeast along Mora Avenue. This line consists of one 550 foot and two 1100 foot seismic spreads. On this line, in general, the interfaces between layers 2 and 3 and between layers 3 and 4 show southwestward components of dip. Between points 0 and 550, on the northeastern end of the line, there is a possible fault zone, judging from the offset shown in the 10,500 fps layer and the apparent disappearance of layer 3 (8000 fps) at the northeastern end of the line. In this area, the 10,500 fps layer is believed to be layer 4, although this velocity is unusually low. Layer 4 was not detected at the southwestern end of this line. The queried interface shown at this end of the line actually represents the minimum depth to this unit based on seismic data.

Line S3. Seismic line S3 (Figure 6) trends southeastward along the Silverado Trail from northwest of Brannan Street to near the intersection with Rosedale Road. This line consists of one 1100 foot long seismic spread that crosses an anomalously low resistivity zone near Brannan Street (Line R-6, Figure 11). On this line, seismic layers 1 and 2 were found to have velocities within the normal range (1500 fps and 6500 fps respectively). However, the third layer detected on this line (at a depth of about 150 feet) has a velocity of between 10,500 and 11,000 fps, which is intermediate in value between velocities normally found for layers 3 and 4.

Thus, either layer 3 was not found on this line, or layer 3 has a higher than normal velocity.

Just east of the Brannan Street intersection, there is some indication in the data to suggest possible faulting, although there is no detectable offset in the layers at this point. This possible fault zone corresponds approximately to a change in apparent resistivity from about 15 ohm feet on the northwest, to approximately 40-60 ohm-feet on the southeast (Line R-6, Figure 11).

Line S4. Seismic line S4 (Figure 7) trends southeastward along Grant Street from the intersection with Greenwood Avenue. This line consists of one 1100 foot long seismic spread that crosses an anomalously low-resistivity zone (line R-7, Figure 12). On this line, layers 1 and 2 were found to have velocities within the normal range (1500 fps and 6500 fps, respectively). However, the only evidence for the interface between layers 2 and 3 (8000 fps velocity) was found in the data from an offset drop taken southeast of the end of the line. Thus, the interface immediately above the 8000 fps layer shown in Figure 7 represents only a minimum depth for this layer. No evidence for velocity layer 4 was observed on this line. Just northwest of the end of this line, data points representing the interfaces between layers 2 and 3, and 3 and 4, as determined on seismic line S1, are shown on the S4 section (Figure 7). The interface between layers 2 and 3 from seismic line S1 (elevation 190 feet) shows good agreement with the minimum depth interface between these layers on line S4 (elevation 210 feet).

Seismic line S4 shows no evidence for a fault or other structures associated with the apparent resistivity anomaly on line R-7 (Figure 12, stations 32-34).

Conclusions

The seismic lines in the Calistoga area show that the interface that may represent Franciscan basement rocks underneath the valley generally dips toward the southwest, at least in the northeastern part of the valley. The deepest point at which the interface was detected was in excess of 500 feet (on line S1). Generally, this interface could not be mapped beyond approximately the center of the valley. On the line that crosses the entire valley (S1), this interface was not detected on the southwest side of the valley.

Seismic evidence for faulting was indicated at a few places on the lines. The best example of this is a possible fault near the north end of line S2 that indicates basement rocks are offset down to the south in this area. In some cases, possible zones of hot water interpreted from the resistivity data may be associated with faults indicated on the seismic data such as on lines S1 and S3. If drill holes are completed in the future near some of these seismic lines, it should be possible to correlate the seismic layers described here with rock units.

Electrical Resistivity Survey

Purpose

Because hot, mineralized water is known to be relatively electrically conductive, geothermal fields are often characterized by anomalously low values of electrical resistivity. The purpose of the resistivity survey at Calistoga was to map electrical properties of the rocks in the vicinity of the known hot water field and attempt to determine both the possible continuity of the resource in the area, and to map possible extensions horizontally and at depth.

Equipment and Field Procedure

The equipment used for this survey consists of a Geotronics Model FT-4 transmitter with an output rated at 4 amps, and 800 volts (3.2 KVA). The power supply, also supplied by Geotronics, is a Model B-2 engine generator with an output of 5 KVA at 400 Hz. The receiver used is the Bison model 2390. This is a digital signal enhancement receiver that provides an average reading every 10 cycles. Because it is necessary to synchronize the precision time base of the transmitter and receiver, the Geotronics transmitter was modified to supply a synchronization pulse that is compatible with the Bison receiver system. Thus, the two units can be operated independently for as long as one day while both units remain on and at the same frequency. In this system, the practical operating time is limited to about 3 hours by the fuel capacity on the the motor generator set.

The resistivity survey in the Calistoga area consists chiefly of a number of lines along which resistivity was measured using the polar dipole-dipole electrode system (Keller, 1966). The dipole interval used was 200-feet and the receiver was usually moved out from a transmitter dipole-receiver dipole distance (N) of N=1 (200 feet) to N=10. The transmitter dipole usually consisted of two electrodes about 3 feet apart at each end. All electrodes were thoroughly wet with salt water. It was found necessary to add water to the transmitter electrodes periodically to prevent them from drying out. After the completion of one series of measurements along the line from distance of N=1 to N=10, the transmitter was moved along the line either 400 or 600 feet, and a new series began. In addition to the dipole-dipole survey, one Schlumberger vertical electrical sounding (VES) was also done in the area.

All resistivity measurements were made at a frequency of one Hz and two measurements were generally made using different values of transmitter current. This yields, at each station, two independent measurements of resistivity which were generally found to be in good agreement. When not in good agreement, these measurements were repeated. Resistivity values were collected in the field, and a resistivity pseudo-section was plotted as the work progressed.

Resistivity Data

Plate 6 shows the locations of 7 dipole-dipole lines, R3-R9, and one VES sounding R1, in the Calistoga area. The total length of the lines surveyed is approximately 7 1/2 miles. A listing of the lines, showing street and road locations and lengths, is given below.

DIPOLE-DIPOLE RESISTIVITY LINES

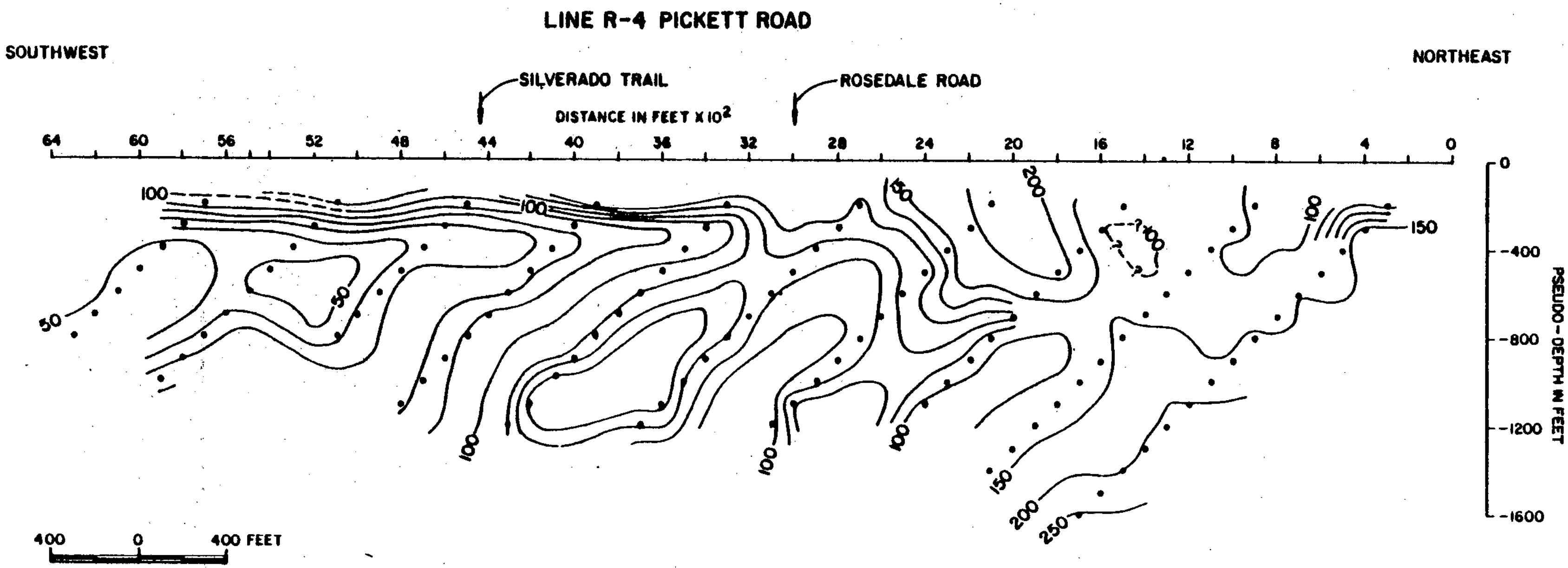
Line No.	Location	Length in feet
R3	Greenwood Avenue	7,200
R4 & R4 Ext.	Pickett Road, Dunaweal Lane	10,800
R5	Bennett Lane	3,600
R6	Silverado Trail	4,200
R7	Myrtledale-Grant Street	5,600
R8	Tubbs Lane	5,600
R9	Brannan Street	2,800
	TOTAL	39,800

The results of the dipole-dipole resistivity measurements were plotted and contoured in the standard manner (Parasnis, 1975, p. 219-222), which results in resistivity pseudo-sections. The individual sections are shown in Figures 8-13 and Plates 7 and 8. These sections, which show apparent resistivity values, are not true scale two-dimensional representations. The one vertical electrical sounding is shown in Figure 14.

Interpretation of Dipole-Dipole Data

All of the dipole-dipole pseudo-sections, with the exception of section R9, which was only recently completed, were sent to the University of Utah Research Institute (UURI) for analysis. The following comments on these data were provided by Bill Sill (Duncan Foley, personal communication, 1980):

> Of the six lines of dipole-dipole data, the four in the vicinity of the geyser (R3, R5, R7, R8) show low resistivity zones (3-10 ohm-feet) that may be of interest. Line R5 shows a limited low resistivity zone (10 ohm-feet) at intermediate N spacings. Near the intersection with line R8, line R7 may also show this zone, although it appears at larger N spacings and has a smaller apparent resistivity (3-6 ohm-feet). On line R7 this conductive zone continues almost to line R3. At this point in the pseudo-section there are some highly suspect values (i.e., 100's of ohm-feet values next to 10's of ohm-feet). These sorts of changes in p for a unit change in N or a horizontal change of one dipole are generally impossible to model, at least with 2 dimensional models. Beyond this region there is again a suggestion of a low resistivity zone, at moderate N values.
>
> Lines R3 and R8, which are roughly parallel and cross the above lines, show similar conductive zones at intermediate depths. The nature and extent of the zones in the intersecting pseudo-sections indicate that the region is not very two dimensional. However, the extent of the conductive zone in lines R5 and R7 suggests that the best choice for two-dimensional modeling would be the perpendicular lines R3 and R8. The modeling of these two lines is discussed in more detail below.

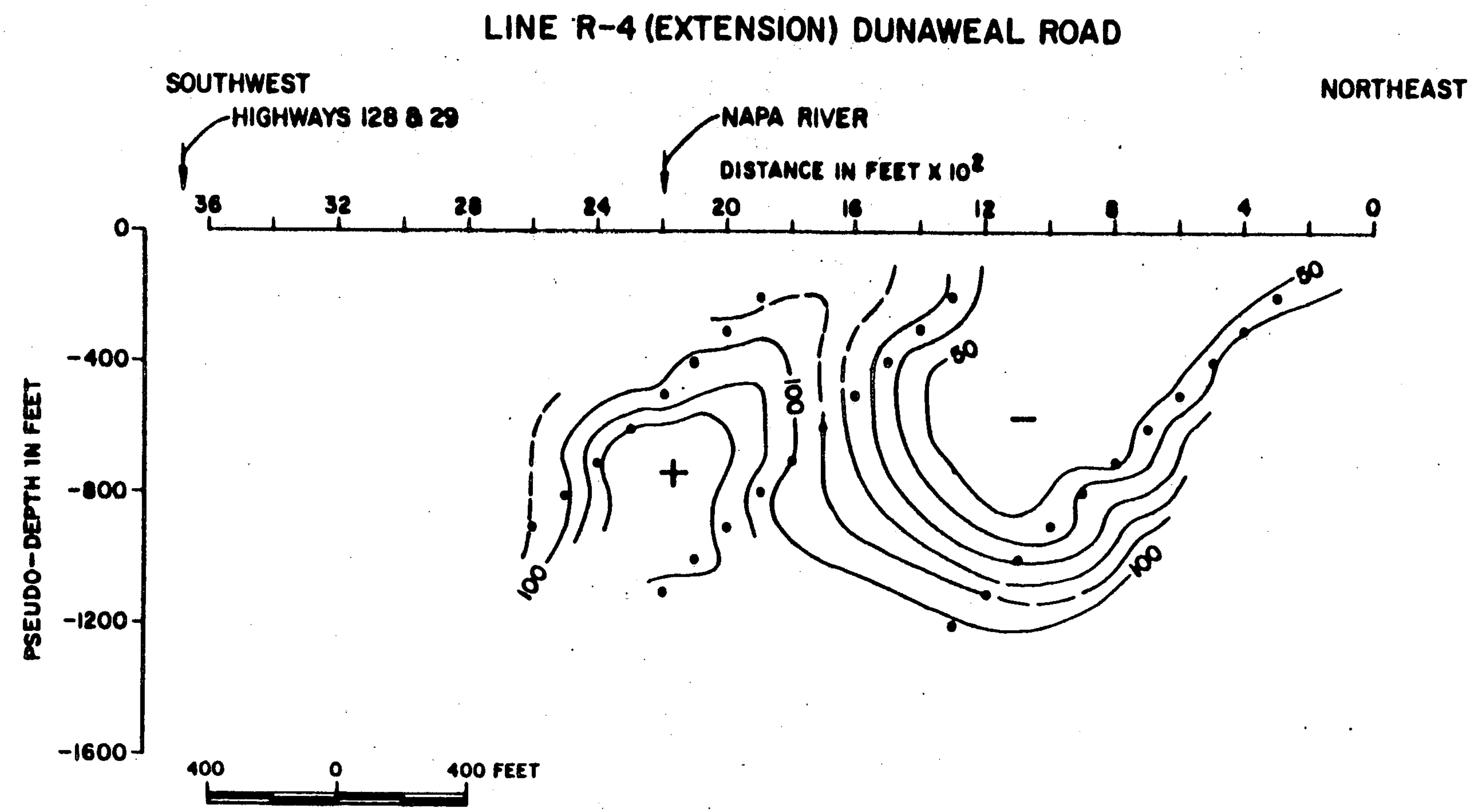


RESISTIVITY PSEUDO SECTION
CALISTOGA AREA

CONTOUR INTERVAL - 10 OHM FEET
- 50 OHM FEET

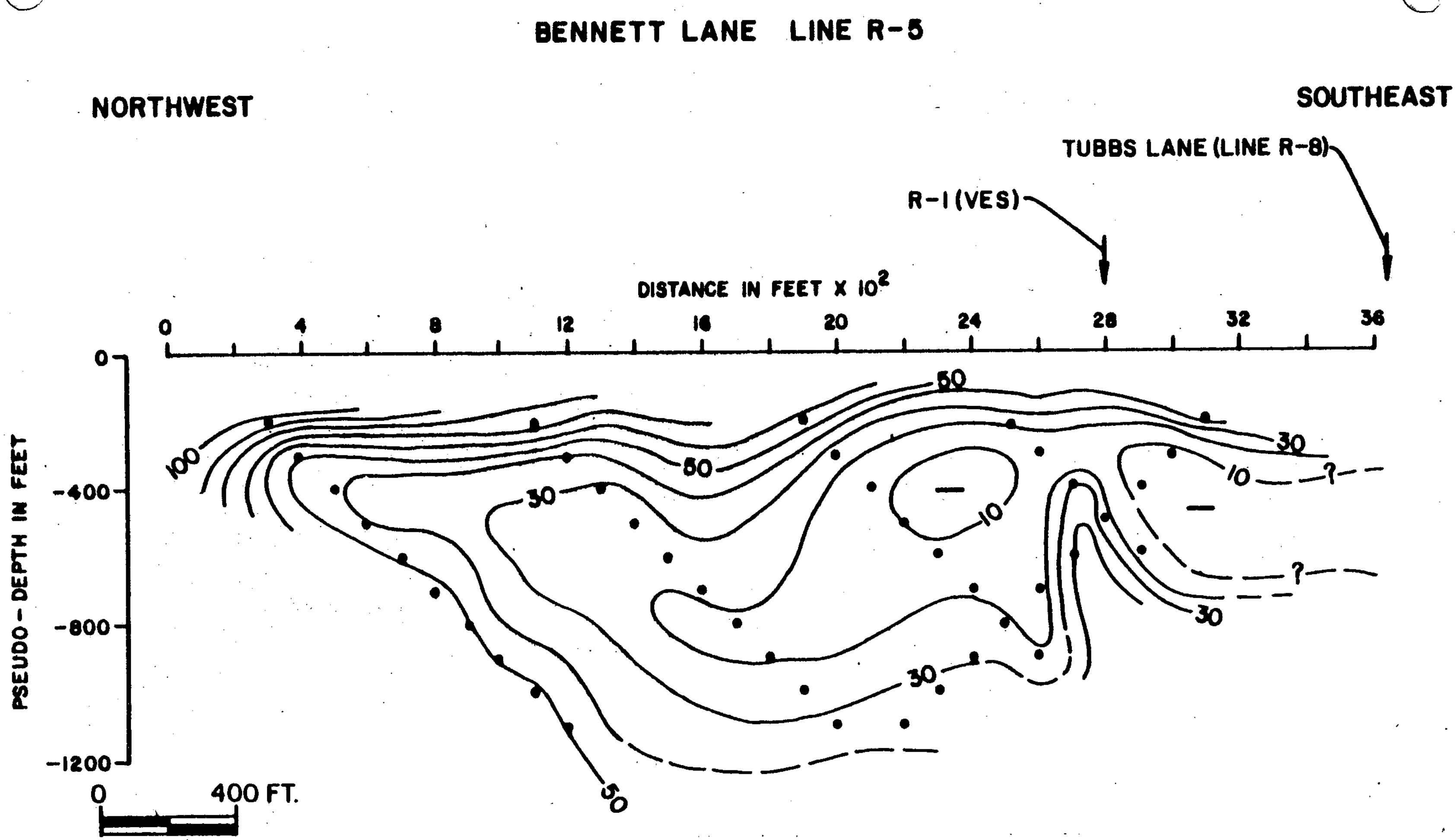
BY
G. W. CHASE

FIGURE 8



RESISTIVITY PSEUDO SECTION
CALISTOGA AREA
CONTOUR INTERVAL - 10 OHM FEET
BY
G. W. CHASE

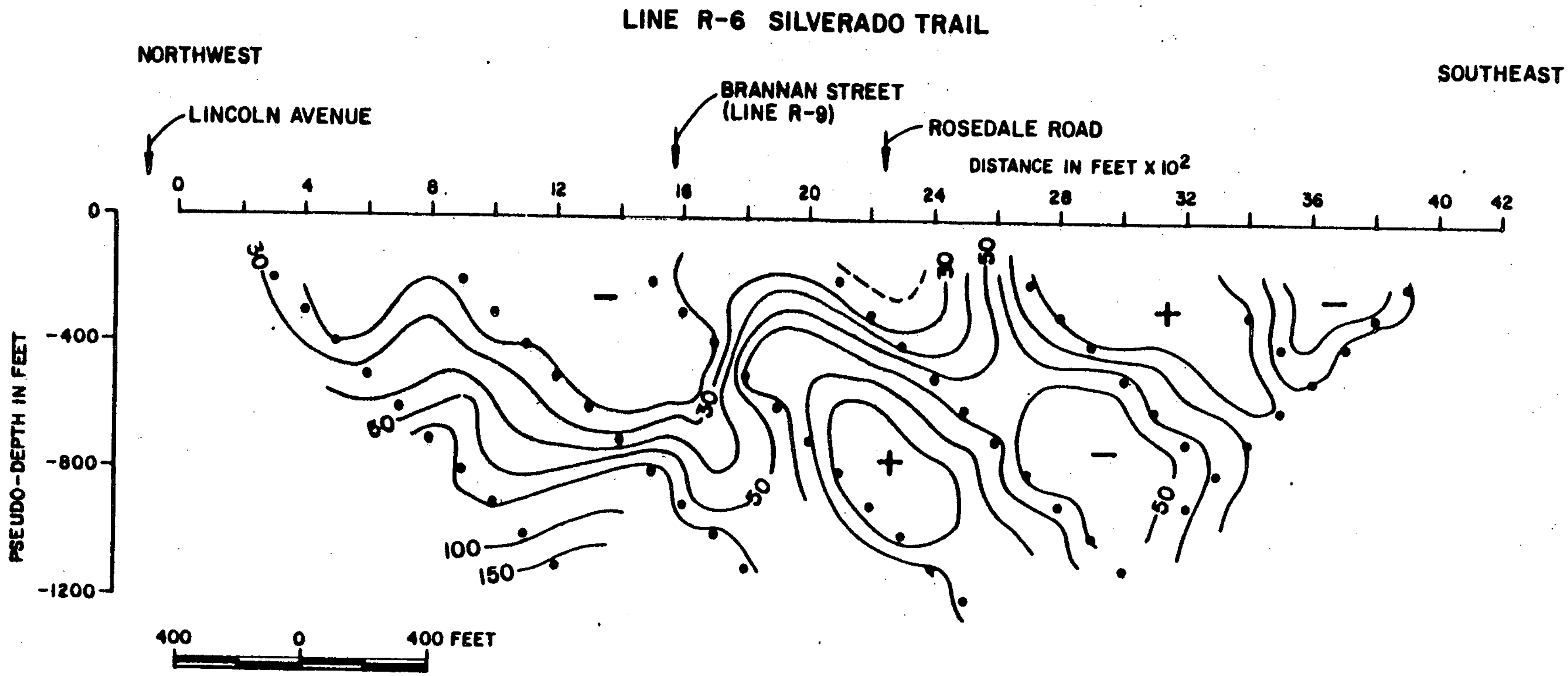
FIGURE 9



RESISTIVITY PSEUDO SECTION
CALISTOGA AREA
CONTOUR INTERVAL - 10 OHM FEET

BY
G. W. CHASE

FIGURE 10



RESISTIVITY PSEUDO SECTION
CALISTOGA AREA
CONTOUR INTERVAL - 10 OHM FEET
- 50 OHM FEET

BY
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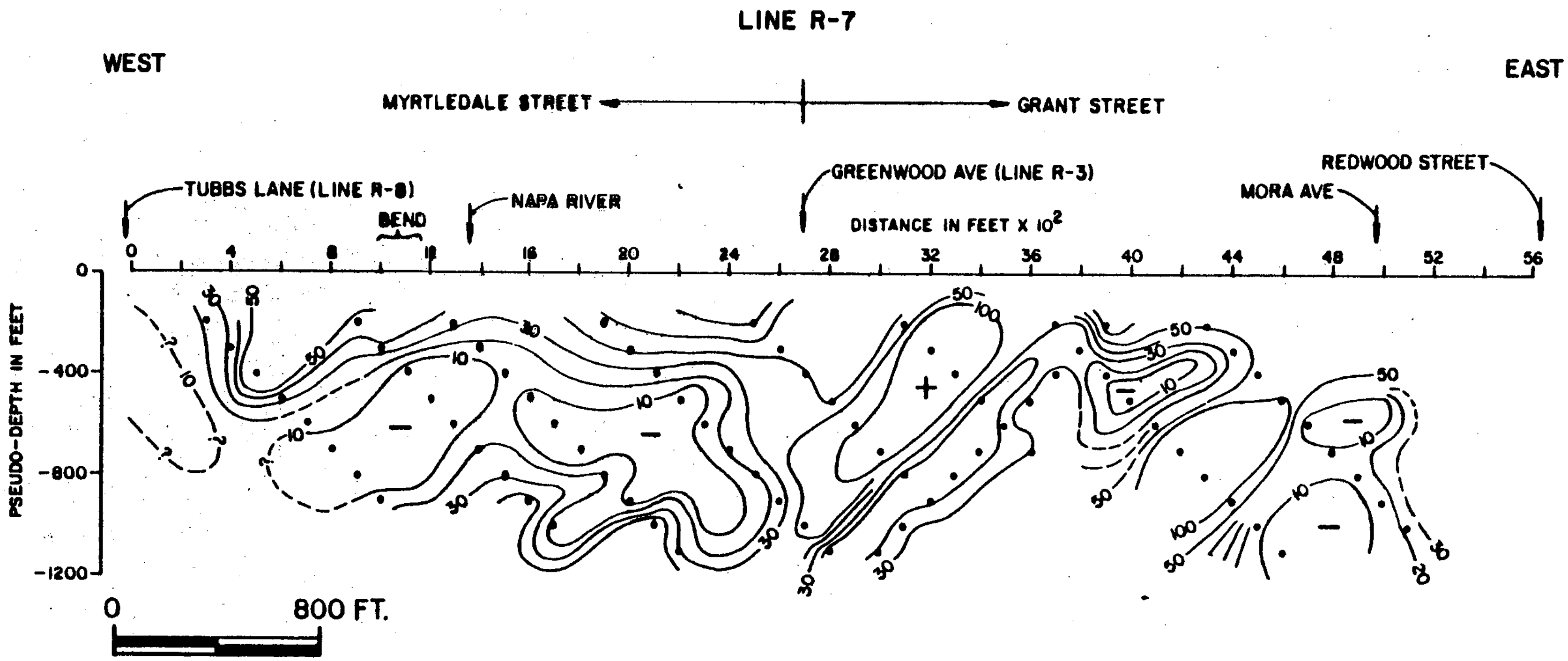
FIGURE 11

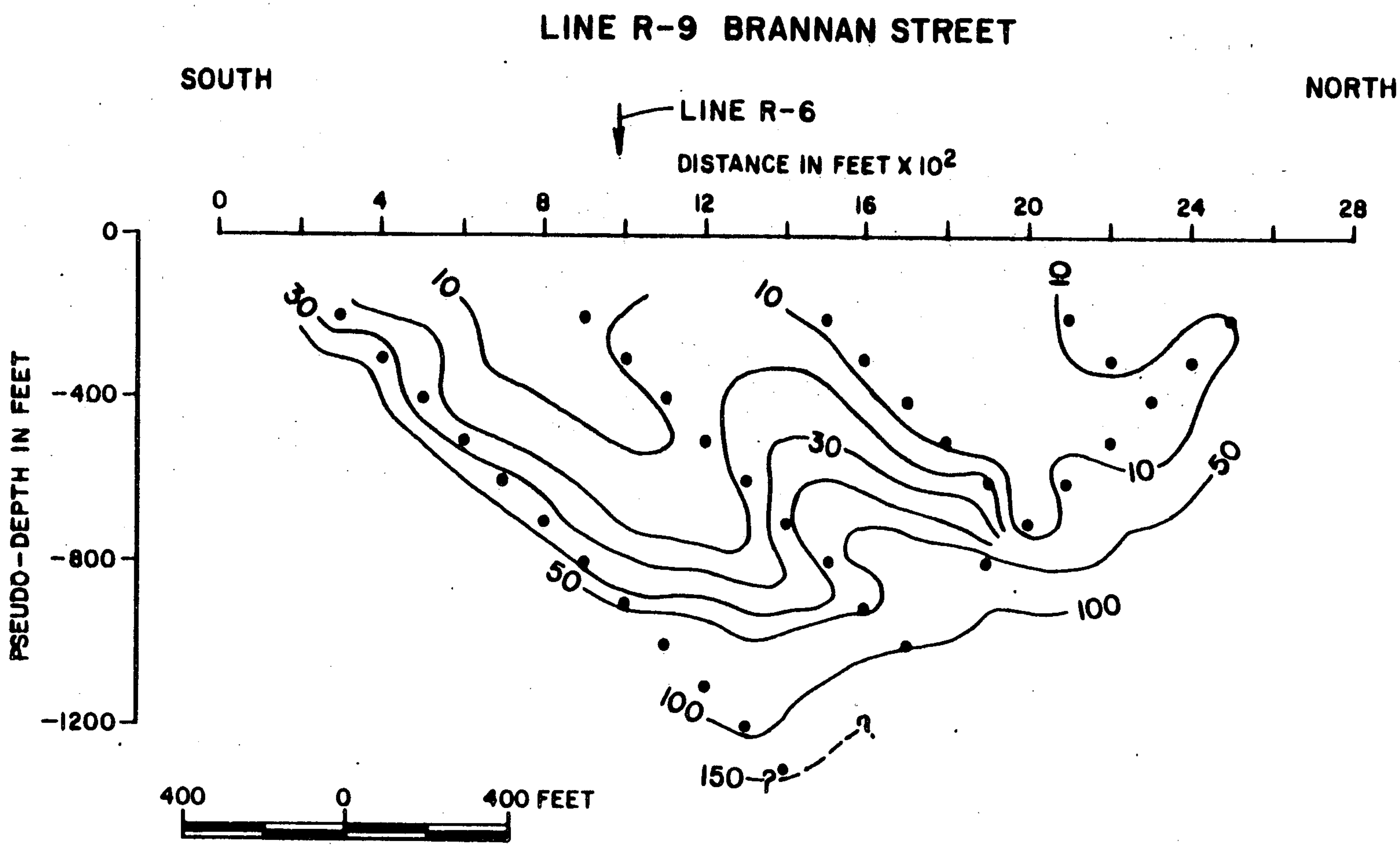


RESISTIVITY PSEUDO SECTION
CALISTOGA AREA

CONTOUR INTERVAL - 10 OHM FEET
- 50 OHM FEET

BY
G. W. CHASE

FIGURE 12



RESISTIVITY PSEUDO SECTION
CALISTOGA AREA
CONTOUR INTERVAL - 10 OHM FEET
- 50 OHM FEET

BY
G. W. CHASE

FIGURE 13

Line R4 shows moderately high resistivity and a general trend of increasing resistivity to the NE. The contours and values suggest the possibility of a contact near 3200'SW. Line R6 shows mainly a shallow more conductive zone to the west.

Models of lines R8 and R3

The model for line R8 and the calculated results and the observed data (contours) are shown in Figure 1 (See Plate 8 in this report). The diagonals show the locations of the lines of observed data. There is generally good agreement between the model results and the observed data except for the region below 3200'SW. Here again, there are some suspicious observed data, with very low values next to very large ones.

The model shows a very broad conductive region (20 ohm-feet) centered roughly on the geyser. The most conductive region (5 ohm-feet) is at the surface right at the geyser and seems to be shifted to the NE at depth. Looking at the model-observed comparison below 2200'SW (the model has larger apparent resistivity) suggests that we might get somewhat better fit by expanding the width of the 5 ohm-foot zone at depth. The data used in the modeling (N 6) does not really limit the depth extent of this zone.

Figure 2 [see Plate 7 in this report] shows a similar display of model and observed data for line R3 . Here the data quality seems to be better and the agreement is quite good. Line R3 shows a conductive zone (10-20 ohm-feet) similar to line R8 but the conductive zone does not extend to the surface. Also, R3 shows a moderately conductive zone (20-30 ohm-feet) extending much further to the SW than is seen in the model R8. Here again, the depth extent of the lower layers in the model are not restricted by the data.

In addition to the resistivity lines discussed above, another line R9 was recently completed along Brannan Street in Calistoga (Figure 13), and additional data were obtained on the southeastern end of line-R7 on Grant Street (Figure 12). Line R9 shows two areas of shallow low resistivity of less than 10 ohm-feet that may be of possible interest. One of these is located just south of Silverado Trail near stations 8-10 and the other, near station 22, on the north end of the line.

The additional data on the southeastern end of line R7 (Figure 12) shows some puzzling zones of high and low values that are difficult to interpret and may be suspect as mentioned in the comments on this line mentioned above.

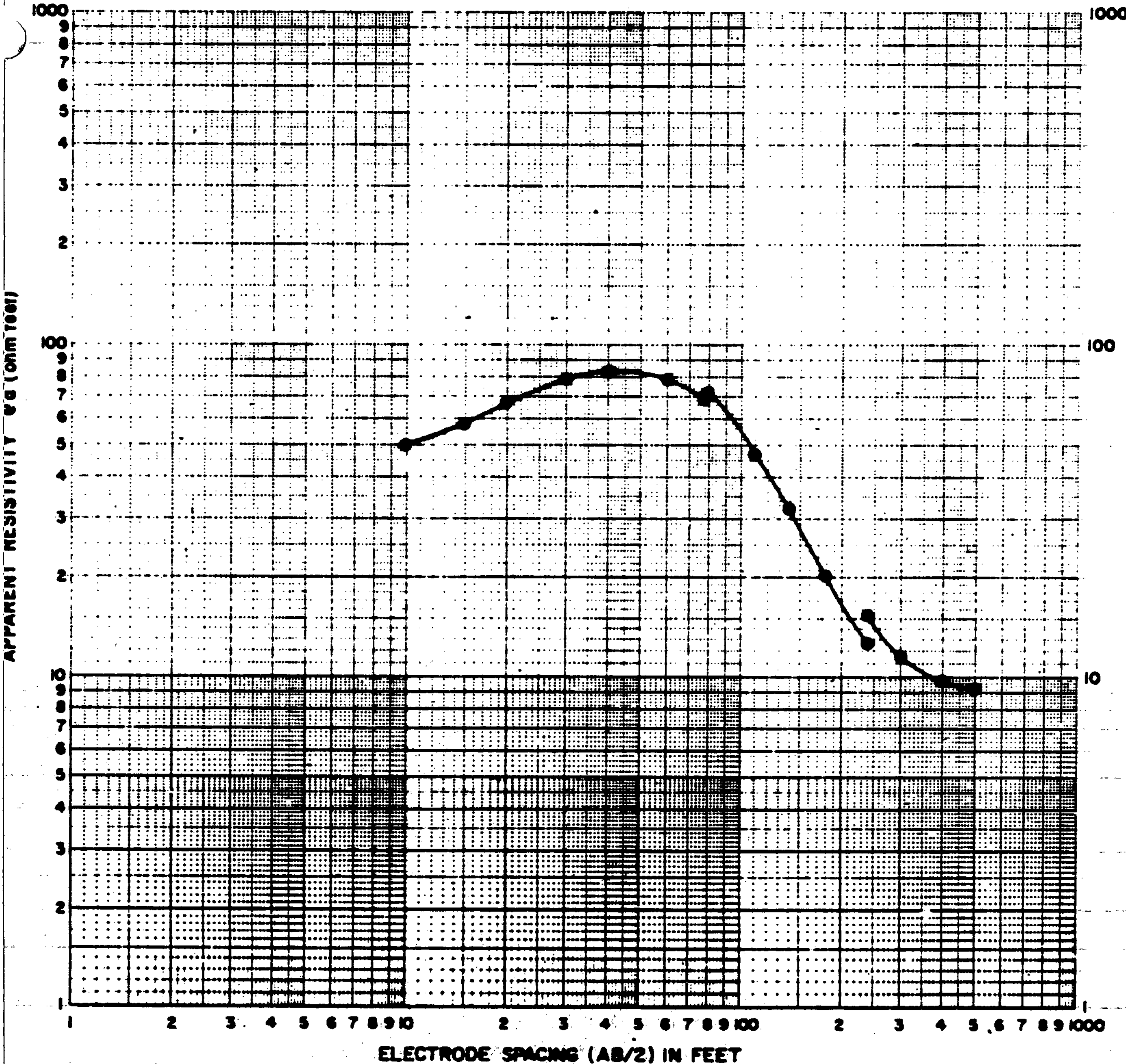
In regard to the interpretation of line R4 (Figure 8), an extension of this line to the southwest might reveal resistivity values low enough to be of interest. The values of resistivity decrease in this direction, and at the present end of the line (stations 60-64) are in the range of 40-50 ohm-feet.

Interpretation of VES Data

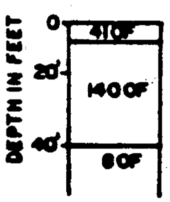
One Schlumberger vertical electrical sounding (VES) (Figure 14) was completed on dipole-dipole line R5 at station 2800. This is a relatively shallow sounding, as the maximum current electrode distance (a-b) obtained was 1500 feet. An interpretation of this sounding was made by means of the theoretical curves by Orellana and Mooney (1966). This analysis (Figure 14) indicates near surface layers with resistivities of about 41 ohm-feet and 140 ohm-feet, respectively. At a depth of about 40 feet, however, a layer with a resistivity of about 8 ohm-feet was encountered that may indicate hot water.

Comparison of dipole-dipole line R5 (Figure 10) and the VES sounding shows that the low resistivity layer of less than 10 ohm-feet is found on

CALISTOGA AREA (VES R-1)



INTERPRETATION



OF = ohm feet

BY
G. W. CHASE

140 - APPARENT
RESISTIVITY

FIGURE 14

both the pseudo-section and the Schlumberger sounding. However, on the pseudo-section, this layer appears at a depth of about 300 feet in comparison with a depth of about 40 feet on the sounding. At least a part of this apparent discrepancy might be resolved if a model could be developed for the dipole-dipole section.

Conclusions

The limited number of dipole-dipole resistivity lines completed for this project in the Calistoga area indicate fairly shallow conductive zones in the vicinity of the geyser on Tubbs Lane (lines R5, R7 and R8). This conductive zone or zones extends southeastward at least as far as Greenwood Avenue where it is deeper (Line R3). No lines were run west of the geyser, however. Unfortunately, it was not possible to conduct these surveys within the City of Calistoga where hot water is also known and is used at a number of resorts. However, conductive zones were also located on lines just north of town (lines R6 and R9).

Limited work, located about a mile southeast of Calistoga, revealed lower conductivity values, at least on the lines run (R4 and R4 extension). The lowest resistivity values of 40-50 ohm-feet in this area are not favorable for hot water. Nevertheless, warm water may be present in this area also.

In general, the resistivity pseudo-sections indicate an irregular distribution of the conductive zones and, therefore, the hot water resource. Some of the lines, notably R3, do not show any lower depth limits for the resource. In order to determine this, a larger electrode spacing would have to be used.

Comparison of Geophysical Traverses on Greenwood Avenue and on Tubbs Lane

Comparison of different types of geophysical data covering the same area is a necessary part of the interpretation process. If data for two or more techniques tend to corroborate each other, the interpretation is much more certain. In this study, a good comparison of different types of data can be made on two lines - Greenwood Avenue and Tubbs Lane.

Plate 7 shows a comparison of electical resistivity data (Sections A and B), seismic refraction (section C), and gravity and ground magnetic lines (D and E, respectively) on Greenwood Avenue. Plate 8 is a similar set of sections and profiles for Tubbs Lane, except that there is no seismic section. The electrical resistivity data on both Plates 7 and 8 include the dipole-dipole pseudo-section (A) and a two-dimensional resistivity interpretation of this section (B) for a maximum dipole spacing of N=6 done by the University of Utah Research Institute (Duncan Foley, written communication, 1980).

A comparison of the sections and profiles on Greenwood Avenue indicates some possible correlations. For example, the zone of lowest electrical resistivity (10 ohm-feet) that represents possible hot water located below a depth of 200 feet between stations 18 and 34 (Plate 7, Part B) corresponds approximately with both a fairly steep gravity gradient (Part D) and a change in the seismic section (Part C) (layer 3, present on the south part of the section, terminates in this zone). Also, the resistivity low is bounded on the northeast by a possible steep contact with a zone of higher resistivity (75 ohm-feet). The contact is somewhat northeast of the center of the steep gravity gradient and also near a low velocity zone in the basement rocks, and, therefore, could be interpreted as a fault. Both the magnetometer and the gravity profiles show small negative anomalies located near the intersection with Grant Street (stations 32-42), but whether or not these anomalies have the same cause and whether or not they are related to the geothermal resource is uncertain.

The geophysical traverses on Tubbs Lane (Plate 8) are somewhat similar in appearance to those on Greenwood Avenue. On these traverses, however, the zones of lowest electrical resistivity (5, 10, and 20 ohm-feet) from the model (Plate 8, part B, between stations 12 and 40) correspond approximately to a small negative gravity anomaly (C) in the same area, but the small negative magnetic anomaly (D) is offset somewhat to the northeast on this line. In this comparison, also, the northeastern boundary of the resistivity low (20 ohm-feet) is near the center of the steep gravity gradient, which could represent a possible fault.

Composite Geophysical Anomaly Map

Plate 9 is a compilation of some of the more important observations from geophysical data in the vicinity of the known hot water zones near Calistoga. This plate shows anomalies in the geophysical data that might be related to the hot water resources directly or to geologic structures that control the location of the resource. Included on the plate are 1) partial contours of the lowest values of apparent resistivity, 2) contacts or discontinuities indicated by the resistivity data, 3) an alignment of relatively steep gravity gradients, 4) discontinuities in the seismic refraction data, and 5) contours of maximum temperatures from wells at depths of from 200 to 300 feet.

The resistivity values shown on the contours of Plate 9 do not represent one particular electrode spacing, rather the contours are smoothed to approximate the lowest values disregarding depth. As discussed in the section of this report on electrical resistivity methods, low resistivity values probably represent relativly hot water. Northwest of Greenwood Avenue, the resistivity low, as marked by the 10 ohm-feet contour, correlates approximately with the known hot water zone (see Plates 9 and 12). The resistivity anomaly has been left open southeast of Greenwood Avenue because reliable data were not obtained in this area. A resistivity low also characterizes the hot water zone northeast of Calistoga (15 ohm-feet contour), but this anomaly is open on the south side because of a lack of data in this area.

Some of the anomalies and anomaly alignments suggested by the seismic, resistivity, and gravity data shown on Plate 9 may represent faults or other contacts as discussed in previous sections of this report. However, because the distribution of the data is inadequate in much of the area to provide corroborative evidence, no fault trends are indicated on the plate with the exception of one gravity anomaly alignment. This alignment is a relatively steep local gradient found on both the Tubbs Lane and Greenwood Avenue lines that could represent a fault or dipping contact.

CONCLUSIONS

Of the geophysical methods used in this study in the Calistoga area, the resistivity data apparently were found to be the most useful for delineating the geothermal resource. A positive correlation was found between zones of high electical conductivity where available and known areas of hot water from temperature measurements in wells. Possible extensions of the hot water zones, both in plan and at depth, were also found on some of the lines surveyed. Two such areas, located on Greenwood Avenue and Brannan Street, respectively, are scheduled to be evaluated by drill holes.

Magnetic data are affected chiefly by serpentinite in the Franciscan basement rocks and possibly by andesite flows in the Sonoma Volcanics in some places, but Franciscan "greenstone" may also cause some of the smaller anomalies. A low-amplitude negative anomaly could be associated with that part of the geothermal field near the Old Faithful (California) geyser, but this is uncertain.

Gravity data indicate a large low-density structure or mass located southwest of Calistoga. This structure or mass could include possible zones favorable for geothermal phenomena. Locally, gravity data reflect the thicknesses of the Cenozoic rocks above the basement rocks and also suggest at least one possible fault zone. A small gravity low could be associated with the geothermal field near the geyser and to the southeast, as is the case with the magnetic anomaly mentioned previously, or it could represent the thickness of valley fill in this area.

The seismic refraction lines have mapped seismic velocity interfaces in the valley near Calistoga. Some of the seismic layers detected can be identified (for example alluvium above the water table and Franciscan basement rocks), but others will only be identified if the units can be recognized in future drill holes in the area. Judging from the seismic results, the basement rocks become deeper toward the southwest in the valley. There is also evidence for faults on some of the seismic sections. In some examples, these fault zones and those suggested by resistivity data, might be related to the apparent boundaries of the geothermal field.

The basic geophysical data used in this report are available on request from the California Division of Mines and Geology, 2815 "O" Street, Sacramento, California 95816.

SHALLOW HOLE TEMPERATURE SURVEY

During the course of geothermal studies at Calistoga, it was decided that combined testing of the microacoustic and shallow temperature probe techniques should be carried out. Both techniques require that a probe hole, approximately six feet deep, be provided for each test site. Holes drilled were used alternately for temperature and then for acoustic probes. So far, the microacoustic method has not yielded conclusive results.

There are several accounts in the literature of the successful use of shallow temperature probes to better define the location of geothermal resource at depth (Chaturvedi, 1977; LeSchack and others, 1978). In theory and in favorable situations in practice, it is possible to take very precise temperature readings in a group of shallow (6 feet or 2 meter) holes, drilled on a grid pattern, to develop a shallow temperature variation pattern that will correspond very favorably with the temperature pattern at depth. Magnitude of the variations is greatly subdued near the surface and, for that reason, a precision temparature reading device, which permits the user to detect small incremental differences, is required. A map, developed by drawing contours on the shallow temperature measurement points, will often reflect areas of highest heat in the deeper subsurface and can be helpful in selecting a drill site to tap a potential geothermal resource. The big advantage in using this technique, as compared to many others, lies in its relatively low cost. In most cases, use is made of accurately calibrated thermistors that are placed in the earth, in drill holes, and allowed to stabilize for a period of time, sometimes over night, before the readings are taken. Corrections are applied for such variables as large differences in elevation, local topographic variation, diurnal variations, albedo, differences in soil moisture, roughness, etc. (see LeShack and others, 1978).

The northern part of Calistoga has provided a unique testing situation for the method because of the occurrence of very shallow groundwater (4-9 feet) under slight artesian pressure. Test holes augered to the water table first transmit a hissing sound, indicating gas escaping from the top of the water surface; this is followed by a quiet flow of water into the hole.

The heat probe used in these tests consists of a carefully calibrated thermistor that was fixed to protrude approximately 1 inch (2.5 cm) from the bottom of a 6.5 foot length of 1/2 inch PVC pipe. The thermistor and the end of the pipe were covered with a thin rubber membrane (baloon) that provided a water-tight cover, but still provided maximum surface and heat contact with the surrounding medium by "collapsing" around the thermistor when the probe is immersed in water or loose soil. Thermistor leads were fed through the pipe to the surface where they could be attached to the read-out instrument, a Simpson 460D, series 3, meter. Readings were taken with the thermistor immersed in water or in loose soil at the bottom of the hole. The top of the probe pipe was plugged with clay. For readings in dry holes, backfill made up of material removed from the hole during excavation and protected from heat or drying, was placed back in the hole around the outside of the probe near the sensor to provide good heat coupling. Time was then allowed for temperature stabilization. For this study, corrections for elevation, topography, albedo, etc. were not considered necessary because all sites were on flat ground with nearly identical characteristics.

Temperature probe stabilization was tested in the Calistoga area both above and below the water table. Results show that stabilization is nearly complete, in a two meter hole above the water table, in approximately 35 minutes. Stabilization below the water table is much more rapid and is complete in only a few minutes. For purposes of the testing performed at Calistoga, readings were taken at several time intervals leading up to stabilization at 35 minutes which was considered a standard reading point. Final readings were taken for each station at double the required stabilization time, or about 70 minutes. No evidence of groundwater movement of the near surface waters was noted with the possible exception of the easternmost station (6.60). In that one instance, a small fluctuation of temperature readings was noted toward the end of the testing period, after about two hours.

In general, the results obtained using the shallow temperature probe method agree extremely well with those obtained using the well-established resistivity technique. Figure 15 shows the preliminary contour map developed as a result of shallow temperature work performed by CDMG in the Bennett Lane area of Calistoga. The cross section is a reduced version of the resistivity profile (described elsewhere in this report) developed by CDMG using new data from readings taken along Bennett Lane. The zone of highest heat, as

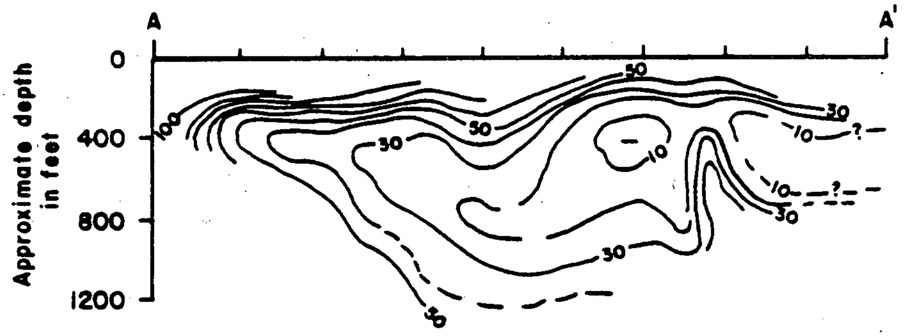


FIG. 15-A Resistivity section along Bennett Lane, Section A-A'. Contours are in ohm-feet.

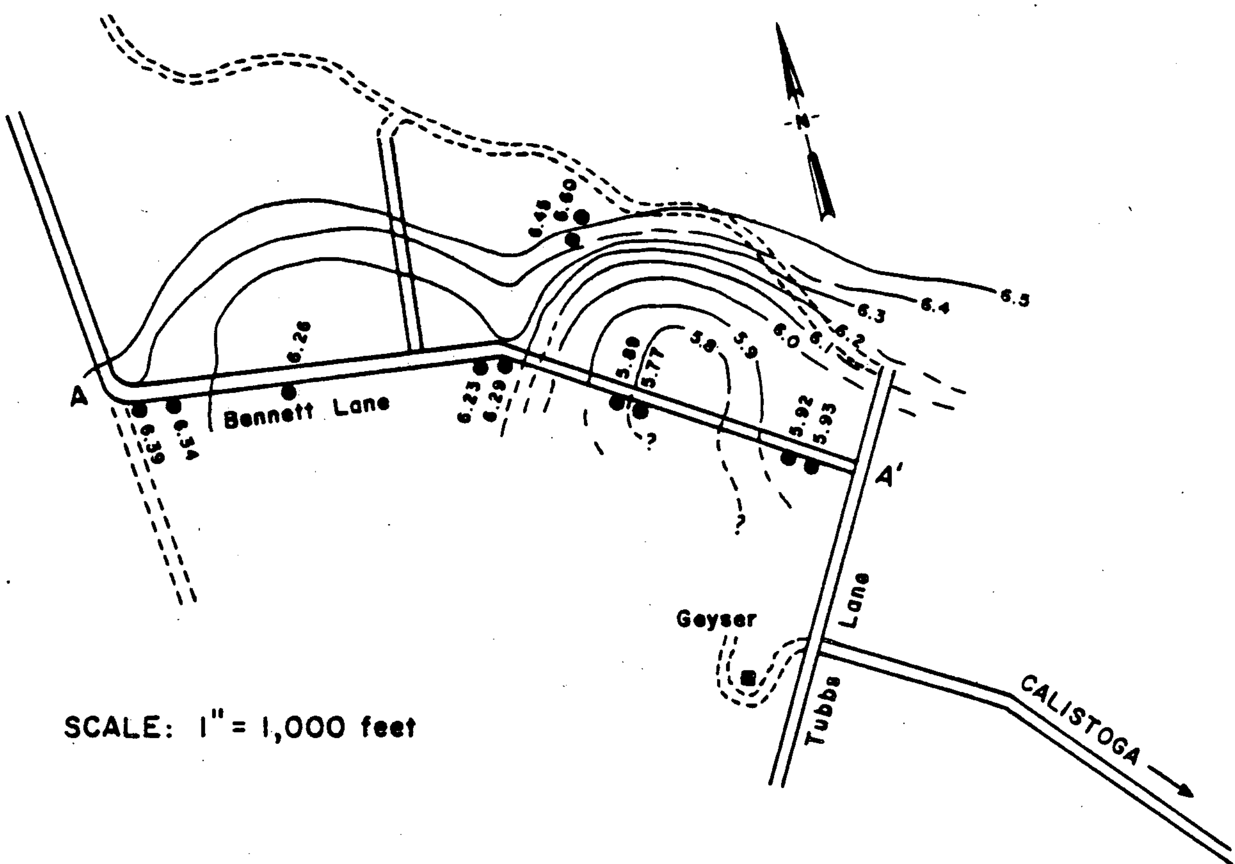


FIG. 15-B Shallow temperature thermistor reading contour map, Bennett Lane vicinity, Calistoga. Contour numbers represent thousands of ohms. (162.5 Ω = 1° C)

FIGURE 15 SHALLOW TEMPERATURE THERMISTOR READINGS COMPARED TO RESISTIVITY RESULTS -- BENNETT LANE AREA

Decreasing numbers in each figure are indicative of higher temperatures or the effects of higher temperatures.

BY: C. F. BACON

indicated in both the temperature map and the resistivity section, lies between the Bennett Lane midpoint curve and Tubbs Lane. A second area with high heat lies west of the curve. Notice that the higher heat zones outlined on the temperature probe map (indicated by lower probe resistance) coincide very well with the low resistivity areas depicted on the resistivity profile. Because the effects of heat are known to cause a lowering of resistivity of the rocks in a thermal area, these two methods provide corroborative results.

The study here described has been a test study to determine the usefulness of the shallow temperature probe method. Although the area studied has turned out to be a special case because of shallow ground water, testing done, both above and below the water table in the area, has shown that results in the two situations are comparable. The effect of a stable body of groundwater in the near subsurface is believed to have a masking effect on the amount of variation in temperature that would be measurable near the surface due to deep subsurface temperature variations. Nevertheless, small lateral variations in temperature are measurable and are believed to be significant in reflecting deep seated temperature variation. The method is therefore planned for extensive use in CDMG's further studies of low and moderate temperature geothermal resource areas.

HYDROLOGY AND GROUNDWATER QUALITY AND ITS RELATION TO GEOLOGIC STRUCTURE AND FORMATIONS AND TO RESOURCE ASSESSMENT

Locations and Extent of Study Area

Two hundred and six water wells were sampled by CDMG in the upper part of Napa Valley surrounding the town of Calistoga. That part of the basin of interest to this study included an area bounded by Bennett Lane and its intersection with Highway 128 on the northwest to Larkmead Avenue on the southeast.

Purpose and Scope

The purpose of this study is to assess the occurrence and quality of ground water in the upper Napa Valley basin and relate the occurrence of waters of particular quality and temperature to geologic formations and structure in the area. Both literature sources (Barnes, 1970; White, Barnes, and O'Neil, 1973; White, 1957a and 1957b) and water-quality data (Faye, 1973; Bader and Svitek, 1973) from the Napa Valley Area indicate that sodium-chloride and sodium-bicarbonate waters are associated with faulting. The association of faulting with ground waters of particular quality provides a mechanism for extrapolating faults into areas where the underlying geology is not readily apparent but where sufficient water-quality data are available. Similar hypothetical extensions can be made with respect to ground waters associated with particular formations whereby formational waters with differing chemical constituents can be used in defining structural boundaries and/or source area limits. In the Calistoga area, the occurrence of sodium-chloride and sodium-bicarbonate waters was used to detect faults in older rocks which underlie undisturbed alluvial deposits of Holocene age, and the existence of the magnesium-bicarbonate water was used to detect ultramafic rocks at depth.

Several investigators (Waring, 1915, Kunkel and Upson, 1960, and Faye, 1975) have suggested that the occurrence of hydrothermal waters in the Calistoga area has been associated with and/or controlled by faulting. Generally, all hot water wells in the Calistoga area have a high sodium chloride content. Barnes (1970) describes water containing high concentrations of sodium, chloride, bicarbonate, and boron ions that issues from springs along known or inferred fault zones in the western Coast Ranges of North America. In northern Napa Valley, a chemical analysis of water from Napa Soda Springs indicates the occurrence of sodium chloride water. The springs issue from orifices along the inferred strike of the Soda Creek fault. Sterns, Sterns, and Waring (1937) also implied an association between faults and the occurrence of hot springs in the Calistoga area.

As has been noted, flowing wells in the Calistoga area are with few exceptions, hydrothermal and yield sodium chloride water. Considering the relation of silica solubility to water temperature (Fournier and Rowe, 1966), it is possible that hot sodium chloride water, rising from depth, along faults mixes with downward-percolating cooler water causing the precipitation of silica and the subsequent cementation of material at the mixing interface. White, Muffler, and Truesdell (1971) indicate that such "self-sealing" phenomena are common in hot-water dominated hydrothermal systems with temperatures in excess of 150°C (302°F). Such activity, taking place over an area of several square miles, could produce a zone of relatively impermeable material that would confine sodium chloride water under a potentiometric head.

The scope of this study includes the tabulation (Appendix A) and preliminary geologic and ground-water quality data for the Calistoga area. A second separately funded study, currently in progress, will utilize water chemistry data in a concerted effort to help delineate subsurface geologic formations and structures. A preliminary map (Figure 16) and commentary on some of the findings from that study are presented here. A separate final report on the results of that study will be presented to DOE upon completion.

Previous Work

Waring (1915) cataloged the various hot springs and "health resorts" located in the study area in the early 1900's. More comprehensive water-resources studies were completed by Bryan (1932), Kunkel and Upson (1960), Bader and Svitek (1973), and Berkstresser (1968). Regional investigations of ground-water quality, containing data and conclusions pertinent to the Napa Valley area, include Barnes (1970), Barnes and O'Neil (1970), Roberson and Whitehall (1961), White (1957a and 1957b), White, Hem and Waring (1963), White, Muffler and Truesdell (1971), White, Barnes and O'Neil (1973), and Garrison (1972).

Faye (1973) developed a digital computer model of ground-water flow through the alluvium in northern Napa Valley and investigated the quality of ground water relative to irrigaton and domestic supplies. Faye (1975, unpublished thesis) also attempted to correlate ground water quality to geologic formations and structure in the Napa Valley. Lack of an adequate water-well data base prevented the validation of Faye's study (Faye, 1980 pers. Communication) and this current geochemical study is an extension of Faye's work.

Ultramafic Rocks, Franciscan Formation, and Sedimentary Rocks of Cretaceous Age

The ultramafic rocks, Franciscan Formation, and the sedimentary Cretaceous rocks are saturated below the water table, but yield very little water to wells. This restricted ability to yield water to wells results from a very low average hydraulic conductivity which, for these rocks, is probably in the order of 10^{-4} fpd (feet per day) or less (Faye, 1973). Ground water flow patterns in these units generally conform to the topographic slopes except where interrupted by faults or other barriers that impede ground-water movement. The few well records available indicate that confined conditions occur locally within this group of rocks (Faye, 1973).

Sonoma Volcanics

The tuff breccia, scoriaceous material, and sedimentary deposits that compose a relatively small part of the Sonoma Volcanics generally are more permeable than the older ultramafic, Franciscan, and sedimentary Cretaceous Rocks and yield, on the average, greater quantities of water to wells. The hydraulic conductivity of the breccia, scoria, and sedimentary deposits is probably on the order of 10^{-2} to 10^{-3} fpd. Other units of the Sonoma Volcanics, most notably the andesitic, basaltic, and rhyolitic flow rocks and the hydrothermally altered material, yield little water to wells and probably have a hydraulic conductivity on the order of 10^{-4} fpd or less (Faye, 1973).

Water in the Sonoma Volcanics commonly is confined, though few wells penetrating this unit actually flow at land surface. Of the wells that do flow, most are located in the Calistoga area, and the majority of these discharge hydrothermal water. Density differences between the hydrothermal water and the cooler ground water are caused by high subsurface temperatures and pressures and probably contribute to the upward movement of hydrothermal water and to the potentiometric heads observed at flowing, hot water wells and "geyser" wells in the Calistoga area. On the other hand, the relation of depth to the occurrence of confined hydrothermal water in wells in the

Calistoga area suggests that the occurrence of hydrothermal water may be associated with a confining zone. The fact that flowing wells, discharging hydrothermal water, occur in the project area is probably due to the combined influence of a local confining zone and the geothermally induced density differences of ground water (Faye, 1973).

Alluvium

The alluvium is by far the best aquifer in the project area and is locally capable of providing water to wells at rates of more than 3,000 gpm. The average hydraulic conductivity of the alluvium, as determined from drillers' logs and from specific-capacity data ranges from 10 to more than 100 fpd, depending on the percentage of sand and gravel in the alluvial deposits. The distribution of sand and gravel is irregular and variable, but the average values of hydraulic conductivity follow a general pattern; hydraulic conductivity increases from north to south and from the peripheries of the valley toward the Napa River. Thus, along any section that crosses the valley, the average hydraulic conductivity near the Napa River is virtually always the highest, and ranges from approximately 40 fpd near Calistoga to more than 110 fpd near Oak Knoll Avenue (Faye, 1973).

Except for small localized areas of semiconfinement, water in the alluvium is unconfined and moves under a natural hydraulic gradient that conforms in a general way to the surface topography.

The thickness of the alluvium increases progressively from north to south, and from the periphery of the valley toward the Napa River. Recharge to the alluvium occurs by infiltration of rain, percolation from streams, and subsurface inflow from older rocks. Discharge from the alluvium occurs by evapotranspiration, ground-water flow to the Napa River, pumping of wells, and subsurface outflow across the southern boundary of the project area.

Relationship of Water Chemistry to Structure

As mentioned previously, several studies have suggested that there is a relation between faulting and the occurrence of hydrothermal waters in the Calistoga area.

Faye (1973) suggests that sodium-chloride water may be associated with faults. Barnes (1970) indicates that similar waters in the Western Coast Ranges "are found issuing from known or inferred faults." White, Muffler, and Truesdell (1971) state that hot-water systems dominated by sodium-chloride type waters "are usually found in permeable sedimentary volcanic rocks and in competent rocks such as granite that can maintain open channels along faults or fractures."

Faye, (1975) presented data to support the hypothesis that "Sodium-chloride, sodium-bicarbonate, and related type water were associated with faulting in the Napa Valley area and this relationship was further supported by the lack of association of both sodium-chloride and sodium-bicarbonate waters with any one particular geologic formation or unit. Faye (1975) concluded that his preliminary water chemistry data suggests the occurrence of a major fault down the topographic axis of the Napa Valley.

CDMG has undertaken to perform a detailed water sampling program in the Calistoga area in the upper Napa Valley. A major reason for conducting the program is to see if a correlation exists, as Faye and others have hypothesized, between water quality and structure. We are interested in learning the extent of the controls on the occurrence of hydrothermal fluids. The detailed water analysis will not be completed until the data from the CDMG Calistoga drilling program is available. By combining the information obtained from drilling and testing the series of strategically placed drill holes with information gleaned from the sampling of 206 water wells in the area, a series of maps will be prepared with contours drawn on chemical constituents in the waters. It is expected that water barriers between different water types, such as those created by faults in the subsurface, will become apparent from these maps. These maps will be completed and presented in the final adendum to this report on the work in the Calistoga area, expected to be completed in early 1981.

Preliminary Interpretation of Water Well Chemistry Data

The information presented in this subsection represents some preliminary results obtained from a separately funded ongoing study of the geochemistry of water samples taken from wells in the Calistoga area. A more complete account of the results of the geochemical study is planned for the addendum to this report to be submitted upon completion of CDMG's drilling program.

The 206 water wells sampled in Calistoga were plotted on an enlarged 7 1/2' base of the area. Overlays of various chemical constituents were made; of particular interest were calcium, magnesium, sodium, and bicarbonate. These individual overlays were plotted in parts per million and contoured using 10 to 25 ppm contour intervals dependant upon the range of values for each chemical constituent.

Calcium - Values ranged from a low of 1 ppm to 234 ppm and were contoured on a 10 ppm interval. Data show a broad linear trend parallel with the axis of the valley with higher values associated with the Northeast side of the valley versus the Southwest side. Higher values are associated with known hot water, which is to be expected, but data do tend to indicate a split coincident with the valley axis.

Sodium - Values ranged from 0 to 282 ppm and were contoured on a 50 ppm interval. Data show linear highs associated with the northeastern side of Napa Valley. Again, sodium values are related to water temperature but an interpretaion of a ground water barrier is warranted, coincident with the axial trend of the valley. Sodium highs are concentrated around known hot water wells, but the sharp falloff of sodium values toward the valley margins could be indicative of a relatively linear source for the hot water, such as upwelling along a fault, with little outward migration.

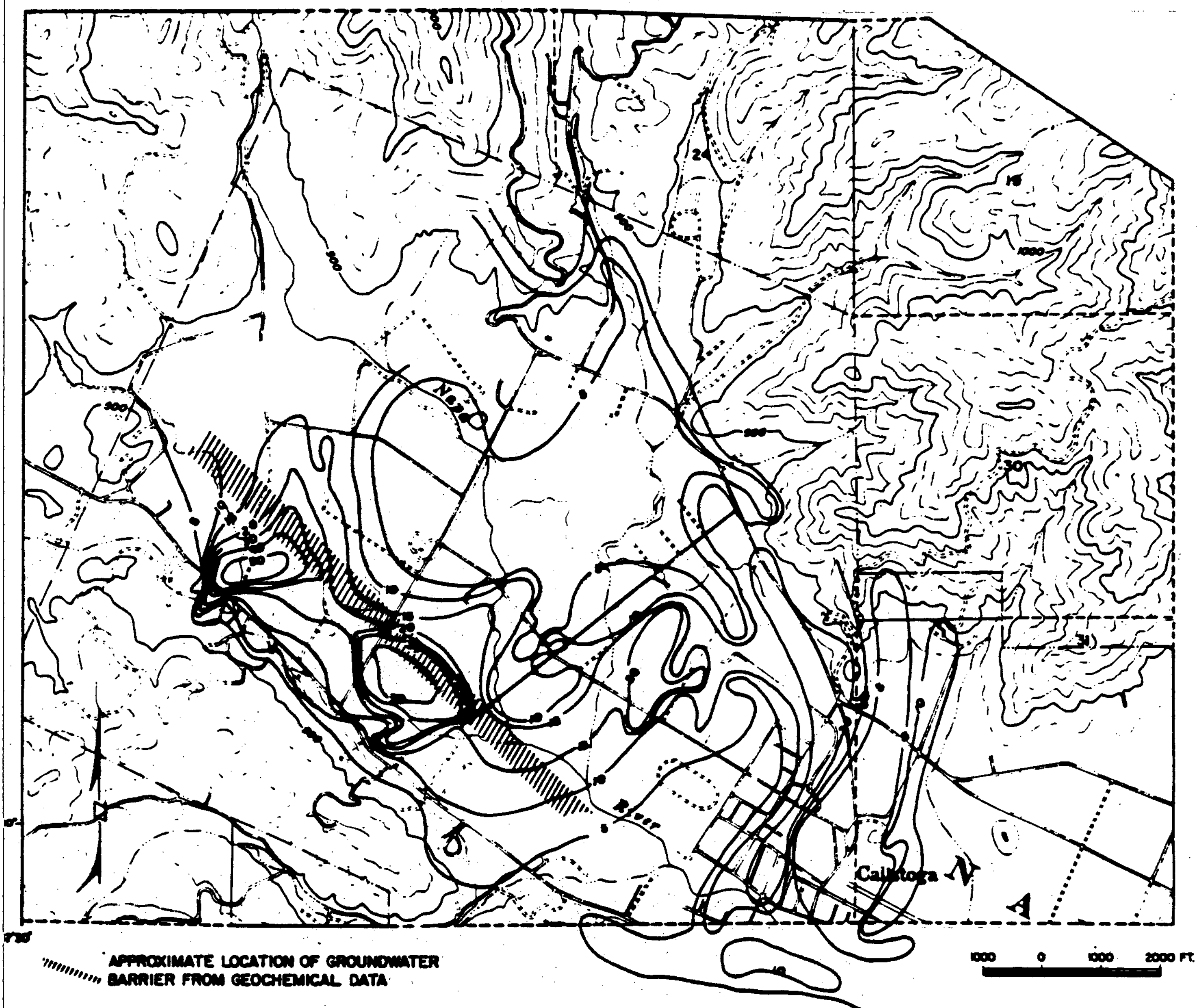
Magnesium - Bicarbonate - These two chemical constituents were individually contoured, but are combined in this discussion because typically Mg-HCO are not temperature dependant but probably are indicative of water source. The Mg overlay (Figure 16) shows a very sharp linear high associated with the southwest side of the valley and a sharp abrupt break in values approximately coincident with a geophysical anomally discovered in a SW-NE traverse along Tubbs Lane.

Barnes & O'Neil (1969) associated magnesium-bicarbonate water in the Coast Ranges with serpentine and ultramafic rocks. Thus, the Mg high depicted on Figure 16 probably represents water that has its source in or in contact with ultramafic rocks underlying the Sonoma Tuff. This high Mg water could indicate: (1) ultramafic rocks localized at a shallow depth along the north part of the southwestern side of the valley, (2) water has its source to the northwest and has picked up Mg content by downslope movement toward the valley. Either way, the localized Mg anomaly tends to support a groundwater barrier, structural or lithologic, between the high Mg content waters and the aquifers lying along the central and northeastern side of the valley.

Preliminary analysis of the water well geochemistry data seems to indicate several common trends between individual constituents. In particular, both calcium and sodium show a broad linear trend associated with the northeastern side of the valley and coincident with known wells producing hot water. This anomaly is to be expected, but interestingly both show a rapid decrease in concentration toward the northeastern margin of the valley coincident with a more general, but still significant, drop in concentration along the southwestern margin of the valley. The rapid decrease along the northeastern margin may help define the hot water resource boundary, as being indicative of a relatively narrowly confined source (that is, a fault). With a narrow linear conduit within the valley, one would not expect much migration upslope against a groundwater surface flowing from Northeast to Southwest toward the Napa River.

Additionally, linear trends between water type ($Mg-HCO_3$) and mineral assemblages (Na-Ca) contours show a common spatial discontinuity along the southwest side of the valley that may define the southwestern margin of a hot water resource basin.

In addition to the preliminary maps showing the plots of contours of chemical constituents in the waters, several preliminary overlay maps were made showing outlines of areas containing waters predominantly of one or another of four regimes. These include: sodium bicarbonate, sodium chloride, calcium bicarbonate, and magnesium calcium bicarbonate. Results



PRELIMINARY CONTOUR MAP SHOWING MAGNESIUM CONTENT IN GROUNDWATER FOR THE CALISTOGA STUDY AREA

(CONTOURS IN PARTS PER MILLION OF MAGNESIUM)

By G. C. Taylor

FIGURE 16

from these plots again show strong linear trends--and linear boundaries between water types--that parallel the axis of the valley. This further supports the concept that subsurface water barriers are present within the valley and that they most likely are fault controlled. In addition to an anomally with a trend and location similar to the one shown in Figure 16, these preliminary plots also show a major boundary marking the break between waters of different chemical constituents that trends northwest-southeast approximately along the center of the valley.

Interestingly, the very pronounced breaks seem to occur in the deeper waters between the 150 and 200 feet depth levels. Plots attempted for waters at shallower depths, 50-100 feet, do not clearly show large, well defined zones, but rather smaller randomly located and oriented zones. This fact also tends to support the idea of major concentrations of waters of certain chemical types welling up along faults in the deeper subsurface where they are also separated by fault related barriers. The near surface waters are apparently diffused and may be intermixing so that no major well-defined zones are apparent.

Also present on some of the preliminary overlay maps are relatively sharp boundaries or sharp changes in contours that trend roughly normal to the axis of the valley. These are not as continuous or as prominent as are the trends that parallel the axis of the valley, but they are strong enough and sharp enough to be interpreted as probably associated with cross cutting faults. Such a trend can be seen on the sample map of Figure 16 near the center of the map and beginning just southeast of the sharp drop off in magnesium content contours. The trend is northeastward from that area.

It appears from this study that the subsurface in the Calistoga valley area is "partitioned off" by a series of water barriers that trend both parallel to and approximately normal to the axis of the valley. These barriers, in at least some of the instances, are approximately coincident with breaks in geophysical lines, where these are intersected--which strongly suggests that the barriers may represent the locations of faults not readily recognized at the surface. This may help explain why wells in certain locations in the main Calistoga resource area fail to produce useful amounts of hot water, while others nearby flow artesian in large quantity.

It also appears that the chemical analyses can help provide information from which to delineate the margins of the thermal area. The rapid drop off of sodium and calcium that coincides well with the boundaries of the hot water reservoir have, in this preliminary study provided such corroborative information. Although these data are preliminary and from an ongoing separate study, results so far indicate that the geochemical techniques here described can be a powerful tool in the study of a geothermal area. A more complete analysis of the results of our study will be available for inclusion in the adendum to this report planned for submittal after completion of CDMG's drilling program.

In summary, from our preliminary results, it appears that in geothermal areas such as Calistoga, where a strong water well data base is available, it is profitable to perform geochemical analyses similar to those described above to locate water barriers that can represent the locations of subsurface faults or structures, and to delineate the boundaries of the resource area.

GEOCHEMISTRY

Introduction

In the exploration for geothermal fields, geochemistry plays a most important role among the branches of the geological sciences. The primary consideration in the development of a geothermal system is the temperature, size, and type of thermal reservoir. The chemical composition of a thermal water provides the only indirect means of quantitatively estimating the temperature of the thermal reservoir and determining the type of thermal system. The concentrations of silicon, sodium, potassium, calcium, and magnesium (for correctional purposes) in thermal waters indicate the temperature at which the water was last in equilibrium with rock in the thermal reservoir.

Early in the investigaton of Calistoga's geothermal resource, California Division of Mines and Geology (CDMG) found that there were many "hot water" wells in an approximately 5-6 square mile area. It was estimated that as many as 100 hot water wells had been drilled there. Calistoga appeared to be a near ideal location to apply geochemical techniques to discover properties of the geothermal resource.

CDMG decided that a door-to-door canvassing of well owners would be the most efficient and productive way to discover and sample geothermal wells in the area. California Division of Oil and Gas (CDOG) also had an interest in a water well survey at Calistoga. A cooperative joint study was initiated. CDOG provided most of the field team for the project.

The field team began the well sampling survey at Calistoga in early March 1980. Sampling continued intermittently for the next three months. A set of goals for the water well sampling project was established:

1. Determine the mineralogical water quality of fresh and geothermal aquifers at Calistoga.
2. Establish the extent of the geothermal reservoir.
3. Determine temperatures of aquifers via direct measurement and geothermal analysis.
4. Determine reservoir relationship to subsurface geology and hydrology.

Sufficient funds were not available in the Department of Energy (DOE) supported Low and Moderate Temperature Geothermal Resources of California project, therefore, the geochemical water well survey was proposed as a complement to the DOE supported project

In this report, the intention is to give an account of the number of wells sampled, the special sampling, filtering, and preservation techniques used, the temperature measuring methods employed at Calistoga, and the details of th analytical techniques used. Some of the detailed interpretations of the chemical analysis and the geothermometrical calculations are reported here; others will be reported at a later date.

A total of 206 water wells were sampled in the Calistoga area. One hundred forty-two of the sampled wells had measured temperatures of less than 25°C, 40 of the wells had temperature measurements between 25° - 50°C, and 24 wells had measured temperatures over 50°C. Plate 10 shows the location of the sampled wells. Wells and associated chemical analyses were assigned sequential reference numbers from G-001-80 to G-206-80. The reference numbers have no significance other than the sequence in which the wells were sampled. Note that only the central portion of each reference number appears on Plate 10 i.e. the numbers 001-206.

Plate 12 is a compilation of locations of 133 "hot water" wells around Calistoga. Sources of well location information include the CDMG's water swell survey, published and unpublished literature, and a down hole temperature survey by Occidental Geothermal, Inc.

It is very difficult to define the term "hot" in low and moderate temperature geothermal resource areas. For the sake of simplification, 25°C was chosen as the temperature limit at Calistoga, above which a water well is labeled "warm" or "hot".*

*Note: For the purpose of preparing Geothermal Resources Map of California, CDMG has chosen 20°C as the starting temperature for warm water. But, in practice, at Calistoga, CDMG found that a 20°-22°C temperature is easily reached by water in metal pressure tanks standing in the sun. Therefore, a starting "warm" temperature threshold of 20°C would be misleading. Hence, 25°C has arbitrarily been chosen as the cutoff point for a geothermal well for the purpose of this investigation only.

Sampling Technique

The purpose of sampling geothermal waters is to determine all the properties of the water in a natural state. Some of the constituents in these fluids are unstable and change with time. Unique problems are encountered because of this instability and/or high concentrations of some constituents. For example (a) silica may occur at concentrations up to several hundred ppm (parts per million). Therefore, silica may polymerize during sample storage and not react with molybdate color-forming reagents (while analyzing for silica) or precipitate with concurrent loss of coprecipitating elements; (b) As^{+3}, Fe^{+2} and other variable valence ions may be rapidly oxidized upon aeration at elevated temperatures, in which case valence species determinations would be precluded; (c) sulfides may be oxidized rapidly by dissolved oxygen; (d) H_2S gas is unstable in the presence of moisture, oxygen, and to a lesser extent, ultraviolet light; (e) pH may rise rapidly (up to two orders of magnitude) due to exsolution of dissolved CO_2, or decrease due to CO_2 uptake or H_2S oxidation.

Because of the instability of the dissolved constituents of geothermal fluids, immediate filtration of the hot water is necessary without allowing degassing of waters supersaturated with CO_2.

$H^+ + HCO_3^- \qquad H_2O + CO_2$

Thus, the main changes in the geothermal samples result from loss of carbon dioxide, oxidation of hydrogen sulfide and ammonia, oxidation and precipitation of arsenic, iron, and manganese, loss of calcium ion as calcium carbonate precipitates, and precipitation of silica. The danger is always with precipitation. Once precipitates are formed, there is no way to restore the initial composition of the sample.

Plastic bottles used for sampling are permeable to oxygen, which is evidenced by continuous oxidation of iron from the ferrous to the ferric state. They are also permeable to hydrogen sulfide, which is evidenced by the smell in the storage cabinets. Some constituents like sodium, potassium, and chloride are stable but many more are unstable (pH, iron, manganese, arsenic, carbonate, bicarbonate, ammonia, hydrogen sulfide, calcium and sulfate) and therefore one or more preservation techniques are used. Plastic bottles are used in this study only because of convenience.

As Presser and Barnes (1974) suggest, the information needed for a particular study and the desired accuracy should be established first and then appropriate sampling techniques should be selected.

Before using the plastic bottles for sampling, they were first soaked for a week in 10% nitric acid and then soaked for a week in deionized distilled water.

Special plastic plexiglass filters were manufactured after the design obtained from U.S. Geological Survey, Menlo Park. A 0.45 micrometer Gelman, 90 mm diameter membrane filter, was used to filter the samples in conjunction with air pressure from a bicycle pump. The filter was rinsed with distilled deionized water immediately prior to use. The plastic bottles were rinsed first with the filtered sample and then the filtered sample was collected.

The water sample collected at each site was sub-divided into four separate bottles: one 125 ml filtered nonacidified for chloride and fluoride determination; one 250 ml filtered nonacidified sample for carbonate, bicarbonate, and total dissolved solids (T.D.S.) determination; and one 125 ml filtered acidified (1 ml Hcl in 125 ml sample) for sulfate determination.

Field Analysis

Temperature measurements were obtained with either a total immersion, maximum reading, mercury-in-glass thermometer or with a conventional mercury-in-glass thermometer. In most of the cases, pipes coming out of wells were directly connected to pressure tanks next to the well-heads.

Because there is no other feasible way to sample, water was taken from these pressure tanks. Water was allowed to flow for considerable time after water pumps were started. When we were sure of sufficient water being allowed to flow freely, a clean one-gallon plastic sample bottle was filled after rinsing several times with the sample water. Then the temperature of water was measured at the mouth of the faucet while water was running out. In some cases, a temperature-probe, manufactured by Gisco-Keck Geophysical Instruments (#DR-789 Digital Temperature Meter), was used for determining the down hole temperature measurements. In very few cases, where we could not sample the water, we took the owner's word for the temperature or relied on the published and unpublished literature.

An "Ionalyzer" specific ion meter model 407-A, manufactured by Orion Research, was used to measure pH of the water samples. The meter was calibrated with pH buffers 7 and 4. Batteries of the meter were charged every alternate day so that no fluctuations in reading could occur. A combination pH electrode was used for pH measurement. It was cleaned with deionized distilled water before and after its use.

Salinity and conductivity were measured with the S-C-T (salinity-conductivity-temperature) meter, model 33, manufactured by Yellow Springs Instrument Co. Salinity measurements are manually temperature compensated by direct dial. Conductivity measurements are not temperature compensated; however, a temperature function is provided on the instrument to aid with calculation of corrections. Salinity is expressed in percent (%)

and conductivity as micromhos/centimeter (umhos/cm). Conductivity measurements are the electrical conductance the sample would show if measured between opposite faces of a 1 cm cube. Salinity is the number of grams of salt per kilogram of sample. Zero of the S-C-T meter is adjusted first and then the meter is calibrated before taking the reading by turning the Mode control to Redline and adjusting the Redline control so that the meter needle lines up with the red line on the meter dial. Readings are taken after plugging the probe into the probe jack on the side of the instrument and putting the probe in the sample to be measured.

Chloride concentration was determined semiquantitatively in the field with the help of "Quantab" chloride titrator tabs.

Laboratory Analysis

The results of field and laboratory analyses are presented in Appendix-A. All of the cation analyses were done by Inductively Coupled Plasma Spectrometer at the Earth Science Laboratory of the University of Utah Research Institute (UURI) at Salt Lake City. UURI also analyzed two anions - chloride (Cl^-) and fluoride (F^-).

Chloride was determined by the Mohr titration method. In a neutral or slightly alkaline solution, potassium chromate indicates the end point of the silver nitrate titration of chloride (also known as Argentometric analysis). Silver chloride is quantitatively precipitated before red silver chromate is formed. Chloride was also determined in the field. The comparison of the results obtained by both methods is in progress and will be given in the second and final part of the report.

Fluoride was determined by a specific ion meter manufactured by Orion Research, using the fluoride combination electrode by the method of addition using Total Ionic Strength Adjustor Base (TISAB).

Carbonate, bicarbonate, sulfate and total dissolved solids (TDS) were determined at the Geochemical Laboratory of the Division of Mines and Geology at San Francisco.

Carbonate and bicarbonate were determined by titration of an acid titrant using phenolphthalein as an indicator for carbonate and methyl orange for bicarbonate.

Sulfate is dissolved in water from most sedimentary rocks. Most chemists prefer to analyze sulfate in the field. Experience has shown that if the sample is preserved with hydrochloric acid and brought to the laboratory within a week's time and analyzed, accurate analysis for sulfate can be achieved. Five ml of acidified sample was pipeted in a test tube, in which 0-1 gm of barium chloride reagent was added. The test tube was shaken side to side until solution was complete. The reaction was allowed to proceed for 5 to 10 minutes (never more than 10 minutes) until barium chloride was in solution. If the sulfate ion is present, white precipitates form. The precipitates in suspension were transferred into a silica or quartz cell and absorbance was determined at 420 mu wavelength in a spectrophotometer. A standard working curve was prepared by treating various sulfate standards with barium chloride and reading the absorbance of the white suspended precipitates and plotting concentration against absorbance. Using this working curve, the sample absorbance readings were converted to ppm (parts per million) values.

Theoretically, dissolved solids are anhydrous residuals of the dissolved substances in water. But in practice, the term "dissolved solids" is not an accurate measure of the weight of substances in solution. The total disolved solids were determined by calculations. Results obtained via calculation methods pose a problem, when compared with results obtained by the "residue-on-evaporation" method. In the "residue-on-evaporation" method, the bicarbonate is converted to carbonate in the evaporation and drying process and thus the amount of TDS determined by the "residue-on-evaporation" method is always less than those determined by "calculation" method. To check the accuracy of our calculation method, sixty samples were also analyzed by the "residue-on-evaporation" method. Results of TDS by both methods do not compare well unless recalculation for bicarbonate reconversion to carbonate is taken into consideration.

On the basis of the amount of bicarbonate present in the sample, corrections were made and the corrected values are given in Appendix A.

$$(\text{Specific Conductance}) \times (0,65 \pm 0.1) = \text{TDS}$$

From the above formula, constants were calculated for all water samples, but the result was different in all cases and was never a constant, 0.65 ± 0.1. The total dissolved solids values were checked by two different methods and are correct. Therefore, it is concluded that the meter with which the specific conductance and salinity were determined, was not accurate.

The conclusions to be derived from the geochemistry are those given in the section on Interpretation and Integration, in Table 4 concerning geothermometric temperatures, and those given in the section on Hydrology and Groundwater concerning preliminary results in the use of geochemical overlay maps to determine the location of groundwater barriers and fault structure and to help delimit the boundaries of the hot water reservoir. The reader is referred to those sections for a complete discussion of the respective conclusions.

CALISTOGA 15 MINUTE QUADRANGLE SEISMICITY

It is widely recognized that seismic activity is often high in and around the major geothermal areas of the world and that, in some geothermal areas, there is a direct correlation between seismic activity and fluid withdrawal. The monitoring of seismic noise associated with geothermal areas has also been used as a tool for geothermal resource exploration.

To evaluate the regional pattern of seismic activity around Calistoga and to ascertain if the seismic activity bore any relationship to the moderate-temperature geothermal resource, all seismic events since 1800 were computer plotted for the Calistoga 15 minute quadrangle. Seismic data used for computer plotting were obtained from the California Division of Mines and Geology (CDMG) Earthquake Catalog System.

Sixty-eight events have been recorded for the Calistoga 15 minute quadrangle. Fifty events were computer plotted. The system does not allow "overprints". Therefore, only one of several events (the largest) occurring at the same coordinates, but at different times, is plotted.

Table 2 is a reproduction of the computer listing of all the earthquakes pertinent to the study. The table provides earthquake data on location, time, depth, magnitude, etc. A magnitude (MAG) of 9.99 means that no data were available to determine the actual magnitude of the event.

TABLE 2

TABULATED DATA OF THE EARTHQUAKES THAT HAVE OCCURRED WITHIN THE CALISTOGA 15 MINUTE QUADRANGLE (1800-1974).

CALIFORNIA DIVISION OF MINES AND GEOLOGY
EARTHQUAKE CATALOG SYSTEM

PROGRAM RETRIEVE
VER. CON109H-123

DATE: 06/26/79
REQUEST: 1-A
PAGE: 4

DATA RETRIEVAL REQUEST FOR: EARTHQUAKES CALISTOGA QUAD

	ID NO.	LATITUDE	LONGITUDE	DATE	TIME	DEPTH	QUAL	REF	MAG	REF	INT	REF
	4400042	38.500	122.500	10/17/1942	6 10 0.0	0.0	D	1	9.99	1	0A	006
	4400068	38.500	122.500	10/13/1948	0 23 0.0	0.0	D	1	9.99	1	5C	001
	4400072	38.500	122.500	8/15/1949	23 52 54.0	0.0	D	1	2.20	1	0	
•	4400105	38.500	122.500	8/11/1951	14 15 59.0	0.0		1	2.80	1	0	
*	4400134	38.500	122.650	1/29/1954	7 36 56.0	0.0	C	1	2.80	1	0	
	4400310	38.500	122.700	10/ 2/1969	5 14 21.0	0.0		1	3.10A	001	0	
	4400296	38.500	122.700	12/ 7/1963	12 4 11.6	0.0		1	2.70	1	0	
	4400080	38.500	122.700	11/ 8/1949	12 41 16.0	0.0	D	1	2.50	1	0	
•	4400312	38.500	122.700	10/ 2/1969	7 10 9.0	0.0		1	3.40A	001	0	
*	4400518	38.501	122.723	10/ 9/1973	20 7 43.7	2.7	B	9	2.44	9	0	
*	4400457	38.504	122.706	2/21/1973	6 52 30.4	8.1	C	9	1.74	9	0	
•	4400438	38.504	122.720	11/26/1972	19 20 35.7	7.3	B	9	2.78	9	0	
•	4400390	38.506	122.716	1/17/1972	11 19 56.8	6.0	B	9	1.20	9	0	
*	4400401	38.506	122.719	5/12/1972	18 4 59.1	3.6	C	9	2.52	9	0	
•	4400399	38.506	122.721	5/10/1972	19 49 36.3	5.0	C	9	2.65	9	0A	006
*	4400347	38.508	122.724	4/21/1971	1 28 12.4	5.0	C	9	1.13	9	0	
*	4400446	38.508	122.728	1/11/1973	5 43 34.2	4.0	C	9	1.54	9	0	
*	4400304	38.510	122.700	1/15/1969	4 28 9.0	0.0		1	3.00	1	4C	006
*	4400450	38.511	122.724	1/26/1973	0 44 16.9	5.8	B	9	1.98	9	0	
•	4400555	38.514	122.729	12/21/1973	17 54 34.8	5.1	B	9	1.13	9	0	
•	4400451	38.516	122.727	1/29/1973	14 45 3.6	6.6	B	9	1.68	9	0	
*	4400477	38.517	122.731	6/22/1973	8 50 56.2	3.8	C	9	1.24	9	0	
*	4400340	38.518	122.716	1/30/1971	12 25 18.0	7.6	B	9	0.92	9	0	
*	4400365	38.519	122.715	8/19/1971	10 1 24.0	8.7	B	9	1.15	9	0	
*	4400324	38.519	122.724	8/30/1970	12 41 33.4	5.4	B	9	0.89	009	0	
*	4400283	38.520	122.580	12/ 6/1962	1 41 6.1	0.0	B	1	2.60	1	0	
	4400111	38.520	122.750	11/26/1951	13 21 26.0	0.0	C	1	2.10	1	0A	006
*	4400109	38.520	122.750	11/26/1951	7 21 53.0	0.0	B	1	3.40	1	0A	006
*	4400350	38.522	122.579	5/11/1971	13 24 20.6	5.0	C	9	1.32	009	0	
*	4400431	38.525	122.727	11/15/1972	20 32 39.0	8.4	B	9	1.34	9	0	
	4400166	38.530	122.520	4/ 5/1956	4 29 32.0	0.0	C	1	4.20A	001	0A	006
	4400169	38.530	122.520	4/ 5/1956	4 33 52.0	0.0	C	1	2.70	1	0	
	4400170	38.530	122.520	4/ 5/1956	6 17 49.0	0.0	C	1	2.50	1	0	
	4400167	38.530	122.520	4/ 5/1956	4 32 29.0	0.0	C	1	2.50	1	0	
	4400168	38.530	122.520	4/ 5/1956	4 33 28.0	0.0	C	1	2.30	1	0	
•	4400165	38.530	122.520	4/ 5/1956	4 29 13.0	0.0	B	1	4.40	001	6C	006

CALIFORNIA DIVISION OF MINES AND GEOLOGY
EARTHQUAKE CATALOG SYSTEM

PROGRAM RETRIEVE
VER. CON109H-123

DATE: 06/26/79
REQUEST: 1-A
PAGE: 5

DATA RETRIEVAL REQUEST FOR: EARTHQUAKES CALISTOGA QUAD

	ID NO.	LATITUDE	LONGITUDE	DATE	TIME	DEPTH	QUAL	REF	MAG	REF	INT	REF
*	4400118	38.530	122.620	7/ 9/1952	22 4 48.0	0.0	C	1	2.50	1	0	
*	4400315	38.530	122.670	10/16/1969	18 15 19.1	0.0		1	2.80	1	0	
	4400373	38.530	122.747	10/19/1971	19 17 31.9	5.0	C	9	1.73	9	0	
*	4400422	38.530	122.747	8/ 4/1972	11 40 50.2	5.2	C	9	2.82	9	0	
*	4400470	38.533	122.744	5/14/1973	21 10 42.3	5.0	C	9	1.35	9	0	
*	4400329	38.534	122.746	10/19/1970	8 19 3.8	3.7	C	9	1.48	009	0	
*	4400493	38.544	122.656	8/29/1973	7 39 7.0	5.3	B	9	1.49	009	0	
*	4400160	38.550	122.550	2/14/1956	17 26 28.0	0.0	C	1	2.30	1	0	
*	4400343	38.552	122.609	2/27/1971	11 17 47.9	5.0	D	9	1.98	009	0	
*	4400277	38.570	122.730	2/28/1962	13 40 32.6	11.0	B	1	3.10	001	4C	006
*	4400434	38.574	122.730	11/21/1972	12 23 2.9	2.0	C	9	1.73	009	0	
	4400011	38.580	122.580	9/23/1932	11 45 0.0	0.0	D	1	9.99	1	0A	006
	4400009	38.580	122.580	9/22/1932	20 50 0.0	0.0	D	1	9.99	1	0A	006
*	4400010	38.580	122.580	9/23/1932	7 48 0.0	0.0	D	1	9.99	1	4C	006
	4400071	38.580	122.670	8/14/1949	8 19 58.0	0.0	D	1	2.50	1	0	
*	4400070	38.580	122.670	8/ 9/1949	0 39 27.0	0.0	B	1	3.60	1	0	
*	4400290	38.580	122.720	9/23/1964	16 30 12.9	0.0		1	3.00	1	0	
*	4400490	38.583	122.677	8/25/1973	4 57 35.5	2.0	B	9	1.91	009	0	
*	4400381	38.598	122.609	12/16/1971	1 11 47.5	5.0	D	9	1.79	009	0	
●	4400293	38.600	122.700	10/18/1965	23 19 0.0	0.0		1	3.00	1	0	
●	4400557	38.610	122.650	3/21/1974	21 16 5.3	0.0		1	3.30	1	6C	006
	4400228	38.650	122.730	6/22/1958	6 21 2.0	0.0	C	1	3.20	1	4C	006
*	4400178	38.650	122.730	7/18/1956	23 3 7.0	0.0	A	1	3.50	1	5C	006
*	4400471	38.651	122.703	5/16/1973	15 42 12.4	3.2	D	9	1.95	009	0	
●	4400468	38.660	122.691	4/25/1973	13 24 15.8	0.0	C	9	1.63	009	0	
*	4400351	38.669	122.724	5/19/1971	11 52 59.0	1.3	D	9	1.30	009	0	
●	4400152	38.670	122.550	5/15/1955	21 15 55.0	0.0	B	1	2.80	1	0	
	4400116	38.700	122.700	2/ 9/1952	18 48 12.0	0.0	D	1	2.40	1	0	
*	4400250	38.700	122.700	6/28/1959	7 58 1.0	0.0	D	1	3.40	001	4C	006
*	4400482	38.714	122.739	7/15/1973	3 44 22.8	0.1	D	9	2.32	009	0	
*	4400410	38.717	122.734	6/17/1972	15 52 30.3	4.4	D	9	3.01	009	0	
●	4400495	38.730	122.747	9/ 2/1973	7 35 49.5	3.5	D	9	2.17	009	0	

-------- END OF REQUEST NUMBER 1-A -------- 68 RECORDS SELECTED --------- 50 RECORDS PLOTTED ----------

The CDMG Earthquake Catalog has been compiled from a great many sources of information. Data for the earthquakes recorded in Table 2 have been compiled from three of those sources.

Number	Reference
1	University of California, Berkeley (1976). Magnetic tape catalog of earthquakes in northern California, 1910-1974.
6	U.S. Department of Commerce, Coast and Geodetic Survey, United States Earthquakes, Annual publications, Washington, D.C.
9	U.S. Geological Survey (1976). Magnetic tape catalog of earthquakes in west-central California, 1969-1973.

Prior to about 1969, earthquake events in northern California were recorded primarily by the U.C. Berkeley seismograph network. Then the U.S. Geological Survey sited several instruments in northern California counties. The higher seismograph station density provides better quality data. Hence, epicenter locations recorded post 1969 by the U.S. Geological Survey are of higher quality than events reported earlier.

The quality (QUAL) ratings listed in the table are somewhat arbitrary and are not directly comparable from one source to another. The following key provides the criteria the institutions above use to assign quality judgements. Also, the codes accompanying the magnitude and intensity (INT) values are explained.

Key to Record Parameter Codes

I. Quality of Hypocenter (QUAL)

A. Source: U.C. Berkeley (REF 001)

Epicenter quality is subjective, ranging in quality from high to low as follows:

A - Excellent
B - Good
C - Fair
D - Poor

B. Source: U.S. Geological Survey (REF 009)

	Epicenter	Focal Depth
A - Excellent	1 km	2 km
B - Good	2.5	5
C - Fair	5	5
D - Poor	5	5

II. Type of Magnitude (MAG)

A - Local Richter
B - Surface wave
C - Body wave
D - Local estimated from intensity
E - Local estimated from duration

III. Type if Intensity (INT)

A - No intensity given but felt
B - Rossi-Forel
C - Modified Mercalli

The epicenter locations were manually plotted over the Calistoga 15 minute topographic quadrangle (Plate 11). The data and map are presented with no discussion of analysis at this time.

INTERPRETATION-INTEGRATION AND RESOURCE ASSESSMENT

Interpretation-Integration

This report, as has been mentioned at appropriate points in the preceding sections, was written prior to completion of the California Division of Mines and Geology drilling investigations in the Calistoga area. Of great importance is the data that CDMG expects to obtain from the drilling of up to six geothermal test wells in the upper Napa Valley area at strategic points in and around the City of Calistoga. Drilling of these wells is expected to begin in the Fall of 1980 and should be completed within a three month period. Upon completion of the drilling, the new data obtained, including water test data, pump data, temperature data, and well log information, will be integrated with the data already obtained in the Calistoga studies, and the results will be submitted in the form of a final addendum to this report. The addendum is expected to be available in early 1981.

Among the important results obtained from the studies so far are the conclusions reached about the relative success of the various instrumental techniques. The resistivity method, as shown in this study and in previous studies, is a most useful tool for delineating the geothermal resource. A positive correlation was found between zones of high electrical conductivity and known areas of hot water. In addition, a test using a shallow hole temperature survey over an area where resistivity lines were also run, has shown an excellent correlation of results from the two methods. This is particularly interesting because of the very shallow ground water encountered in the area of the tests--a factor that can be detrimental, under adverse circumstances, to the use of the shallow hole temperature method.

Also of particular importance was the finding that the gravity data indicate the presence of a large low-density structure or mass centered southwest of Calistoga. The discovery of this feature was a direct result of the geophysical exploration done for this project, and so far no other substantiating information has been developed. This structure or mass could include possible zones favorable for geothermal resources, or it could be a source of heat for the geothermal phenomena. If either of these hypotheses is correct, the most favorable zone for possible additional geothermal resource development is located within the negative gravity anomaly generally between the Mark West Springs road, on the northwest, and the Diamond Mountain road, on the southeast. Temperature and temperature gradient measurements in drill holes in this general area could be used to help evaluate these hypotheses.

Both gravity and magnetic data indicate a low or negative anomaly in the vicinity of the Old Faithful (California) Geyser. At present, it is uncertain whether these anomalies are related to the geothermal field or are merely representative of the thickness of valley fill in the area. Drilling that is planned for the area should provide some answers for this problem.

Seismic refraction lines run by CDMG in the valley near Calistoga have indicated a velocity interface between seismic layers and also a general deepening of the basement rocks in the valley toward the southwest. Gravity and resistivity have also shown a general thickening of the sediments to the south. These facts, coupled with the linear and abrupt topographic change, tend to support the concept of a fault along the southwestern margin of the valley (shown dashed on the geologic map Plate 1). However, additional proof may depend on the outcome of the drilling program.

Faults are, in some cases, indicated in the geophysical sections but not on the maps of the valley area. Preliminary results have shown (see section on Hydrology and Groundwater Quality Related to Geologic Structures) that by drawing contours, on map overlays, based on water chemistry, it is possible to approximately delineate some of the faults indicated in the geophysical sections. In addition, it is expected that by drilling, logging, and testing water chemistry for certain selected drill holes it may be possible to further delineate some of these faults on maps. The outcome is partially dependent on the hypothesis presented by Faye (1973) that chemistry of the highly mineralized waters, given enough data points (wells), can be used to delineate the structural controls (faults) on the waters of the area. Additional information on the testing of this promising hypothesis will be presented in the final report addendum.

One of the problems brought on by the relatively high mineralization of the thermal waters in the Calistoga area is that of scaling and corrosion of pipes and other handling equipment. Another is that the deleterious substances in the thermal waters can cause a severe impact on agriculture if allowed to get into irrigation water in the area. As was mentioned above, in another section of this report, a plan has been suggested to use geothermal heat to remove deleterious salts from poor quality water and thus make it satisfactory for domestic use. The local electorate, however, has voted to import fresh water to make up local shortages of good quality water. This means that geothermal heat could be used in a heat exchange system for hydroponics or other agricultural processing. Space heating has long been a use for geothermal energy at Calistoga and light industrial processing is also a potential use. The area has great potential for such utilization.

In general, the indications developed so far in this study of the geothermal resource at Calistoga point toward a significantly larger resource than was previously believed. Heat or hot water may extend to the southwest beneath the upland area. Additional testing not covered by current year funding, would be required to prove the quantity and quality of the geothermal resource in that area.

Resource Assessment

Introduction

A geothermal resource assessment, by necessity, must be updated, refined, and reevaluated as more data on a particular resource area become available. Hence, some of the material presented below, about the low to moderate temperature geothermal resource at Calistoga, California, may be modified in the future. The pending CDMG exploratory drilling program at Calistoga, the pending CDMG interpretation of water well geochemical data from Calistoga, and private geothermal resource utilization in Calistoga will all add greatly to the refinement of the assessment of the geothermal resource.

Reservoir Model

The geothermal resource at Calistoga is a hydrothermal convection system or, probably more correctly, a combination of two or more hydrothermal convection systems. Such systems require a heat source, a fluid, and sufficient vertical permeability for hot, low-density fluids to rise and, in most systems, be recharged by descending cooler fluids. Convective circulation of hot fluids is the mechanism that transports energy from depth to reservoirs near the earth's surface.

Hydrothermal convection systems are most likely to develop in areas where there is a residual heat supply related to relatively young volcanism. Fault zones are most generally the conduits for moving fluids in convection systems. Many known hydrothermal convection systems appear to be located at and controlled by intersecting geologic structures.

Waring (1915, p. 109) early suggested that faulting was responsible for the hot water seepage at the original hot springs at Calistoga. Faye (1975) inferred from his study the existence of a fault aligned with the topographic axis of the upper Napa Valley at Calistoga. Others have speculated, at various times, on the existence and location of faulting in the subsurface of the upper Napa Valley. The geophysical studies conducted by CDMG at Calistoga and reported herein indicate locations of possible faulting. Preliminary maps, from the forthcoming CDMG water well geochemical analyses of Calistoga, indicate locations of possible faulting around Calistoga.

Figure 17 depicts a model of an ascending portion of a hydrothermal convection system and two inferred fault locations near Tubbs Lane in Calistoga. The hypothetical model is based primarily on five temperature logs along section A-A' of Plate B-1 in Appendix B.

Temperature logs from wells numbered 6 and 9 show an abrupt decrease in temperature with depth (or change in sign of slope of temperature curve from positive to negative) at approximately 164 feet and 190 feet resepctively. Whereas temperature logs from wells numbered 7 and 8 (aligned between wells

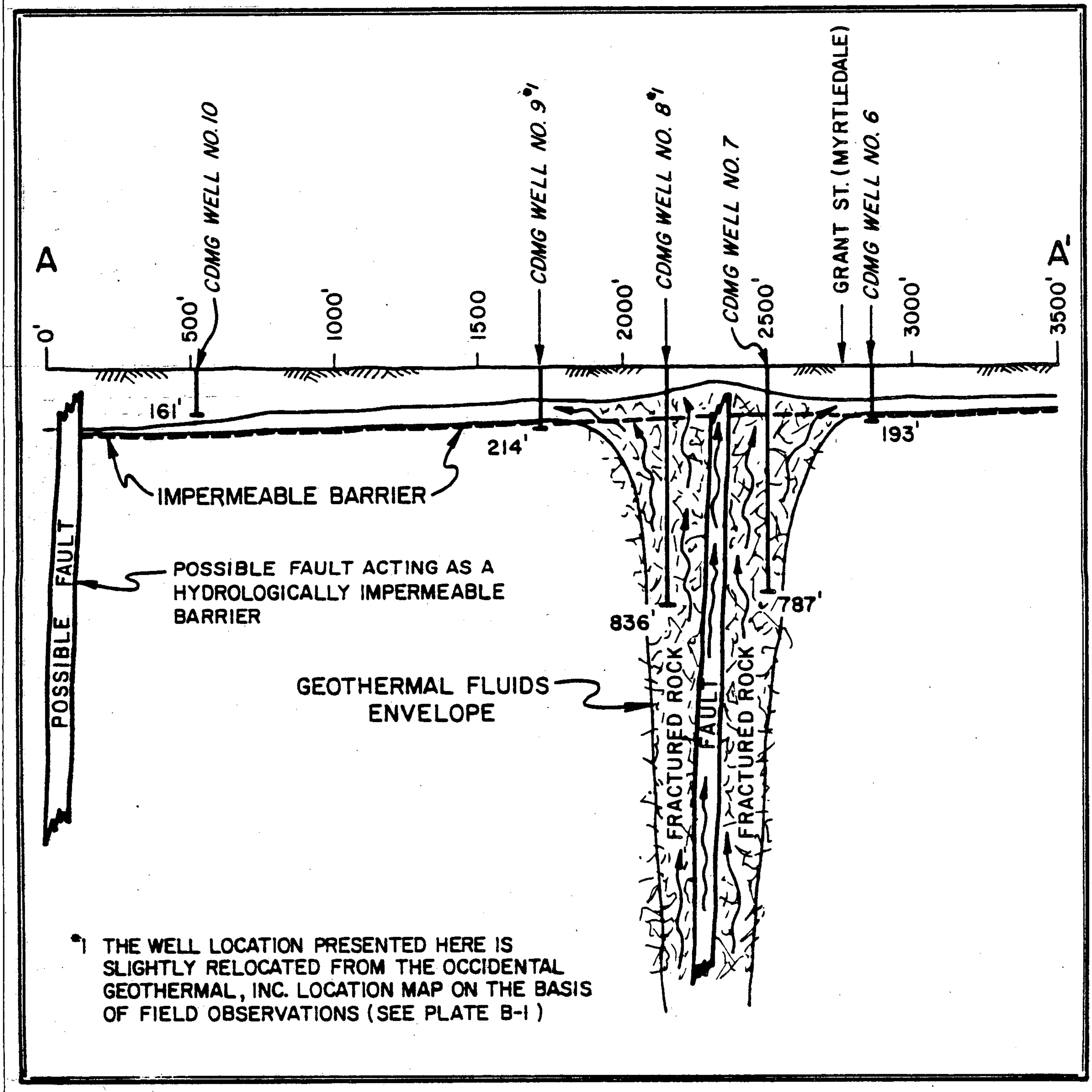


Figure 17. Diagrammatic cross-section of a portion of the geothermal reservoir at Calistoga, California based primarily on temperature logs along section A-A' of Plate B-1, Appendix B. By L.G. Youngs, 1980, CDMG.

numbered 6 and 9) show a continuous positive slope or increase in temperature with depth throughout their respective temperature curves.

The hypothetical cross-section in Figure 17 offers one possible explanation that satisfies these temperature log criteria. Wells numbered 6 and 9 have completely penetrated through the hot water table and into a cooler environment. Whereas wells 7 and 8 may be within a permeable fracture zone associated with faulting where deep seated hot water rises to near surface.

Well no. 10 (Figure 17) shows no change in the sign of the slope of the temperature curve; also, this well does not have nearly as "hot" a temperature as the other 4 wells mentioned above. Hence, this well probably does not intersect the main body of the "hot water" table.

The Tertiary Sonoma Volcanics draping the hills about Calistoga are evidence of relatively recent volcanic activity in the Upper Napa Valley. The heat source or "driving" mechanism for hydrothermal convection systems at Calistoga is probably the remnant heat from the magma chamber or chambers that were the source of the Tertiary volcanic rocks.

The remaining requirement for a hydrothermal convection system, a fluid, is probably primarily provided by meteoric waters ascending fault or fracture zones in the vicinity of Calistoga. Faults act like conduits bringing the meteoric water near the heat source and providing a passage way for the hotter, less dense geothermal fluids to rise toward the surface. Thus, Figure 17 shows geothermal fluids rising through fractured bedrock and migrating outward through the much more permeable and porous alluvial stratum.

Preliminary maps (not included in this report) from a forthcoming report on water well data from Calistoga, show at least three markedly different chemical types of geothermal fluids distributed around Calistoga. This may indicate the presence of several subsurface hydrothermal convection systems.

Reservoir Volume

Thickness of Reservoir Rocks: A geothermal reservoir is a complex, heterogeneous volume of rock and water, but most of the thermal energy is contained in the rock. Most volumetric estimates consider the reservoir as a volume of rock and water regardless of permeability and porosity. That is, no attempt is made to distinguish those parts of a reservoir that are permeable and porous from those that are not. This often leads to choosing a somewhat arbitrary thickness or depth of a geothermal reservoir.

The intention in this report is simply to provide an approximate estimate of the volume of alluvium that probably contains geothermal waters at Calistoga. This value does not include "hot" water available in basement rock fracture zones or fault zones. To this end, then, an average depth of valley alluvium of 400 feet is inferred from well data and geophysical surveys at Calistoga.

The average depth (derived from 13 temperature logs in Appendix B) of the top of the "hot" water aquifer is approximately 120 feet. This is the average depth at which those particular temperature curves exhibited a markedly high increase in temperature versus depth. Subtracting this figure from the figure for the average depth of valley alluvium yields an average thickness of 280 feet of possible "hot" water bearing alluvial aquifer.

Areal extent of geothermal Reservoir: Plate 12 is a compilation of 133 "hot" water wells located near Calistoga. It is assumed that all of these wells have temperatures greater than or equal to 25°C. An approximate boundary line has been constructed enclosing the wells and has been modified to fit geophysical and other evidence as appropriate. This boundary serves as an estimate of the lateral extent of the geothermal aquifer pending revisions based on future drill holes. The enclosed area is approximately 5.79 square miles.

Therefore, there is an approximate volume of sediments 280 feet deep by 5.79 square miles in area (3.07×10^{-1} mi^3) that probably contains intersticial waters with a temperature greater than 25°C. Results from flow testing during the forthcoming CDMG drilling program at Calistoga should further refine the potential volume of geothermal fluids available at

Calistoga, and also help determine whether or not fluids contained in basement rock fracture zones can provide a significant part of the resource.

Reservoir Temperature

Direct Temperature Measurement: Appendix B of this report contains 26 down-hole temperature logs from the Calistoga area. Occidental Geothermal, Inc. provided 20 of the logs, and 6 were measured during the CDMG, 1980, water well survey at Calistoga. The logs from Occidental Geothermal, Inc. have been redrafted and assigned new location numbers to economize space and to make it easier to locate the wells on the location map (Plate B-1, Appendix B). Occidental's well numbers also appear on the logs when appropriate.

The greatest directly recorded temperature on the logs is 275.1°F/135°C at a depth of 192 feet (CDMG well no. 3).

Data from the temperature logs have been recorded in Table 3. Temperatures were picked from each thermal curve at the 50 foot, 100 foot, and 200 foot depth. Temperature extrapolations were made if the well's depth was near, but less than, these selected depths. All 26 wells were ranked from "hottest to coldest", first, by their 50 foot temperatures, secondly, by their 100 foot temperatures, and, thirdly, by their 200 foot temperatures. Then the three rank numbers for each well were averaged. Table 3 lists the

TABLE 3 Approximate order from "hottest to coldest" of selected wells in Calistoga, California based on temperature log data.

Approximate Rank	CDMG Temperature Log Number	Temperature at 50 Foot Depth (°F)	Temperature at 100 Foot Depth (°F)	Temperature at 200 Foot Depth (°F)	Temperature and depth of deepest probe penetration (°F/Feet)	Remarks
1	3	254.5°	265°	Extrapolated ~277°	275.1°/192'	
2	18	213°	250°	Extrapolated ~252°	251.9°/190'	
3	7	232.7°	241°	245°	255.5°/787'	
4	6	217.2°	227°	Extrapolated ~237°	240.3°/193'	
5	2	195°	Extrapolated ~233°	NA	223.3°/92'	
6	17	199°	213°	236.2°	273.7°/1890'	
7	8	167°	190°F	204.7°F	243.6°/836'	
8	12	93°	Extrapolated ~140°	NA	135°/96'	"Could not get down to bottom. Put well on production, producing water temperature 204°F."
9	9	154°	159°	178.4°	178°/214'	
10	5	150.8°	157.7°	Extrapolated ~180°	178°/198'	
11	16	139°	152°	Extrapolated ~208°	203.5°/192.5'	
12	13	98.2°	150°	NA	161.8°/137'	
13	15	120.2°	135°	NA	142.5°/137'	
14	4	Extrapolated ~108°	NA	NA	106.5°/46'	
15	26	91.3°	109.5°	154.3°	157.1°/207'	
16	14	96°	111°	152.5°	152.5°/216'	
17	11	122.8°	124.8°	130°	132.4°/237'	
18	22	67.7°	92°	114°	137.5°/340'	
19	19	76.5°	88.5°	Extrapolated ~108°	107.4/196'	
20	20	76°	78°	NA	85.2°/137'	
21	23	72°	76.7°	94°	103.5°/255'	
22	10	75.2°	74°	Extrapolated ~84°	81.8°/161'	
23	24	72°	NA	NA	72.4°/55'	
24	21	71°	Extrapolated ~77°	NA	72°/87'	
25	1	71°	74°	83°	88.8°/260'	
26	25	69.3°	70.3°	NA	72.5°/117'	

NOTE: Wells are approximately ranked by temperature measured or anticipated at 200 foot depth at each well location. Well locations are presented on Plate B-1, in Appendix B.

26 wells by their relative averaged rank., Given the data available, this method of ranking the wells--first by their different depth temperatures and then by their averaged ranks--provides the best possible quantitative temperature comparison of the 26 wells. Coincidentally, the ranking based on averaged ranks is almost exactly the same as the ranking based on the 200 foot temperature.

Well No. 3 (CDMG numbers) is relatively the "hottest" well of the 26 wells and well No. 25 is the least "hot".

Plate B-1, Appendix B shows the 26 thermally logged water wells approximately grouped in three areas; Tubbs Lane, around the City of Calistoga, and southeast of Calistoga along the Silverado Trail. Four of the first five "hottest" wells from Table 3 are near Tubbs Lane. The wells numbered 20-25 (Southeast of Calistoga) appear in the ranks of the nine "coldest" wells in Table 3. This apparent temperature distribution indicates that the geothermal resource is "hottest" around Tubbs Lane, slightly less "hot" around the city of Calistoga, and much "cooler" southeast of Calistoga.

Plate 12 displays the location of 133 "hot water" wells around Calistoga. Most locations are annotated with the well depth and a directly recorded temperature. The well locations have been compiled from three sources: (1) Koenig and Anderson, 1970, (2) Occidental Geothermal, Inc., 1977, and (3) the CDMG, 1980, water well survey at Calistoga. The recorded temperatures were derived from several methods as indicated in the explanation on Plate 12.

Plate 13 is a contour map of the estimated water temperature at a depth of approximately 200-300 feet at Calistoga. There are 32 annotated well locations posted on the map. The posted temperature is that temperature recorded for the indicated depth at each well location. The contours have been approximately located utilizing the posted well data, inferences from empirical well data not shown (mainly from Plate 12), local well driller's experiences, inferences from geophysical data (discussed elsewhere in this report) and topographic effects. Because the contour lines are approximately located, further refinement of the contour locations is expected with additional information from CDMG's forthcoming drilling program and information available from private geothermal resource utilization at Calistoga.

Indirect Temperature Measurement: Geothermometry (that is, the use of chemical geothermometers) is an indirect method of assessing the temperature of a geothermal reservoir. Geothermometry methods are based on temperature-dependent, water-rock reactions which determine the chemical and isotopic composition of thermal waters. The most common soluable chemical constituents of thermal waters are SiO_2, Na, K, Ca, Mg, Cl, HCO_3, and CO_3. The silica, Na-K-Ca, and sulfate-isotope geothermometers are those most generally used to estimate geothermal reservoir temperatures. The validity of these geothermometers is based on the following assumptions:

1. Temperature-dependent reactions at depth control the concentration of the geothermometer.
2. The reservoir contains an adequate supply of the reactants.
3. Water-rock equilibrium is established in the reservoir.
4. The constituents used in the geothermometer do not reequilibrate with the confining rock as the water flows to the surface.
5. Mixing of thermal and nonthermal groundwater does not occur.

Problems arise in using the geothermometers when one or more of these assumptions are violated. Hence, some of the calculated geothermometric temperatures presented below may be subject to considerable error.

Table 4 is a list of 64 water wells from Calistoga (having surface temperatures of 24°C/75°F or greater) that were geochemically analyzed. The geochemical sample numbers refer to the individual geochemical analyses in Appendix A and to the water well locations on Plate 10. For each well, geothermal reservoir temperatures have been calculated using five geothermometers or geothermometric techniques.

Muffler (1979, p. 64), utilizing the Na-K-Ca geothermometric method, calculated a reservoir temperature of 141° C/286° F for the geothermal reservoir at Calistoga. The average of the Na-K-Ca method of calculating temperature for all the wells from Table 4, except those footnoted, is 137° C/279°F. Muffler's value and CDMG's calculated value compare favorably.

Further analysis of the data in Table 4 is expected in a forthcoming CDMG report on the interpretation of the geochemical data collected at Calistoga. Preliminarily, however, the geothermal reservoir temperature at Calistoga is approximately 140°C/284°F.

Table 4. Geothermometric temperatures for the well water samples above 24°C (surface temperature) at Calistoaga, California. By H.H. Majmundar, 1980, CDMG.

Sample Numbers	Surface Temp. (°C)*1	SiO_2 Temp. adiabatic (°C)	SiO_2 Temp. conductive (°C)	Na/K Temp. White &Ellis (cf.Trusdell 1975)(°C)	Na/K Temp. Fornier & Trusdell (1973)(°C)	NaKCa Temp. (°C)
G-001-80	45	142	146	107	98	144
G-003-80	31	103	101	127	120	131
G-008-80	25	79	73	143	136	149
G-009-80	135	143	147	113	104	161
G-010-80	39.5	130	133	90	81	141
G-012-80	65	147	153	96	87	150
G-016-80	37	98	95	66	58	201
G-019-80	64	141	145	90	80	137
G-020-80	97.5	146	152	100	91	131
G-021-80	97.9	148	154	86	76	134
G-022-80	47	157	165	121	113	149
G-025-80	36	126	127	132	125	134
G-027-80	25	121	122	149	142	163
G-037-80	42	115	116	101	92	141
G-044-80	40	121	122	148	141	165
G-054-80	24	98	95	96	86	133
G-057-80	37.5	113	112	74	63	116
G-058-80	57	129	131	64	54	115
G-063-80	28	91	88	111	102	129
G-066-80	35	101	99	119	111	117
G-067-80	36	98	95	149	143	135
G-068-80	34	105	103	78	68	119
G-071-80*2	30	76	70	291	298	29
G-084-80*3	24	73	66	179	175	23

Table 4 (Continued)

Sample Numbers	Surface Temp. (°C)	SiO_2 Temp. adiabatic (°C)	SiO_2 Temp. conductive (°C)	Na/K Temp. White &Ellis (cf.trusdell 1975)(°C)	Na/K Temp. Fornier & Trusdell (1973)(°C)	NaKCa Temp. (°C)
G-086-80	24	51	42	166	160	141
G-088-80	26	87	82	109	100	116
G-091-80 *4	28	94	90	233	234	28
G-092-80	41	137	141	121	113	159
G-093-80	93	141	145	111	102	157
G-095-80	52	122	123	81	71	129
G-096-80	85	128	130	89	79	91
G-097-80	95	143	147	115	107	158
G-098-80	96	140	144	110	102	145
G-099-80	94	138	142	113	104	150
G-100-80	86	138	142	106	97	96
G-101-80 *4	25	69	62	271	276	172
G-102-80	65.5	126	127	59	48	119
G-103-80	34	111	111	74	64	120
G-104-80	45	135	139	83	73	134
G-105-80	44	145	151	97	87	131
G-106-80	55	147	153	96	87	142
G-107-80	25	87	82	57	46	110
G-108-80	57	111	111	95	86	126
G-109-80	51	107	105	68	57	113
G-110-80	28	98	95	98	89	115
G-111-80	104	141	145	113	105	152
G-112-80	30	124	126	85	75	132

Table 4 (Continued)

Sample Numbers	Surface Temp. (°C)	SiO_2 Temp. adiabatic (°C)	SiO_2 Temp. conductive (°C)	Na/K Temp. White &Ellis cf.Trusdell 1975) (°C)	Na/K Temp. Fornier & Trusdell (1973) (°C)	NaKCa Temp. (°C)
G-113-80	57	117	117	73	62	124
G-114-80	41	111	111	90	80	131
G-115-80	35	119	120	152	146	164
G-116-80	30	123	125	85	75	126
G-117-80	24	103	101	93	84	112
G-137-80	27	107	105	140	133	130
G-138-80	25	100	97	159	154	139
G-156-80	30	89	85	125	117	127
G-157-80 *5	28	69	62	332	345	193
G-161-80	35	130	133	327	339	223
G-169-80	40	101	99	117	110	126
G-178-80	30	103	101	147	140	129
G-179-80	55	123	125	95	85	130
G-180-80	55	113	112	112	103	142
G-201-80	33	117	117	143	137	161
G-202-80	27	110	109	147	140	162
G-206-80	55	117	117	102	93	132

Footnotes:

1. Surface temperatures were usually measured at a convenient faucet closest to the well head. Water pumps were generally allowed to run for several minutes to ensure that the water was as fresh as possible from the well. Note that this temperature probably is not the hottest water temperature in the well.

Footnotes (Continued)

Note: Some calculated temperatures are anomalous. The following footnotes provide an explanation for the indicated abnormal temperatures.

2. Ca and Mg predominate over Na and K, and K is minimum of all.

3. Ca predominates Na and Mg predominates K; K is less than 2.5, yet 2.5 value has been taken for calculations which might have brought this abnormality in the calculated temperatures.

4. Ca and Mg are considerably higher than Na and K. K is less than 2.5, yet 2.5 value has been taken for calculations which might have brought this abnormality in the calculated temperatures.

5. Ca is considerably higher than K. K is less than 2.5, yet 2.5 value has been taken for calculations which might have brought this abnormality in the calculated temperatures.

CDMG EXPLORATORY DRILLING PROGRAM AT CALISTOGA, CALIFORNIA

Background

In the initial phase of the California Division of Mines and Geology (CDMG) investigations of the moderate temperature geothermal resource at Calistoga, California, over 200 water well driller's reports were obtained from the files of the California Department of Water Resources' (CDWR). It was hoped that correlation of these logs would reveal the subsurface geology of the Upper Napa Valley, yield temperature data, and allow correlation of aquifers. Several correlation attempts proved entirely futile, due to the un-technical nature of the driller's "geologic" logs, on most of which temperature data was omitted. Probably the unsuccessful correlation attempts were also partly due to the unexpected complexity of the subsurface geology.

Three deep geothermal wells (over 1500 feet) were drilled exploring for steam in Calistoga in the late 1950's and early 1960's. These were logged by a geologist, but unfortunately, the records cannot be located.

In view of the lack of usable drill hole data, it became evident that drilling some exploratory holes at Calistoga would add a great deal of scientific information to CDMG's investigation of the geothermal resource.

Goals of the Drilling Program

While organizing the exploratory drilling program for the Calistoga investigation, careful consideration was given to the amount of funding set aside for drilling operations. It was essential to glean the greatest amount of scientific information from the smallest number of drill holes.

Depths to the hot water zone or zones were needed. Geologic columns were required to unravel the subsurface geology and augment geophysical surveys that CDMG performed at Calistoga. Down hole temperatures were required from temperature gradient surveys (to this end, approximately 25 temperature gradient surveys were obtained from Occidental Geothermal, Inc. of existing "hot water" wells around Calistoga). The areal extent of the geothermal resource might be determined by "wildcat" type drilling. Aquifer testing is required to determine the volumetric nature of the geothermal resource. Chemical analysis of the resource was required to ascertain geochemical and geothermometric properties. Keeping all of these goals in mind, a drilling and casing program was devised and drill site selection was begun.

Rationale for Drill Site Selection

It was determined that as many as six drill holes could be completed with the funding available. Site selection was done with the goals of the program in mind. The goals are to provide (1) base data for geophysical investigations and interpretations, (2) base data on the aquifers and the flow of the aquifers, and (3) geochemical information for use in better understanding aquifer limits and geologic structure and to aid in understanding the source and replenishment of water in the system. Along with these goals, the following considerations were weighed in choosing drill sites:

1. Noise pollution.
2. Ease of accessibility.
3. Visual pollution.
4. Nearness of structures.
5. Availability of existing wells at the site for possible reinjection of discharge from the test well.
6. Landowner acceptance.

Initially, six sites were chosen. Then, it was deemed prudent to select six more sites to be alternates if some of the original sites were disallowed due to environmental reasons or landowner rejection. Eventually, 13 drill hole sites were selected in and around Calistoga mostly in vacant fields. The Figure 18 map shows the locations.

Each site was assigned a number for reference purposes. The sites are numbered LES-1 through LES-13. (LES-5 does not appear on the map because it has already been withdrawn by the landowner). The sequence of site numbers has no significance other than the order in which property owners were contacted. It is assumed that at a later date, the drill sites will be re-numbered after completion of each hole. A preliminary sequence of drill sites in order of preference has been established:

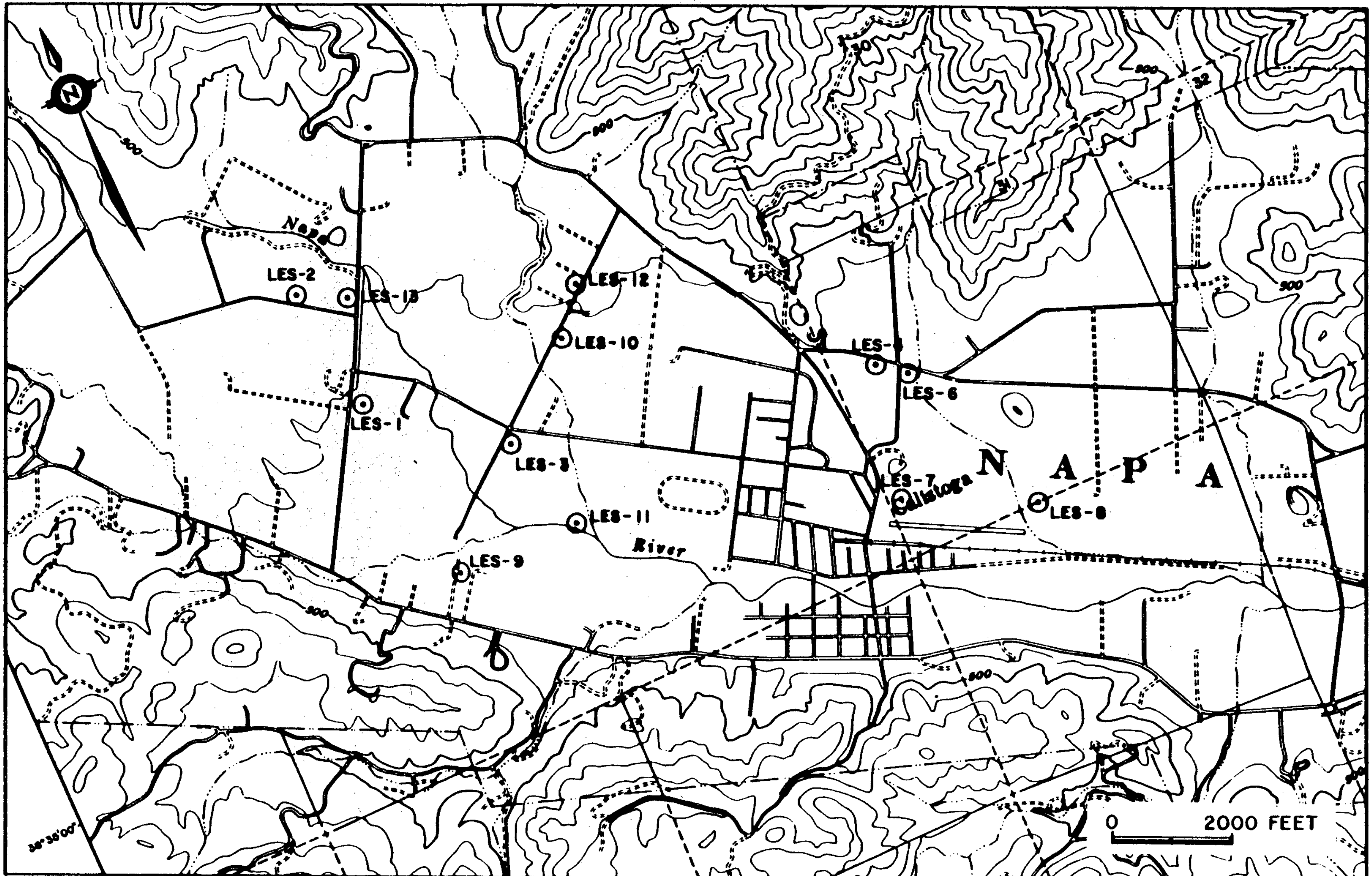


Figure 18. Location map of proposed geothermal exploratory drill sites at Calistoga, California.

RANK OF PREFERENCE	DRILL SITE
1.	LES-1
2.	LES-3
3.	LES-9
4.	LES-10
5.	LES-2
6.	LES-4
7.	LES-7
8.	LES-11
9.	LES-8
10.	LES-13
11.	LES-12
12.	LES-6
13.	LES-5 (withdrawn)

The following list details the significance of each drill hole site to the overall moderate temperature geothermal investigation at Calistoga:

LES-1 The site is along a traverse where three different geophysical surveys were performed by CDMG. The site has three abandoned wells (two over 1500 feet deep) which may be adequate for reinjection purposes if the exploratory well is across the street. Several of the wells on the property are flowing and there are some more nearby. It was reported that the Franciscan Formation (assumed to be the basement rock type under the valley is only about 200 feet from the surface at this site (Unexpectedly shallow). It is assured that the geothermal resource can be tapped at this site.

LES-2 Four geophysical techniques have been employed along a traverse near this site, including a shallow hole temperature survey. Correlation of stratigraphy, depth to basement, and vertical position, thickness, and type of aquifers are among the geologic questions to be answered. Local residents and geophysical data indicate a very shallow "hot water" zone at this site (worthy of scientific investigation). The site is essentially close to the edge of an area that encloses the known "hot water" wells at Calistoga. It is expected that the resource can be tapped at this site.

LES-3 The site is near the center of a traverse across the valley where four geophysical surveys were preformed. A geologic log from this site correlated with logs from LES-9 and LES-10 (or LES-12 as an alternate) could produce an excellent geologic cross-section laterally across the valley. There is an estimated 85% chance of striking the resource at this site.

LES-4 The site is along a traverse where three geophysical techniques were performed. Some of the lowest electrical resistivity values were recorded at this site. This may indicate a very hot water zone, very mineralized water zone, a large volume of hot water, or a combination of any of the above. The site is near a possible N-S trending fault trace.

LES-5 This site has been withdrawn from the list of proposed drill sites by the property owner.

LES-6 The site is proposed as an alternate for LES-4 if drilling is disallowed there. It is significant for the same reason as LES-4.

LES-7 No geophysical surveys were performed near this site. It is on the grounds of "Pacheteau's" spa where three wells (approximately 180 feet deep) are reported to bottom in serpentine. It is suspected that this is not the case. Several "hot water" wells are nearby lending themselves to possible piezometric head measurements if an exploratory well were flow tested here. This is the site of the original hot springs at Calistoga. The greatest volume of hot water appears to be available at "Pacheteau's".

LES-8 No geophysical surveys were performed very near this site. It is near the edge of the area of known geothermal wells at Calistoga. It is also on the edge of the old original hot springs grounds (now dried up).

LES-9 The site lies on the outer edge of a traverse where four different geophysical surveys were performed. The site, in conjunction with LES-3 and LES-10 (Les-12 as an alternate), would provide geologic data that may be correlated to produce a geologic cross-section across the valley. There may be a fault trace between LES-3 and

LES-9. The site is in an area long thought by local residents to be void of "hot water".

LES-10 Four geophysical techniques were employed along a traverse near this site. This site (or LES-12 as an alternate), in conjunction with LES-3 and LES-9, could provide geologic information that may be correlated to produce a geologic cross-section across the valley.

LES-11 There were no geophysical surveys near this site. The site is slightly remote from any known geothermal well. A temperature gradient survey here would fill in a blank area on the map.

LES-12 This site is an alternate to LES-10 if that site should be disallowed for environmental reasons or landowner disapproval. It has the same significance to the geothermal investigation of Calistoga as LES-10.

LES-13 The site was chosen as an alternate location if several other sites and their alternate were rejected due to environmental objections or landowner disapproval. Three different geophysical techniques were employed on a traverse near this site. The site is apparently on the edge of an area suspected of having a very shallow "hot water" aquifer. Geologic questions to be answered are the same as for the LES-2 site.

Limited Licenses and NOI's

In all, three drill sites are within Napa County jurisdiction, eight sites lie within the limits of the City of Calistoga, and one site (LES-13) is on California State owned property.

CDMG staff have drafted a "Limited License" form for landowners to grant permission for drilling the exploratory wells on their property. As of this writing, seven property owner's have responded favorably and one property owner has withdrawn from the program.

Notices of Intention to Drill a Geothermal Resources Well (NOI) have been drafted for each proposed drill site as required by the California Divison of Oil and Gas (CDOG). A copy of the proposed drilling and casing program described above was attached to each NOI.

The NOI's have recently been submitted to the proper agencies. For sites within the city limits of Calistoga, they have been submitted to the City of Calistoga, and for sites within the Napa County limits, but outside city limits, they have been submitted to the Napa County Planning Department.

The submitting of the NOI's initiates the processes involved under the California Environmental Quality Act (CEQA) as administered by the lead agency (city or county and/or CDOG). The CEQA program allows approval, conditional approval, or disapproval of a drill site. There are three progressively more stringent filing categories under CEQA regulations that allow approval of a particular drill site: 1) Notice of exemption, 2) Negative declaration, 3) Environmental impact report (EIR). However, a site could be disallowed after preparing an EIR, the category that requires the most rigorous and complete assessment of the impact the proposed activity may have on the environment.

Napa County is currently deciding what category of the CEQA process the proposed drill sites should be regulated by, while the City of Calistoga has issued a notice of exemption. Also, each is responsible for issuing the Land Use Permits for drilling for the sites that come under their respective jurisdicitons.

Drilling Contract

CDMG has prepared and recently released for bid a drilling contract to perform all proposed drilling operations at Calistoga. The contract has been made available to 14 northern California well drilling companies, and bids were received from three of those companies. Award is pending.

Final Report

Upon completion of the drilling tests, the data developed by all of the tasks of this project will be considered in developing a comprehensive interpretation of the geothermal resources of the area. A final report covering the Calistoga area will then be prepared and released to the public.

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APPENDIX A

The following are reproductions of annotated computer printouts of the geochemical analysis of water wells sampled by California Division of Mines and Geology (CDMG) at Calistoga, California. The analyses are numbered G-001-80 through G-206-80.

Correspondingly, the analyses' identification numbers relate to the water well location numbers 001-206 on Plate 10 .

For a later report CDMG plans to present this data on microfiche.

CALISTOGA SET 1

1 G-001-80

ELEMENT		CONCENTRATION (PPM)
NA		198
K		8
CA		5
MG		1
FE		0.07
AL	<	0.625
SI		55
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.58
BE	<	0.005
B		9.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		202
F^-		10.5
HCO_3^-		147.9
$SO_4^=$	<	10
T.D.S.		659

Temperature 45°C
pH 7.00
Salinity 0.05%
Specific Conductance 600 µmoh/cm

CORRECTED T.D.S. 586

CALISTOGA SET 1

2 G-002-80

ELEMENT		CONCENTRATION (PPM)
NA		34
K	<	2.50
CA		25
MG		9
FE	<	0.025
AL	<	0.625
SI		25
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		35
F^-		0.2
HCO_3^-		81.6
$SO_4^=$		15
T.D.S.		249
CORRECTED T.D.S.		209

Temperature	18.5 °C
pH	6.20
Salinity	0.00 %
Specific Conductance	250 umoh/cm

CALISTOGA SET 1

3 G-003-80

ELEMENT		CONCENTRATION (PPM)
NA		57
K		3
CA		19
MG		8
FE	<	0.025
AL	<	0.625
SI		23
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		2.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		43
F^-		0.4
HCO_3^-		169.3
$SO_4^=$	<	10
T.D.S.		345
CORRECTED T.D.S.		262

Temperature	31°C
pH	5.8
Salinity	0.00%
Specific Conductance	380 umho/cm

CALISTOGA SET 1

4 G-004-80

ELEMENT		CONCENTRATION (PPM)
NA		64
K		3
CA		23
MG		2
FE		0.46
AL	<	0.625
SI		30
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.3
HCO_3^-		179.2
$SO_4^=$		30
T.D.S.		358
CORRECTED T.D.S.		270

Temperature	13.5 °C
pH	7.20
Salinity	0.00 %
Specific Conductance	290 µmho/cm

CALISTOGA SET 1

5 G-005-80

ELEMENT		CONCENTRATION (PPM)
NA		93
K		3
CA		15
MG		6
FE		0.56
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.3
HCO_3^-		246.3
$SO_4^=$		22
T.D.S.		446
CORRECTED T.D.S.		325

Temperature 19° C

pH 6.15

Salinity 0.02 %

Spec. Conductance 300 μmoh/cm

CALISTOGA SET 1

6 G-006-80

ELEMENT		CONCENTRATION (PPM)
NA		13
K	<	2.50
CA		9
MG		3
FE	<	0.025
AL	<	0.625
SI		31
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-	<	0.1
HCO_3^-		61.8
$SO_4^=$	<	10
T.D.S.		147
CORRECTED T.D.S.		117

Temperature	16°C
pH	6.25
Salinity	0.00%
Specific Conductance	100 umoh/cm

CALISTOGA SET 1

7 G-007-80

ELEMENT		CONCENTRATION (PPM)
NA		11
K	<	2.50
CA		18
MG		20
FE	<	0.025
AL	<	0.625
SI		13
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		10
F^-	<	0.1
HCO_3^-		125.8
$SO_4^=$	<	10
T.D.S.		221
CORRECTED T.D.S.		159

Temperature	18°C
pH	5.80
Salinity	0.0 %
Specific Conductance	245 umoh/cm

CALISTOGA SET 1

8 G-008-80

ELEMENT		CONCENTRATION (PPM)
NA		111
K		7
CA		22
MG		11
FE		1.04
AL	<	0.625
SI		12
TI	<	0.125
P	<	0.625
SR		0.17
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.12
BE	<	0.005
B		6.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		111
F^-		1.4
HCO_3^-		213.5
$SO_4^=$		10
T.D.S.		527
CORRECTED T.D.S.		422

Temperature	25°C
pH	6.20
Salinity	0.02 %
Specific Conductance	500 µmoh/cm

CALISTOGA SET 1

9 G-009-80

ELEMENT		CONCENTRATION (PPM)
NA		206
K		9
CA		2
MG	<	0.500
FE	<	0.025
AL	<	0.625
SI		56
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI		1.95
BE	<	0.005
B		9.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		201
F^-		11.5
HCO_3^-		N.D.
SO_4		N.D.
T.D.S.		518

Temperature	275°F at 190 ft.
pH	8.5
Salinity	0.5 %
Specific Conductance	1150 μmoh/c

CALISTOGA SET 1

10 G-010-80

ELEMENT		CONCENTRATION (PPM)
NA		157
K		5
CA		2
MG		1
FE		0.04
AL	<	0.625
SI		43
TI	<	0.125
P	<	0.625
SR		0.02
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI		1.42
BE	<	0.005
P		3.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		76
F^-		8
HCO_3^-		221.1
SO_4^-		25
T.D.S.		563
CORRECTED T.D.S.		451

Temperature	39.5°C
pH	7.25
salinity	0.10%
Specific Conductance	670 umoh/cm

CALISTOGA SET 1

11 G-011-80

ELEMENT		CONCENTRATION (PPM)
NA		173
K		5
CA		1
MG	<	0.500
FE		0.04
AL	<	0.625
SI		51
TI	<	0.125
P	<	0.625
SR	<	0.013
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.52
BE	<	0.005
B		6.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		130
F^-		11
HCO_3^-		180.7
$SO_4^=$	<	10
T.D.S.		581
CORRECTED T.D.S.		492

Temperature 178°F @ 214'
pH 7.4
Salinity 0.01%
Specific Conductance 650

CALISTOGA SET 1

12 G-012-80

ELEMENT		CONCENTRATION (PPM)
NA		202
K		7
CA		2
MG	<	0.500
FE		0.08
AL	<	0.625
SI		61
TI	<	0.125
P	<	0.625
SR		0.02
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.81
BE	<	0.005
B		9.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		190
F^-		11
HCO_3^-		151
$SO_4^=$	<	10
T.D.S.		654
CORRECTED T.D.S.		580

Temperature	65°C
pH	7.20
Salinity	0.01 %
Specific Conductance	600 µmho/cm

CALISTOGA SET 1

13 G-013-80

ELEMENT		CONCENTRATION (PPM)
NA		84
K	<	2.50
CA		24
MG		20
FE		0.23
AL	<	0.625
SI		14
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		4.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		87
F^-		0.3
HCO_3^-		189.1
$SO_4^=$	<	10
T.D.S.		447
CORRECTED T.D.S.		354

Temperature	20°C
pH	5.50
Salinity	0.00%
Specific Conductance	500 µmoh/cm

CALISTOGA SET 1

14 G-014-80

ELEMENT		CONCENTRATION (PPM)
NA		67
K	<	2.50
CA		26
MG		33
FE		0.36
AL	<	0.625
SI		17
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		3.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		69
F^-		0.3
HCO_3^-		220.4
$SO_4^=$		15
T.D.S.		475
CORRECTED T.D.S.		366

Temperature 15°C

pH 6.35

Salinity 0.01 %

Specific Conductance 490 µmoh/cm

CALISTOGA SET 1

15 G-015-80

ELEMENT		CONCENTRATION (PPM)
NA		29
K	<	2.50
CA		29
MG		39
FE		7.27
AL	<	0.625
SI		18
TI	<	0.125
P	<	0.625
SR		0.15
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.7
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		64
F^-		0.2
HCO_3^-		235.6
$SO_4^=$	<	10
T.D.S.		445
CORRECTED T.D.S.		329

Temperature	20°C
pH	6.70
Salinity	0.01%
Specific Conductance	500 µmoh/cm

CALISTOGA SET 1

16 G-016-80

ELEMENT		CONCENTRATION (PPM)
NA		184
K		4
CA		28
MG		2
FE		0.56
AL	<	0.625
SI		20
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.12
BE	<	0.005
B		9.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		190
F^-		8.5
HCO_3^-		193.7
$SO_4^=$		0
T.D.S.		662
CORRECTED T.D.S.		567

Temperature 37 °C
pH 6.50
Salinity 0.03%
Specific Conductance 980 µmoh/cm

CALISTOGA SET 1

17 G-017-80

ELEMENT		CONCENTRATION (PPM)
NA		161
K	<	2.50
CA		26
MG		9
FE		0.04
AL	<	0.625
SI		19
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.23
BE	<	0.005
B		9.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		169
F^-		5.5
HCO_3^-		214.3
$SO_4^=$	<	10
T.D.S.		652
CORRECTED T.D.S.		546

Temperature 17.5°C
pH 6.80
Salinity 0.03%
Specific Conductance 730 μmoh/cm

CALISTOGA SET 1

18 G-018-80

ELEMENT		CONCENTRATION (PPM)
NA		165
K	<	2.50
CA		30
MG		9
FE		0.53
AL	<	0.625
SI		19
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.23
BE	<	0.005
B		9.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		171
F^-		5.5
HCO_3^-		217.3
SO_4^-	<	10
T.D.S.		641
CORRECTED T.D.S.		534

Temperature	19.5°C
pH	7.00
Salinity	0.03%
Specific Conductance	790 µmoh/cm

CALISTOGA SET 2

19 G-019-80

ELEMENT		CONCENTRATION (PPM)
NA		190
K		6
CA		5
MG	<	0.500
FE	<	0.025
AL	<	0.625
SI		54
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.99
BE	<	0.005
B		7.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		152
F^-		9.5
HCO_3^-		179.2
$SO_4^=$		16
T.D.S.		646
CORRECTED T.D.S.		558

Temperature	64°C
pH	7.40
Salinity	0.03%
Specific Conductance	1200 µmoh/cm

CALISTOGA SET 2

20 G-020-80

ELEMENT	CONCENTRATION (PPM)
NA	190
K	7
CA	30
MG	1
FE	0.08
AL	< 0.625
SI	60
TI	< 0.125
P	< 0.625
SR	0.06
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	< 0.250
CO	< 0.025
NI	< 0.125
CU	< 0.063
MO	< 1.25
PB	< 0.250
ZN	0.8
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	2.05
BE	< 0.005
B	9.9
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	201
F^-	11.0
HCO_3^-	154.8
$SO_4^=$	< 10
T.D.S.	675
CORRECTED T.D.S.	599

Temperature 97.5° C

pH 7.75

salinity 0.04%

Specific Conductance 1220 μmoh/cm

CALISTOGA SET 2

21 G-021-80

ELEMENT		CONCENTRATION (PPM)
NA		201
K		6
CA		6
MG	<	0.500
FE	<	0.025
AL	<	0.625
SI		62
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		2.10
BE	<	0.005
B		9.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		193
F^-		10.5
HCO_3^-		N.D.
SO_4^-		N.D.
T.D.S.		507

Temperature	97.9°C
pH	7.45
Salinity	0.05%
Specific Conductance	1360 μmol/cm

CALISTOGA SET 2

22 G-022-80

ELEMENT		CONCENTRATION (PPM)
NA		185
K		9
CA		14
MG		1
FE		0.31
AL	<	0.625
SI		75
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.78
BE	<	0.005
B		9.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		187
F^-		11.0
HCO_3^-		159.4
$SO_4^=$	<	10
T.D.S.		673
CORRECTED T.D.S.		594

Temperature 47°C
pH 7.30
Salinity 0.02%
Specific Conductance 1070 µmho/cm

[redacted]

CALISTOGA SET 2

23 G-023-80

ELEMENT		CONCENTRATION (PPM)
NA		5
K	<	2.50
CA		86
MG		13
FE		0.20
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU		0.1
MO	<	1.25
PB	<	0.250
ZN		3.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-	<	0.1
HCO_3^-		84.6
$SO_4^=$		13
T.D.S.		236
CORRECTED T.D.S.		194

Temperature 19°C
pH 6.75
Salinity 0.01%
Specific Conductance 142 µmoh/cm

CALISTOGA SET 2

24 G-024-80

ELEMENT		CONCENTRATION (PPM)
NA		101
K		3
CA		22
MG		12
FE		0.15
AL	<	0.625
SI		8
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		4.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.57
BE	<	0.005
B		4.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		97
F^-		4.5
HCO_3^-		179.2
SO_4^-	<	10
T.D.S.		456
CORRECTED T.D.S.		368

Temperature	9°C
pH	6.81
Salinity	0.01 %
Specific Conductance	510 µmohs

CALISTOGA SET 2

25 G-025-80

ELEMENT		CONCENTRATION (PPM)
NA		179
K		10
CA		22
MG		4
FE		0.12
AL	<	0.625
SI		39
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.53
BE	<	0.005
B		9.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		188
F^-		9.1
HCO_3^-		166.2
$SO_4^=$		13
T.D.S.		615
CORRECTED T.D.S.		557

Temperature	36 °C
pH	6.97
Salinity	0.03 %
Specific Conductance	910 µmhos

CALISTOGA SET 2

26 G-026-80

ELEMENT		CONCENTRATION (PPM)
NA		94
K		3
CA		30
MG		3
FE		0.05
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.15
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		4.3
ZR	<	0.125
LA		2.7
CE	<	0.250
TH	<	2.50
Cl^-		88
F^-		2.6
HCO_3^-		207.7
SO_4^-		—
T.D.S.		257
CORRECTED T.D.S.		151

Temperature 74°F
pH 7.80
Salinity 0.01 %
Specific Conductance 510 µmol/cm

CALISTOGA SET 2

27 G-027-80

ELEMENT		CONCENTRATION (PPM)
NA		177
K		12
CA		15
MG		5
FE		0.54
AL	<	0.625
SI		35
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.18
BE	<	0.005
B		10.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		194
F^-		7.8
HCO_3^-		209.7
$SO_4^=$	<	10
T.D.S.		478
CORRECTED T.D.S.		371

Temperature 25°C
pH 6.85
Salinity 0.04
Specific Conductance 895 µmoh/cm

CALISTOGA SET 2

28 G-028-80

ELEMENT		CONCENTRATION (PPM)
NA		150
K		3
CA		15
MG		13
FE	<	0.025
AL	<	0.625
SI		17
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.06
BE	<	0.005
B		8.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		152
F^-		4.1
HCO_3^-		209.7
$SO_4^=$	<	10
T.D.S.		592
CORRECTED T.D.S.		489

Temperature 65°F
pH 6.80
Salinity 0.03%
Specific Conductance 730 umoh/cm

CALISTOGA SET 2

29 G-029-80

ELEMENT		CONCENTRATION (PPM)
NA		66
K	<	2.50
CA		19
MG		8
FE		0.09
AL	<	0.625
SI		25
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.20
BE	<	0.005
B		2.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		63
F^-		1.3
HCO_3^-		130.4
$SO_4^=$		26
T.D.S.		364
CORRECTED T.D.S.		300

Temperature	70°F
pH	6.65
Salinity	0.01%
Specific Conductance	400 μmho/cm

CALISTOGA SET 2

30 G-030-80

ELEMENT		CONCENTRATION (PPM)
NA		121
K		3
CA		23
MG		12
FE		0.44
AL	<	0.625
SI		18
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.07
BE	<	0.005
B		6.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		117
F^-		3.6
HCO_3^-		150.2
$SO_4^=$		11
T.D.S.		486
CORRECTED T.D.S.		412

Temperature 70°F
pH 6.90
Salinity 0.02%
Specific Conductance 580 µmoh/cm

CALISTOGA SET 2

31 G-031-80

ELEMENT		CONCENTRATION (PPM)
NA		45
K	<	2.50
CA		60
MG		11
FE		0.39
AL	<	0.625
SI		20
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		3.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.05
BE	<	0.005
B		1.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		44
F^-		0.9
HCO_3^-		119.7
$SO_4^=$		50
T.D.S.		375
CORRECTED T.D.S.		316

Temperature	17°C
pH	6.70
Salinity	0.00 %
Specific Conductance	296 umoh/cm

CALISTOGA SET 2

32 G-032-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K	<	2.50
CA		10
MG		3
FE		0.36
AL		0.7
SI		15
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-	<	0.1
HCO_3^-		157.8
$SO_4^=$		14
T.D.S.		[redacted] 136
CORRECTED T.D.S.		105

- Temperature: 14°C
- pH: 6.05
- Salinity: 0.02 %
- Specific Conductance: 98 µmoh/cm

CALISTOGA SET 2

33 G-033-80

ELEMENT		CONCENTRATION (PPM)
NA		25
K	<	2.50
CA		39
MG		12
FE	<	0.025
AL	<	0.625
SI		14
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		13
F^-		0.4
HCO_3^-		218
$SO_4^=$		23
T.D.S.		367
CORRECTED T.D.S.		260

Temperature	21°C
pH	6.30
Salinity	0.04 %
Specific Conductance	390 μmoh/cm

CALISTOGA SET 2

34 G-034-80

ELEMENT		CONCENTRATION (PPM)
NA		18
K	<	2.50
CA		15
MG		5
FE		0.20
AL	<	0.625
SI		19
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		2.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.2
ZR	<	0.125
LA		1.0
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-		0.1
HCO_3^-		91.5
SO_4^-		23
T.D.S.		207
CORRECTED T.D.S.		162

Temperature	18°C
pH	6.19
Salinity	0.02 %
Specific Conductance	185 umoh/cm

CALISTOGA SET 2

35 G-035-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K	<	2.50
CA		13
MG		4
FE		0.49
AL	<	0.625
SI		17
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-	<	0.1
HCO_3		64.1
$SO_4^=$		24
T.D.S.		159
CORRECTED T.D.S.		127

Temperature	16°C
pH	6.20
salinity	0.03%
Specific Conductance	112 μmoh/c

CALISTOGA SET 2

36 G-036-80

ELEMENT		CONCENTRATION (PPM)
NA		11
K	<	2.50
CA		49
MG		6
FE		0.55
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU		0.1
MO	<	1.25
PB	<	0.250
ZN		3.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.1
HCO_3^-		82.4
$SO_4^=$		16
T.D.S.		219
CORRECTED T.D.S.		178

Temperature	13°C
pH	6.40
Salinity	0.002 %
Specific Conductance	159 µmoh/cm

CALISTOGA SET 2

37 G-037-80

ELEMENT		CONCENTRATION (PPM)
NA		188
K		7
CA		8
MG		1
FE		0.21
AL	<	0.625
SI		31
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.75
BE	<	0.005
B		10.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		195
F^-		10.0
HCO_3^-		172.3
SO_4^-	<	10
T.D.S.		645
CORRECTED T.D.S.		560

Temperature 42°C
pH 6.70
salinity 0.08 %
Specific Conductance 1190 umoh/cm

CALISTOGA SET 2

38 G-038-80

ELEMENT	CONCENTRATION (PPM)
NA	87
K	< 2.50
CA	20
MG	7
FE	2.39
AL	< 0.625
SI	16
TI	< 0.125
P	< 0.625
SR	0.09
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	< 0.250
CO	< 0.025
NI	< 0.125
CU	< 0.063
MO	< 1.25
PB	< 0.250
ZN	3.0
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	< 0.050
BE	< 0.005
B	5.1
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	92
F^-	0.9
HCO_3^-	164.7
SO_4	13
T.D.S.	435
CORRECTED T.D.S.	354

Temperature 16.5°C
pH 6.10
Salinity 0.05%
Specific Conductance 590 µmoh/cm

CALISTOGA SET 2

39 G-039-80

ELEMENT		CONCENTRATION (PPM)
NA		11
K	<	2.50
CA		17
MG		6
FE		0.13
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-	<	0.1
HCO_3^-		80.8
SO_4^-		15
T.D.S.		180
CORRECTED T.D.S.		140

Temperature	16°C
pH	6.08
Salinity	0.03%
Specific Conductance	170 µmoh/cm

CALISTOGA SET 2

40 G-040-80

ELEMENT		CONCENTRATION (PPM)
NA		173
K		5
CA		41
MG		9
FE		1.26
AL	<	0.625
SI		20
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.13
BE	<	0.005
B		10.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		186
F^-		4.2
HCO_3^-		219.6
$SO_4^=$	<	10
T.D.S.		692
CORRECTED T.D.S.		584

Temperature 14.5°C
pH 6.55
Salinity 0.09%
Specific Conductance 870 μmoh/cm

CALISTOGA SET 2

41 G-041-80

ELEMENT		CONCENTRATION (PPM)
NA		26
K	<	2.50
CA		25
MG		7
FE		0.58
AL		0.8
SI		25
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.6
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.07
BE	<	0.005
B		0.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		16
F^-		0.6
HCO_3^-		97.6
$SO_4^=$		14
T.D.S.		236
CORRECTED T.D.S.		188

Temperature	17°C
pH	6.10
Salinity	0.04%
Specific Conductance	202 umo

CALISTOGA SET 2

42 G-042-80

ELEMENT		CONCENTRATION (PPM)
NA		147
K		5
CA		20
MG		12
FE	<	0.025
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.6
CO	<	0.025
NI	<	0.125
CU		0.1
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.26
BE	<	0.005
B		8.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		156
F^-		3.6
HCO_3^-		207.4
$SO_4^=$	<	10
T.D.S.		603
CORRECTED T.D.S.		501

Temperature	15°C
pH	6.30
Salinity	0.06 %
Specific Conductance	750 µmoh/cm

CALISTOGA SET 2

43 G-043-80

ELEMENT		CONCENTRATION (PPM)
NA		42
K	<	2.50
CA		20
MG		10
FE		1.22
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.07
BE	<	0.005
B		1.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		39
F^-		0.7
HCO_3^-		109.8
$SO_4^=$		25
T.D.S.		294
CORRECTED T.D.S.		240

Temperature	16°C
pH	6.52
Salinity	0.04%
Specific Conductance	400 µmoh/cm

CALISTOGA SET 2

44 G-044-80

ELEMENT		CONCENTRATION (PPM)
NA		180
K		12
CA		11
MG		4
FE	<	0.025
AL	<	0.625
SI		35
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.14
BE	<	0.005
B		10.2
ZR	<	0.125
LA		0.8
CE	<	0.250
TH	<	2.50
Cl^-		194
F^-		7.0
HCO_3^-		203
$SO_4^=$	<	10
T.D.S.		678
CORRECTED T.D.S.		578

Temperature	40°C
pH	6.65
Salinity	0.07%
Specific Conductance	1100 μmoh/cm

CALISTOGA SET 2

45 G-045-80

ELEMENT		CONCENTRATION (PPM)
NA		171
K		13
CA		11
MG		6
FE		0.67
AL	<	0.625
SI		30
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.06
BE	<	0.005
B		9.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		186
F^-		7.1
HCO_3^-		188
$SO_4^=$	<	10
T.D.S.		644
CORRECTED T.D.S.		551

Temperature	24°C
pH	5.94
Salinity	0.07 %
Specific Conductance	900 umoh/cm

CALISTOGA SET 2

46 G-046-80

ELEMENT		CONCENTRATION (PPM)
NA		79
K	<	2.50
CA		21
MG		10
FE		1.96
AL		2.1
SI		21
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.48
BE	<	0.005
B		3.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		67
F^-		3.0
HCO_3^-		172
$SO_4^=$	<	10
T.D.S.		404
CORRECTED T.D.S.		319

Temperature	22°C
pH	5.90
Salinity	0.05%
Specific Conductance	410 µmoh/cm

CALISTOGA SET 2

47 G-047-80

ELEMENT		CONCENTRATION (PPM)
NA		116
K	<	2.50
CA		17
MG		15
FE		0.31
AL	<	0.625
SI		18
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		7.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		132
F^-		1.1
HCO_3^-		188
$SO_4^=$	<	10
T.D.S.		413
CORRECTED T.D.S.		320

Temperature	15°C
pH	6.00
Salinity	0.05%
Specific Conductance	650 umoh/cm

CALISTOGA SET 2

48 G-048-80

ELEMENT		CONCENTRATION (PPM)
NA		103
K	<	2.50
CA		28
MG		30
FE		2.94
AL	<	0.625
SI		17
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.1
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		8.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		162
F^-		1.4
HCO_3^-		204.4
SO_4^-	<	10
T.D.S.		581
CORRECTED T.D.S.		480

Temperature	18°C
pH	5.79
Salinity	0.06%
Specific Conductance	720 µmho/cm

CALISTOGA SET 2

49 G-049-80

ELEMENT		CONCENTRATION (PPM)
NA		149
K		3
CA		15
MG		19
FE	<	0.025
AL	<	0.625
SI		20
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.07
BE	<	0.005
B		10.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		176
F^-		1.3
HCO_3^-		215
$SO_4^=$	<	10
T.D.S.		629
CORRECTED T.D.S.		523

Temperature 19°C
pH 5.90
salinity 0.08%
Specific Conductance 850 µmoh/cm

CALISTOGA SET 2

50 G-050-80

ELEMENT		CONCENTRATION (PPM)
NA		155
K		3
CA		14
MG		19
FE		0.22
AL	<	0.625
SI		21
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.08
BE	<	0.005
B		10.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		178
F^-		1.3
HCO_3^-		218
$SO_4^=$		17
T.D.S.		640
CORRECTED T.DS.		533

Temperature	13°C
pH	5.99
Salinity	0.08 %
Specific Conductance	700 µmoh/cm

CALISTOGA SET 2

51 G-051-80

ELEMENT		CONCENTRATION (PPM)
NA		128
K	<	2.50
CA		25
MG		13
FE		0.23
AL	<	0.625
SI		17
TI	<	0.125
P	<	0.625
SR		0.14
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		3.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		7.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		130
F^-		3.5
HCO_3^-		214.3
$SO_4^=$		22
T.D.S.		710
CORRECTED T.D.S.		604

Temperature 13°C
pH 6.10
Salinity 0.08 %
Specific Conductance 700 µmoh/cm

CALISTOGA SET 2

52 G-052-80

ELEMENT		CONCENTRATION (PPM)
NA		27
K	<	2.50
CA		66
MG		19
FE		0.04
AL	<	0.625
SI		24
TI	<	0.125
P	<	0.625
SR		0.26
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		2.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		38
F^-	<	0.1
HCO_3^-		142.6
$SO_4^=$		49
T.D.S.		389
CORRECTED T.D.S.		319

Temperature	19°C
pH	6.25
Salinity	0.05 %
Specific Conductance	590 μmoh/cm

CALISTOGA SET 2

53 G-053-80

ELEMENT		CONCENTRATION (PPM)
NA		92
K	<	2.50
CA		65
MG		23
FE		0.15
AL	<	0.625
SI		23
TI	<	0.125
P	<	0.625
SR		0.22
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		29.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		67
F^-		0.2
HCO_3^-		302.7
$SO_4^=$		43
T.D.S.		669
CORRECTED T.D.S.		520

Temperature	19.5°C
pH	6.12
Salinity	0.08 %
Specific Conductance	820 μmoh/cm

CALISTOGA SET 2

54 G-054-80

ELEMENT		CONCENTRATION (PPM)
NA		203
K		7
CA		18
MG		9
FE		0.04
AL	<	0.625
SI		20
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.59
BE	<	0.005
B		11.7
ZR	<	0.125
LA		0.1
CE	<	0.250
TH	<	2.50
Cl^-		189
F^-		0.7
HCO_3^-		284.4
$SO_4^=$		11
T.D.S.		775
CORRECTED T.D.S.		635

Temperature	24°C
pH	6.90
Salinity	0.09%
Specific Conductance	1050 umoh/cm

CALISTOGA SET 2

55 G-055-80

ELEMENT		CONCENTRATION (PPM)
NA		55
K		4
CA		27
MG		10
FE		2.61
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		6.9
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		37
F^-		0.2
HCO_3^-		196
SO_4^-		16
T.D.S.		397
CORRECTED T.D.S.		300

Temperature	19°C
pH	6.50
Salinity	0.03 %
Specific Conductance	450 μmoh/cm

CALISTOGA SET 3

56 G-056-80

ELEMENT		CONCENTRATION (PPM)
NA		17
K	<	2.50
CA		23
MG		8
FE		0.22
AL	<	0.625
SI		21
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		10
F^-		0.1
HCO_3^-		99.9
$SO_4^=$		11
T.D.S.		213
CORRECTED T.D.S.		164

Temperature	18°C
pH	5.63
Salinity	0.01 %
Specific Conductance	203 μmoh/cm

CALISTOGA SET 3

57 G-057-80

ELEMENT		CONCENTRATION (PPM)
NA		203
K		5
CA		25
MG		8
FE		0.12
AL	<	0.625
SI		29
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.32
BE	<	0.005
B		8.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		181
F^-		2.2
HCO_3^-		302.7
$SO_4^=$	<	10
T.D.S.		797
CORRECTED T.D.S.		648

Temperature	37.5°C
pH	6.50
Salinity	0.08%
Specific Conductance	1180 µmhos

CALISTOGA SET 3

58 G-058-80

ELEMENT		CONCENTRATION (PPM)
NA		191
K		4
CA		10
MG		1
FE		0.14
AL	<	0.625
SI		42
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.40
BE	<	0.005
B		9.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		191
F^-		8.5
HCO_3^-		165.5
$SO_4^=$	<	10
T.D.S.		643
CORRECTED T.D.S.		561

Temperature	57°C
pH	6.65
Salinity	0.06%
Specific Conductance	1120 μmoh/cm

CALISTOGA SET 3

59 G-059-80

ELEMENT		CONCENTRATION (PPM)
NA		62
K		4
CA		27
MG		8
FE		0.08
AL	<	0.625
SI		19
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		39
F^-		0.5
HCO_3^-		196
SO_4^-		13
T.D.S.		389
CORRECTED T.D.S.		292

Temperature	20°C
pH	6.35
Salinity	0.03 %
Specific Conductance	490 μmoh/cm

CALISTOGA SET 3

60 G-060-80

ELEMENT		CONCENTRATION (PPM)
NA		46
K	<	2.50
CA		25
MG		10
FE		0.26
AL	<	0.625
SI		24
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		27
F^-		0.2
HCO_3^-		171.6
$SO_4^=$		12
T.D.S.		335
CORRECTED T.D.S.		250

Temperature	16°C
pH	6.64
Salinity	0.03%
Specific Conductance	390 µmho/cm

CALISTOGA SET 3

61 G-061-80

ELEMENT		CONCENTRATION (PPM)
NA		27
K	<	2.50
CA		35
MG		7
FE		0.48
AL	<	0.625
SI		27
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU		0.6
MO	<	1.25
PB	<	0.250
ZN		1.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		14
F^-		0.2
HCO_3^-		127.3
SO_4^-		14
T.D.S.		276
CORRECTED T.D.S.		213

Temperature	14.5°C
pH	6.55
Salinity	0.01 %
Specific Conductance	290 umoh/cm

CALISTOGA SET 3

62 G-062-80

ELEMENT	CONCENTRATION (PPM)
NA	46
K	< 2.50
CA	39
MG	14
FE	0.34
AL	< 0.625
SI	25
TI	< 0.125
P	< 0.625
SR	0.12
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	< 0.250
CO	< 0.025
NI	< 0.125
CU	< 0.063
MO	< 1.25
PB	< 0.250
ZN	0.3
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	< 0.050
BE	< 0.005
B	0.5
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	49
F^-	0.2
HCO_3^-	173.1
$SO_4^=$	34
T.D.S.	403
CORRECTED T.D.S.	318

Temperature 19°C
pH 6.54
Salinity 0.04 %
Specific Conductance 495 µohm/cm

CALISTOGA SET 3

63 G-063-80

ELEMENT	CONCENTRATION (PPM)
NA	141
K	6
CA	54
MG	21
FE	2.23
AL	< 0.625
SI	17
TI	< 0.125
P	< 0.625
SR	0.19
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	1.7
CO	< 0.025
NI	< 0.125
CU	< 0.063
MO	< 1.25
PB	< 0.250
ZN	< 0.125
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	< 0.050
BE	< 0.005
B	3.8
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	190
F^-	0.4
HCO_3^-	243.2
$SO_4^=$	37
T.D.S.	737
CORRECTED T.D.S.	617

Temperature	28°C
pH	6.80
Salinity	0.09%
Specific Conductance	1150 µmoh/cm

CALISTOGA SET 3

64 G-064-80

ELEMENT		CONCENTRATION (PPM)
NA		56
K	<	2.50
CA		34
MG		11
FE		2.00
AL	<	0.625
SI		23
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		38
F^-		0.3
HCO_3^-		162.4
SO_4^-		29
T.D.S.		380
CORRECTED T.D.S.		300

Temperature	21°C
pH	6.80
Salinity	0.03%
Specific Conductance	450 umoh/cm

CALISTOGA SET 3

65 G-065-80

ELEMENT		CONCENTRATION (PPM)
NA		54
K	<	2.50
CA		57
MG		14
FE		0.72
AL	<	0.625
SI		17
TI	<	0.125
P	<	0.625
SR		0.15
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		83
F^-		0.1
HCO_3^-		160.9
SO_4^-		26
T.D.S.		318
CORRECTED T.D.S.		239

Temperature	15°C
pH	6.78
Salinity	0.04%
Specific Conductance	530 µmoh/cm

CALISTOGA SET 3

66 G-066-80

ELEMENT		CONCENTRATION (PPM)
NA		84
K		4
CA		47
MG		19
FE		1.51
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.16
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.2
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		53
F^-		0.2
HCO_3^-		292
$SO_4^=$		28
T.D.S.		572
CORRECTED T.D.S.		428

Temperature	35°C
pH	6.80
Salinity	0.05 %
Specific Conductance	840 µmoh/cm

CALISTOGA SET 3

67 G-067-80

ELEMENT		CONCENTRATION (PPM)
NA		59
K		4
CA		65
MG		25
FE		0.12
AL	<	0.625
SI		20
TI	<	0.125
P	<	0.625
SR		0.23
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		43
F^-		0.2
HCO_3^-		163.9
SO_4^-		50
T.D.S.		454
CORRECTED T.D.S.		372

Temperature 36°C

pH 6.99

Salinity 0.05%

Specific Conductance 850 μmoh/cm

CALISTOGA SET 3

68 G-068-80

ELEMENT		CONCENTRATION (PPM)
NA		152
K		4
CA		12
MG		4
FE		0.21
AL	<	0.625
SI		24
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.49
BE	<	0.005
B		7.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		140
F^-		4.8
HCO_3^-		191.4
$SO_4^=$		41
T.D.S.		600
CORRECTED T.D.S.		506

Temperature	34°C
pH	6.95
Salinity	0.06%
Specific Conductance	800 µmoh/cm

CALISTOGA SET 3

69 G-069-80

ELEMENT		CONCENTRATION (PPM)
NA		38
K	<	2.50
CA		35
MG		23
FE		0.33
AL	<	0.625
SI		24
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.34
BE	<	0.005
B		0.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		10
F^-		2.8
HCO_3^-		272.2
SO_4^-		14
T.D.S.		416
CORRECTED T.D.S.		282

Temperature – UNKNOWN
pH 6.90
salinity 0.03%
Specific Conductance 420 umoh/cm

CALISTOGA SET 3

70 G-070-80

ELEMENT		CONCENTRATION (PPM)
NA		14
K	<	2.50
CA		35
MG		6
FE		0.33
AL	<	0.625
SI		10
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-		0.2
HCO_3^-		145.6
SO_4^-		16
T.D.S.		219
CORRECTED T.D.S.		147

Temperature	15°C
pH	6.90
Salinity	0.01 %
Specific Conductance	260 μmoh/cm

CALISTOGA SET 3

71 G-071-80

ELEMENT		CONCENTRATION (PPM)
NA		32
K		7
CA		234
MG		46
FE		4.75
AL	<	0.625
SI		11
TI	<	0.125
P	<	0.625
SR		0.51
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.9
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		26
F^-		0.3
HCO_3^-		327.1
SO_4^-		85
T.D.S.		746
CORRECTED T.D.S.		585

Temperature	30°C
pH	6.88
Salinity	0.06 %
Specific Conductance	1030 umoh/cm

CALISTOGA SET 3

72 G-072-80

ELEMENT		CONCENTRATION (PPM)
NA		7
K	<	2.50
CA		14
MG		4
FE		0.24
AL	<	0.625
SI		13
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.1
HCO_3^-		57.2
SO_4^-		195
T.D.S.		310
CORRECTED T.D.S.		285

Temperature	14°C
pH	7.28
Salinity	0.01 %
specific Conductance	68 µmoh/cm

CALISTOGA SET 3

73 G-073-80

ELEMENT		CONCENTRATION (PPM)
NA		7
K	<	2.50
CA		14
MG		4
FE		0.20
AL	<	0.625
SI		12
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.9
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-	<	0.1
HCO_3^-		66.3
SO_4^-		89
T.D.S.		307
CORRECTED T.D.S.		274

Temperature	11°C
pH	6.74
Salinity	0.01 %
Specific Conductance	180 µmoh/cm

CALISTOGA SET 3

74 G-074-80

ELEMENT		CONCENTRATION (PPM)
NA		32
K	<	2.50
CA		54
MG		16
FE		0.64
AL	<	0.625
SI		13
TI	<	0.125
P	<	0.625
SR		0.29
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		8
F^-		0.1
HCO_3^-		252.4
$SO_4^=$		30
T.D.S.		429
CORRECTED T.D.S.		305

Temperature	16°C
pH	6.80
Salinity	0.03%
Specific Conductance	500 μmohs/cm

CALISTOGA SET 3

75 G-075-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K	<	2.50
CA		26
MG		5
FE		3.58
AL	<	0.625
SI		11
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		5.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-	<	0.1
HCO_3^-		121.2
SO_4^-		29
T.D.S.		318
CORRECTED T.D.S.		258

Temperature	13°C
pH	6.84
salinity	0.01 %
Specific Conductance	162 μmho/cm

CALISTOGA SET 3

76 G-076-80

ELEMENT		CONCENTRATION (PPM)
NA		19
K	<	2.50
CA		75
MG		10
FE		0.56
AL	<	0.625
SI		13
TI	<	0.125
P	<	0.625
SR		0.19
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		10
F^-		0.2
HCO_3^-		163.9
SO_4^-	<	10
T.D.S.		316
CORRECTED T.D.S.		235

Temperature	16°C
pH	6.70
Salinity	0.02 %
Specific Conductance	300 umoh/cm

CALISTOGA SET 3

77 G-077-80

ELEMENT		CONCENTRATION (PPM)
NA		12
K	<	2.50
CA		51
MG		21
FE		0.12
AL	<	0.625
SI		15
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		4.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		32
F^-	<	0.1
HCO_3^-		193
SO_4^-		20
T.D.S.		370
CORRECTED T.D.S.		275

Temperature 19°C
pH 6.80
Salinity 0.03%
Specific Conductance 440 µmho/cm

CALISTOGA SET 3

78 G-078-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K	<	2.50
CA		23
MG		5
FE		0.21
AL	<	0.625
SI		10
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-	<	0.1
HCO_3^-		67.9
$SO_4^=$		21
T.D.S.		244
CORRECTED T.D.S.		211

Temperature	15°C
pH	6.99
Salinity	0.01 %
Specific Conductance	170 μmoh/cm

CALISTOGA SET 3

79 G-079-80

ELEMENT		CONCENTRATION (PPM)
NA		22
K	<	2.50
CA		57
MG		11
FE	<	0.025
AL	<	0.625
SI		10
TI	<	0.125
P	<	0.625
SR		0.14
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		8
F^-		0.3
HCO_3^-		237.1
$SO_4^=$		28
T.D.S.		399
CORRECTED T.D.S.		282

Temperature	20.5°C
pH	6.77
Salinity	0.03%
Specific Conductance	460 µmoh/cm

CALISTOGA SET 3

80 G-080-80

ELEMENT		CONCENTRATION (PPM)
NA		15
K	<	2.50
CA		15
MG		4
FE		0.90
AL	<	0.625
SI		12
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		17
F^-		0.1
HCO_3^-		87.7
SO_4^-		23
T.D.S.		198
CORRECTED T.D.S.		155

Temperature	19°C
pH	6.78
Salinity	0.02
Specific Conductance	148 μmoh/cm

CALISTOGA SET 3

81 G-081-80

ELEMENT		CONCENTRATION (PPM)
NA		7
K	<	2.50
CA		10
MG		3
FE		0.43
AL	<	0.625
SI		12
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-	<	0.1
HCO_3^-		46.5
$SO_4^=$		13
T.D.S.		161
CORRECTED T.D.S.		118

Temperature	16 °C
pH	7.00
Salinity	0.01 %
Specific Conductance	93 μmho/cm

CALISTOGA SET 3

82 G-082-80

ELEMENT		CONCENTRATION (PPM)
NA		14
K	<	2.50
CA		73
MG		17
FE		0.16
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		2.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		13
F^-		0.2
HCO_3^-		314.9
SO_4^-		14
T.D.S.		212
CORRECTED T.D.S.		189

Temperature	16°C	
pH	6.50	
Salinity	0.03%	
Specific Conductance	490	μmoh/cm

CALISTOGA SET 3

83 G-083-80

ELEMENT		CONCENTRATION (PPM)
NA		10
K	<	2.50
CA		30
MG		7
FE		0.68
AL	<	0.625
SI		10
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS		1.0
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-	<	0.1
HCO_3^-		112.1
SO_4^-		13
T.D.S.		212
CORRECTED T.D.S.		157

Temperature	19°C
pH	5.98
Salinity	0.01 %
Specific Conductance	178 µmoh/cm

CALISTOGA SET 3

84 G-084-80

ELEMENT		CONCENTRATION (PPM)
NA		27
K	<	2.50
CA		67
MG		17
FE		0.36
AL	<	0.625
SI		10
TI	<	0.125
P	<	0.625
SR		0.21
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		28
F^-		0.4
HCO_3^-		253.9
SO_4^-		16
T.D.S.		443
CORRECTED T.D.S.		318

Temperature	24°C
pH	6.13
Salinity	0.04%
Specific Conductance	540 µmoh/cm

CALISTOGA SET 3

85 G-085-80

ELEMENT		CONCENTRATION (PPM)
NA		16
K	<	2.50
CA		49
MG		4
FE		0.08
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.18
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.3
HCO_3^-		168.5
$SO_4^=$		27
T.D.S.		304
CORRECTED T.D.S.		221

Temperature	19°C
pH	6.20
salinity	0.01%
Specific Conductance	268 umoh/c

CALISTOGA SET 3

86 G-086-80

ELEMENT		CONCENTRATION (PPM)
NA		31
K	<	2.50
CA		22
MG		6
FE		0.07
AL	<	0.625
SI		5
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		15
F^-		0.1
HCO_3^-		157.8
$SO_4^=$		15
T.D.S.		277
CORRECTED T.D.S.		199

Temperature	24°C
pH	6.4
Solubility	0.01%
Specific Conductance	250 µmho/cm

CALISTOGA SET 3

87 G-087-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K	<	2.50
CA		119
MG		7
FE		1.80
AL		2.0
SI		16
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		3.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-	<	0.1
HCO_3^-		51.1
SO_4^-	<	10
T.D.S.		235
CORRECTED T.D.S.		210

Temperature 18°C

pH 6.05

Salinity 0.01 %

Specific Conductance 112 µmoh/cm

CALISTOGA SET 3

88 G-088-80

ELEMENT		CONCENTRATION (PPM)
NA		60
K	<	2.50
CA		52
MG		13
FE		1.27
AL	<	0.625
SI		15
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.9
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		13
F^-		0.4
HCO_3^-		311.9
SO_4^-	<	10
T.D.S.		492
CORRECTED T.D.S.		338

Temperature	26 °C
pH	6.15
Salinity	0.03 %
Specific Conductance	500 µmoh/cm

CALISTOGA SET 3

89 G-089-80

ELEMENT		CONCENTRATION (PPM)
NA		11
K	<	2.50
CA		13
MG		3
FE		0.15
AL	<	0.625
SI		12
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA		0.7
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-	<	0.1
HCO_3^-		41.9
$SO_4^=$	<	10
T.D.S.		104
CORRECTED T.D.S.		83

Temperature 22°C
pH 6.18
salinity 0.01 %
Specific Conductance 135 umoh/cm

CALISTOGA SET 3

90 G-090-80

ELEMENT		CONCENTRATION (PPM)
NA		11
K	<	2.50
CA		11
MG		4
FE		0.17
AL	<	0.625
SI		11
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.1
HCO_3^-		29.7
SO_4^-		16
T.D.S.		112
CORRECTED T.D.S.		97

Temperature	20°C
pH	5.80
Salinity	0.01 %
Specific Conductance	112 umoh/cm

CALISTOGA SET 3

91 G-091-80

ELEMENT	CONCENTRATION (PPM)
NA	17
K	< 2.50
CA	39
MG	29
FE	< 0.025
AL	< 0.625
SI	18
TI	< 0.125
P	< 0.625
SR	0.08
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	< 0.250
CO	< 0.025
NI	< 0.125
CU	< 0.063
MO	< 1.25
PB	< 0.250
ZN	< 0.125
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	< 0.050
BE	< 0.005
B	< 0.125
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	9
F^-	0.4
HCO_3^-	261.5
SO_4^-	11
T.D.S.	408
CORRECTED T.D.S.	279

Temperature	28°C
pH	5.90
Salinity	0.03 %
Specific Conductance	510 umoh/cm

CALISTOGA SET 3

92 G-092-80

ELEMENT		CONCENTRATION (PPM)
NA		185
K		9
CA		7
MG		3
FE		0.06
AL	<	0.625
SI		50 ✓
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.72
BE	<	0.005
B		9.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		189
F^-		10.5
HCO_3^-		157.8
$SO_4^=$		0
T.D.S.		644
CORRECTED T.D.S.		564

Temperature 41°C
pH 6.50
Salinity 0.06%
Specific Conductance 780 µmoh/cm

CALISTOGA SET 4

93 G-093-80

ELEMENT		CONCENTRATION (PPM)
NA		211
K		9
CA		3
MG	<	0.500
FE	<	0.025
AL	<	0.625
SI		54
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		2.17
BE	<	0.005
B		10.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		216
F^-		12.0
HCO_3^-		156.3
$SO_4^=$		<10
T.D.S.		712
CO_3		0.7
CORRECTED T.D.S.		635

Temperature 93°C
pH 8.80
Salinity 0.08%
Spec. Conductance 1430 µmoh/cm

CALISTOGA SET 4

94 G-094-80

ELEMENT		CONCENTRATION (PPM)
NA		184
K		5
CA		17
MG		1
FE		0.14
AL	<	0.625
SI		38
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.85
BE	<	0.005
B		3.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		81
F^-		6.8
HCO_3^-		376.7
$SO_4^=$		20
T.D.S.		756
CORRECTED T.D.S.		570

Temperature 22°C
pH 8.00
Salinity 0.06%
Spec. Conductance 860 µmho/cm

CALISTOGA SET 4

95 G-095-80

ELEMENT		CONCENTRATION (PPM)
NA		218
K		6
CA		9
MG		1
FE		0.03
AL	<	0.625
SI		36
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		2.30
BE	<	0.005
B		7.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		162
F^-		8.3
HCO_3^-		270.7
SO_4^-		35
T.D.S.		741
CORRECTED T.D.S.		608

Temperature	52°C
pH	7.82
Salinity	0.08%
Specific Conductance	1420 umoh/c

CALISTOGA SET 4

96 G-096-80

ELEMENT		CONCENTRATION (PPM)
NA		192
K		6
CA		10
MG	<	0.500
FE	<	0.025
AL	<	0.625
SI		41
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		2.02
BE	<	0.005
B		8.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		187
F^-		10.7
HCO_3^-		203.6
SO_4^-		19
T.D.S.		681
CORRECTED T.D.S.		581

Temperature	85°C
pH	8.05
Salinity	0.08%
Specific Conductance	1420 umoh/cm

CALISTOGA SET 4

97 G-097-80

ELEMENT		CONCENTRATION (PPM)
NA		222
K		10
CA		4
MG	<	0.500
FE		0.05
AL	<	0.625
SI		56
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI		2.26
BE	<	0.005
B		11.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		219
F^-		12.3
HCO_3^-		121.2
CO_3^-		3.0
SO_4^-		12
T.D.S.		682
CORRECTED T.D.S.		622

Temperature	95°C
pH	8.40
Salinity	0.08 %
Specific Conductance	1420 umoh/cm

CALISTOGA SET 4

98 G-098-80

ELEMENT		CONCENTRATION (PPM)
NA		213
K		9
CA		13
MG	<	0.500
FE		0.05
AL	<	0.625
SI		53
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.6
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI		2.16
BE	<	0.005
B		10.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		217
F^-		12.2
HCO_3^-		128.1
CO_3^-		2.6
SO_4^-	<	10
T.D.S.		663
CORRECTED T.D.S.		619

Temperature	96°F
pH	8.48
salinity	0.07%
Specific Conductance	1410 umoh/cm

CALISTOGA SET 4

99 G-099-80

ELEMENT		CONCENTRATION (PPM)
NA		206
K		9
CA		8
MG	<	0.500
FE	<	0.025
AL	<	0.625
SI		51
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI		2.09
BE	<	0.005
B		10.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		212
F^-		11.8
HCO_3^-		131.9
CO_3^-		1.9
SO_4^-	<	10
T.D.S.		663
CORRECTED T.D.S.		598

Temperature	94°C
pH	8.59
Salinity	0.08 %
Specific Conductance	1350 umoh/cm

CALISTOGA SET 4

100 G-100-80

ELEMENT		CONCENTRATION (PPM)
NA		200
K		8
CA		6
MG	<	0.500
FE	<	0.025
AL	<	0.625
SI		51
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.2
LI		2.04
BE	<	0.005
B		10.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		209
F^-		12.0
HCO_3^-		184.5
$SO_4^=$		11
T.D.S.		781
CORRECTED T.D.S.		691

Temperature 252° F @ 190'

pH 7.60

Salinity 0.08 %

Specific Conductance 1320 μmoh/cm

CALISTOGA SET 4

101 G-101-80

ELEMENT		CONCENTRATION (PPM)
NA		13
K	<	2.50
CA		15
MG		11
FE	<	0.025
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.12
BE	<	0.005
B		0.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.2
HCO_3^-		113.6
$SO_4^=$		20
T.D.S.		192
CORRECTED T.D.S.		134

Temperature	25 °C
pH	7.20
Salinity	0.01 %
Specific Conductance	250 umoh/

CALISTOGA SET 4

102 G-102-80

ELEMENT		CONCENTRATION (PPM)
NA		210
K		4
CA		4
MG		1
FE		0.26
AL	<	0.625
SI		39
TI	<	0.125
P	<	0.625
SR		0.02
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.2
LI		1.77
BE	<	0.005
B		8.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		192
F^-		10.0
HCO_3^-		224.2
SO_4^{-}		30
T.D.S.		715
CORRECTED T.D.S.		605

Temperature	66°F
pH	7.24
salinity	0.08 %
Specific Conductance	1180 µmho

CALISTOGA SET 4

103 G-103-80

ELEMENT		CONCENTRATION (PPM)
NA		282
K		7
CA		31
MG		3
FE		0.14
AL	<	0.625
SI		28
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		3.31
BE	<	0.005
B		9.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
CL^-		206
F^-		7.9
HCO_3^-		199
$SO_4^=$		19
T.D.S.		796
CORRECTED T.D.S.		698

Temperature	34°C
pH	7.25
Salinity	0.10%
Specific Conductance	1680 umo

CALISTOGA SET 4

104 G-104-80

ELEMENT		CONCENTRATION (PPM)
NA		212
K		6
CA		5
MG		1
FE		0.21
AL	<	0.625
SI		48
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.2
LI		1.63
BE	<	0.005
B		8.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		204
F^-		8.7
HCO_3^-		224.9
$SO_4^=$	<	10
T.D.S.		741
CORRECTED T.D.S.		630

Temperature	45°C
pH	7.32
Salinity	0.08%
Specific Conductivity	1300 µmoh/cm

CALISTOGA SET 4

105 G-105-80

ELEMENT		CONCENTRATION (PPM)
NA		200
K		7
CA		6
MG	<	0.500
FE		0.12
AL	<	0.625
SI		59
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.59
BE	<	0.005
B		9.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		191
F^-		9.1
HCO_3^-		219.6
$SO_4^=$	<	10
T.D.S.		724
CORRECTED T.D.S.		616

Temperature	44°C
pH	7.40
Salinity	0.08%
Specific Conductance	1270 μmo

CALISTOGA SET 4

106 G-106-80

ELEMENT		CONCENTRATION (PPM)
NA		202
K		7
CA		5
MG	<	0.500
FE		0.15
AL	<	0.625
SI		61
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI		1.60
BE	<	0.005
B		9.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		191
F^-		9.1
HCO_3^-		218.8
SO_4^-	<	10
T.D.S.		727
CORRECTED T.D.S.		619

Temperature	130°F
pH	7.41
salinity	0.08 %
Specific Conductance	1350 μmoh/cm

CALISTOGA SET 4

107 G-107-80

ELEMENT		CONCENTRATION (PPM)
NA		163
K		3
CA		7
MG	<	0.500
FE		0.08
AL	<	0.625
SI		15
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.97
BE	<	0.005
B		2.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		66
F^-		6.5
HCO_3^-		356.1
SO_4^-		20
T.D.S.		642
Corrected T.DS.		467

Temperature	25°C
pH	7.40
Salinity	0.05%
Specific Conductance	760 µmoh/cm

CALISTOGA SET 4

108 G-108-80

ELEMENT		CONCENTRATION (PPM)
NA		117
K		4
CA		14
MG		5
FE		0.85
AL	<	0.625
SI		28
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.20
BE	<	0.005
B		3.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		55
F^-		1.9
HCO_3^-		288.2
$SO_4^=$		47
T.D.S.		538
Corrected T.D.S.		396

Temperature	57°C
pH	7.02
Salinity	0.04%
Specific Conductance	800 µmoh/cm

CALISTOGA SET 4

109 G-109-80

ELEMENT		CONCENTRATION (PPM)
NA		112
K	<	2.50
CA		7
MG		2
FE		0.13
AL	<	0.625
SI		25
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.47
BE	<	0.005
B		3.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		49
F^-		3.6
HCO_3^-		260.8
$SO_4^=$	<	10
T.D.S.,		496
Corrected T.D.S		368

Temperature	51°C
pH	7.25
Salinity	0.03 %
Specific Conductance	500 µmho/

CALISTOGA SET 4

110 G-110-80

ELEMENT		CONCENTRATION (PPM)
NA		112
K		4
CA		85
MG		27
FE		0.03
AL	<	0.625
SI		20
TI	<	0.125
P	<	0.625
SR		0.36
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		174
F^-		0.2
HCO_3^-		363
SO_4^-		28
T.D.S.		835
Corrected T.D.S.		656

Temperature	28°C
pH	6.71
Salinity	0.05 %
Specific Conductance	790 umoh/cm

CALISTOGA SET 4

111 G-111-80

ELEMENT		CONCENTRATION (PPM)
NA		205
K		9
CA		6
MG	<	0.500
FE	<	0 025
AL	<	0.625
SI		54
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		2.09
BE	<	0.005
B		10.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		212
F^-		11.5
HCO_3^-		174
$SO_4^{=}$		14
T.D.S.		719
Corrected T.DS		633

Temperature	219°F
pH	7.85
Salinity	0.07 %
Specific Conductance	1390 umoh/c

CALISTOGA SET 4

112 G-112-80

ELEMENT		CONCENTRATION (PPM)
NA		239
K		7
CA		10
MG		2
FE		0.31
AL	<	0.625
SI		38
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		2.28
BE	<	0.005
B		8.9
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		198
F^-		8.8
HCO_3^-		279.8
SO_4^-		37
T.D.S.		851
Corrected T.D.S		713

Temperature	30°C
pH	6.40
Salinity	0.08
Specific Conductance	1120 µmoh/cm

CALISTOGA SET 4

113 G-113-80

ELEMENT		CONCENTRATION (PPM)
NA		249
K		6
CA		10
MG		1
FE	<	0.025
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		2.76
BE	<	0.005
B		9.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		205
F^-		9.0
HCO_3^-		224.9
SO_4^-		54
T.D.S.		823
Corrected T.D.S.		712

Temperature	57°C
pH	6.94
Salinity	0.06 %
Specific Conductance	950 µmoh/cm

CALISTOGA SET 4

114 G-114-80

ELEMENT		CONCENTRATION (PPM)
NA		189
K		6
CA		12
MG	<	0.500
FE		1.72
AL	<	0.625
SI		28
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.99
BE	<	0.005
B		8.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		155
F^-		10.0
HCO_3^-		259.5
SO_4^-		16
T.D.S.		707
Corrected T.D.S.		580

Temperature	41°C
pH	7.15
Salinity	0.05%
Specific Conductance	910 µmoh/cm

CALISTOGA SET 4

115 G-115-80

ELEMENT		CONCENTRATION (PPM)
NA		143
K		10
CA		6
MG		3
FE		0.43
AL	<	0.625
SI		34
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.93
BE	<	0.005
B		8.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		76
F^-		4.2
HCO_3^-		316.4
$SO_4^=$		11
T.D.S.		633

Corrected T.D.S. 477

Temperature	35 °C
pH	7.00
Salinity	0.04%
Specific Conductance	760 µmoh/cm

CALISTOGA SET 4

116 G-116-80

ELEMENT		CONCENTRATION (PPM)
NA		238
K		7
CA		8
MG		3
FE		0.59
AL	<	0.625
SI		37
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.48
BE	<	0.005
B		12.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		191
F^-		3.1
HCO_3^-		359.9
$SO_4^{=}$	<	10
T.D.S.		922
Corrected T.D.S.		744

Temperature	30°C
pH	6.95
Salinity	0.07%
Specific Conductance	1120 umho/cm

CALISTOGA SET 5

117 G-117-80

ELEMENT		CONCENTRATION (PPM)
NA		75
K	<	2.50
CA		25
MG		3
FE		0.04
AL	<	0.625
SI		23
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.2
HCO_3^-		318.7
SO_4^-		20
T.D.S.		495
Corrected T.D.S		334

Temperature	24°C
pH	6.20
Salinity	0.02%
Specific Conductance	450 μmol/cm

CALISTOGA SET 5

118 G-118-80

ELEMENT		CONCENTRATION (PPM)
NA		47
K	<	2.50
CA		26
MG		4
FE	<	0.025
AL	<	0.625
SI		23
TI	<	0.125
P	<	0.625
SR		0.01
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.4
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		11
F^-		0.4
HCO_3^-		219.6
$SO_4^=$		19
T.D.S.		373
Corrected T.D.S.		262

Temperature	14°C
pH	6.20
Salinity	0.02%
Specific Conductance	320 µmoh/cm

CALISTOGA SET 5

119 G-119-80

ELEMENT		CONCENTRATION (PPM)
NA		10
K	<	2.50
CA		12
MG		4
FE		0.46
AL		0.9
SI		19
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		<0.1
HCO_3^-		54.1
$SO_4^=$	<	10
T.D.S.		139
Corrected T.D.S.		112

Temperature	20°C
pH	6.35
Salinity	0.00 %
Specific Conductance	122 µmoh/cm

CALISTOGA SET 5

120 G-120-80

ELEMENT		CONCENTRATION (PPM)
NA		51
K	<	2.50
CA		13
MG		1
FE		0.11
AL	<	0.625
SI		21
TI	<	0.125
P	<	0.625
SR	<	0.013
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-		0.4
HCO_3^-		196
$SO_4^=$	<	10
T.D.S.		324
corrected T.D.S.		225

- Temperature: 13°C
- pH: 6.80
- salinity: 0.01 %
- Specific Conductance: 300 µmho/cm

CALISTOGA SET 5

121 G-121-80

ELEMENT		CONCENTRATION (PPM)
NA		26
K		4
CA		15
MG		5
FE		0.26
AL	<	0.625
SI		31
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU		0.1
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-		0.5
HCO_3^-		125
$SO_4^=$	<	10
T.D.S		246
Corrected T.D.S		183

Temperature 15°C
pH 6.90
salinity 0.01%
Specific Conductance 95 µmoh/cm

CALISTOGA SET 5

122 G-122-80

ELEMENT		CONCENTRATION (PPM)
NA		29
K		4
CA		17
MG		7
FE		2.20
AL	<	0.625
SI		25
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.7
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.6
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		12
F^-		0.8
HCO_3^-		180.7
SO_4^-	<	10
T.D.S.		309
corrected T.D.S.		217

Temperature	15 °C
pH	6.98
Salinity	0.02 %
Specific Conductance	228 µmoh/cm

CALISTOGA SET 5

123 G-123-80

ELEMENT		CONCENTRATION (PPM)
NA		38
K		5
CA		35
MG		13
FE		5.71
AL	<	0.625
SI		32
TI	<	0.125
P		0.9
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.4
CO	<	0.025
NI	<	0.125
CU		1.2
MO	<	1.25
PB	<	0.250
ZN		1.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.4
ZR	<	0.125
LA		1.6
CE	<	0.250
TH	<	2.50
Cl^-		55
F^-		0.3
HCO_3^-		168.5
$SO_4^=$	<	10
T.D.S.		379
corrected T.D.S.		294

Temperature	17°C
pH	6.60
Salinity	0.02 %
Specific Conductance	440 µmoh/cm

CALISTOGA SET 5

124 G-124-80

ELEMENT		CONCENTRATION (PPM)
NA		10
K	<	2.50
CA		7
MG		5
FE		0.95
AL		1.4
SI		23
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.6
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.1
HCO_3^-		55.7
SO_4^-	<	10
T.D.S.		140

Corrected T.D.S. 112

Temperature	17°C
pH	6.89
Salinity	0.01 %
Specific Conductance	105 µmho/cm

CALISTOGA SET 5

125 G-125-80

ELEMENT		CONCENTRATION (PPM)
NA		44
K		6
CA		21
MG		13
FE		0.77
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		71
F^-		0.4
HCO_3^-		135
$SO_4^{=}$		10
T.D.S.		346
Corrected T.D.S.		278

Temperature	17°C
pH	6.12
Salinity	0.03 %
Specific Conductance	430 μmoh/cm

CALISTOGA SET 5

126 G-126-80

ELEMENT		CONCENTRATION (PPM)
NA		29
K	<	2.50
CA		18
MG		12
FE		0.12
AL	<	0.625
SI		26
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.6
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		33
F^-		0.2
HCO_3^-		106
SO_4^-		13
T.D.S.		262
Corrected T.D.S.		198

Temperature	18°C
pH	6.35
salinity	0.02 %
Specific Conductance	350 µmoh/cm

CALISTOGA SET 5

127 G-127-80

ELEMENT		CONCENTRATION (PPM)
NA		10
K	<	2.50
CA		5
MG		2
FE		0.93
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-	<	0.1
HCO_3^-		37.4
SO_4^-	<	10
T.D.S.		118

Corrected T.D.S 100

Temperature	17°C
pH	6.39
Salinity	0.00 %
Specific Conductance	85 µmoh/cm

CALISTOGA SET 5

128 G-128-80

ELEMENT		CONCENTRATION (PPM)
NA		15
K		4
CA		9
MG		4
FE		0.39
AL		0.7
SI		25
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		10
F^-		0.1
HCO_3^-		83.1
SO_4	<	10
T.D.S.		182
Corrected T.D.S.		140

Temperature	18°C
pH	6.45
Salinity	0.01 %
Specific Conductance	92 µmho/cm

CALISTOGA SET 5

129 G-129-80

ELEMENT		CONCENTRATION (PPM)
NA		7
K		3
CA		11
MG		5
FE		0.40
AL		0.7
SI		12
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA		0.2
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-	<	0.1
HCO_3^-		76.3
SO_4^-	<	10
T.D.S.		151
Corrected T.D.S.		113

Temperature	17°C
pH	6.55
Salinity	0.01 %
Specific Conductance	128 µmoh/cm

CALISTOGA SET 5

130 G-130-80

ELEMENT		CONCENTRATION (PPM)
NA		7
K	<	2.50
CA		5
MG		1
FE		1.27
AL		2.3
SI		17
TI	<	0.125
P	<	0.625
SR		0.01
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl		6
F^-	<	0.1
HCO_3^-		13.7
$SO_4^=$	<	10
T.D.S.		86
Corrected T.D.S.		79

Temperature	17°C
pH	6.90
Salinity	0.00 %
Specific Conductance	51 μmoh/cm

CALISTOGA SET 5

131 G-131-80

ELEMENT		CONCENTRATION (PPM)
NA		9
K	<	2.50
CA		10
MG		2
FE		1.47
AL		1.4
SI		21
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU		0.1
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-	<	0.1
HCO_3^-		63.8
$SO_4^=$	<	10
T.D.S.		149
Corrected T.D.S.		116

Temperature 18°C
pH 6.45
Salinity 0.00 %
Specific Conductance 91 µmoh/cm

CALISTOGA SET 5

132 G-132-80

ELEMENT		CONCENTRATION (PPM)
NA		15
K		5
CA		16
MG		8
FE		0.99
AL	<	0.625
SI		18
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		10
F^-	<	0.1
HCO_3^-		83.9
$SO_4^=$	<	10
T.D.S.		188
Corrected T.D.S.		144

Temperature	17°C
pH	6.30
Salinity	0.00%
Specific Conductance	119 umho/cm

CALISTOGA SET 5

133 G-133-80

ELEMENT		CONCENTRATION (PPM)
NA		9
K		5
CA		25
MG		2
FE		0.47
AL		1.5
SI		20
TI	<	0.125
P		1.2
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-	<	0.1
HCO_3^-		44.2
$SO_4^=$		17
T.D.S.		152
Corrected T.D.S.		129

Temperature	16°C
pH	6.29
Salinity	0.01 %
Specific Conductance	82 umoh/cm

CALISTOGA SET 5

134 G-134-80

ELEMENT		CONCENTRATION (PPM)
NA		81
K		13
CA		21
MG		12
FE		0.06
AL	<	0.625
SI		26
TI	<	0.125
P		0.7
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.14
BE	<	0.005
B		1.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		13
F^-		0.6
HCO_3^-		257
$SO_4^=$		19
T.D.S.		459
Corrected T.D.S.		328

Temperature	17°C
pH	6.45
Salinity	0.04 %
Specific Conductance	580 µmoh/cm

CALISTOGA SET 5

135 G-135-80

ELEMENT		CONCENTRATION (PPM)
NA		61
K		9
CA		14
MG		7
FE		0.19
AL	<	0.625
SI		29
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		3.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.27
BE	<	0.005
B		0.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-		0.3
HCO_3^-		231.8
$SO_4^=$		50
T.D.S.		436
Corrected T.D.S.		345

Temperature	19°C
pH	6.52
Salinity	0.03%
Specific Conductance	480 µmoh/cm

CALISTOGA SET 5

136 G-136-80

ELEMENT	CONCENTRATION (PPM)
NA	5
K	< 2.50
CA	13
MG	11
FE	0.20
AL	< 0.625
SI	8
TI	< 0.125
P	< 0.625
SR	0.07
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	< 0.250
CO	< 0.025
NI	< 0.125
CU	< 0.063
MO	< 1.25
PB	< 0.250
ZN	1.7
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	< 0.050
BE	< 0.005
B	< 0.125
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	7
F^-	0.1
HCO_3^-	112.1
$SO_4^=$	45
T.D.S.	226
Corrected T.D.S.	169

Temperature	17°C
pH	5.80
Salinity	0.01 %
Specific Conductance	180 µmoh/cm

CALISTOGA SET 5

137 G-137-80

ELEMENT		CONCENTRATION (PPM)
NA		41
K	<	2.50
CA		31
MG		5
FE		0.19
AL	<	0.625
SI		25
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		2.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-		0.2
HCO_3^-		224.9
$SO_4^=$		23
T.D.S.		380

Corrected T.D.S. 266

Temperature	27°C
pH	5.85
Salinity	0.01 %
Specific Conductance	282 µmoh/cm

CALISTOGA SET 5

138 G-138-80

ELEMENT	CONCENTRATION (PPM)
NA	33
K	< 2.50
CA	24
MG	2
FE	0.11
AL	< 0.625
SI	21
TI	< 0.125
P	< 0.625
SR	0.05
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	< 0.250
CO	< 0.025
NI	< 0.125
CU	< 0.063
MO	< 1.25
PB	< 0.250
ZN	0.3
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	< 0.050
BE	< 0.005
B	< 0.125
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	5
F^-	0.1
HCO_3^-	147.2
$SO_4^=$	12
T.D.S.	268
Corrected T.D.S.	193

Temperature	25°C
pH	5.90
Salinity	0.01 %
Specific Conductance	265 umho/cm

CALISTOGA SET 6

139 G-139-80

ELEMENT		CONCENTRATION (PPM)
NA		7
K	<	2.50
CA		25
MG		2
FE		0.55
AL		1.1
SI		15
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		5.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-	<	0.1
HCO_3^-		60.2
SO_4	<	10
T.D.S.		153

Corrected T.D.S. 123

Temperature	18°C
pH	7.00
Salinity	0.00%
Specific Conductance	62 umol/

CALISTOGA SET 6

140 G-140-80

ELEMENT		CONCENTRATION (PPM)
NA		60
K	<	2.50
CA		4
MG		1
FE		1.40
AL	<	0.625
SI		23
TI	<	0.125
P	<	0.625
SR	<	0.013
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.05
BE	<	0.005
B		0.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		1.2
HCO_3^-		186.8
$SO_4^=$		14
T.D.S.		320

Corrected T.D.S. 226

Temperature	18°C
pH	6.70
Salinity	0.01 %
Specific Conductance	300 µmoh/cm

CALISTOGA SET 6

141 G-141-80

ELEMENT		CONCENTRATION (PPM)
NA		23
K		7
CA		5
MG		4
FE		1.33
AL	<	0.625
SI		36
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.3
HCO_3^-		127
$SO_4^=$	<	10
T.D.S.		240
Corrected T.D.S.		176

Temperature	23°C
pH	6.91
Salinity	0.01 %
Specific Conductance	118 µmoh/

CALISTOGA SET 6

142 G-142-80

ELEMENT		CONCENTRATION (PPM)
NA		72
K		6
CA		11
MG		9
FE		0.67
AL	<	0.625
SI		29
TI	<	0.125
P		1.5
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.0
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		25
F^-		0.6
HCO_3^-		250
$SO_4^=$		22
T.D.S.		446

Corrected T.D.S. 319

Temperature 18°C
pH 6.88
Salinity 0.02%
Specific Conductance 4990 umoh/

[redacted]

CALISTOGA SET 6

143 G-143-80

ELEMENT		CONCENTRATION (PPM)
NA		138
K		5
CA		14
MG		8
FE		1.50
AL	<	0.625
SI		24
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		8.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		130
F^-		1.2
HCO_3^-		275.3
$SO_4^=$		15
T.D.S.		641

Corrected T.D.S. 501

Temperature	22°C
pH	6.88
salinity	0.07 %
Specific Conductance	880 umoh

CALISTOGA SET 6

144 G-144-80

ELEMENT		CONCENTRATION (PPM)
NA		13
K	<	2.50
CA		7
MG		4
FE		0.24
AL	<	0.625
SI		18
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-	<	0.1
HCO_3^-		69.4
$SO_4^=$		11
T.D.S.		155

Temperature	19°C
pH	5.90
Salinity	0.00 %
Specific Conductance	142 umoh/cm

Corrected T.D.S. 119

CALISTOGA SET 6

145 G-145-80

ELEMENT		CONCENTRATION (PPM)
NA		33
K	<	2.50
CA		10
MG		7
FE		0.21
AL	<	0.625
SI		26
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		8
F^-		0.4
HCO_3^-		151
SO_4		16
T.D.S.		276
Corrected T.D.S		199

Temperature 18°C

pH 6.13

Salinity 0.01%

Specific Conductance 298 umoh/c

CALISTOGA SET 6

146 G-146-80

ELEMENT		CONCENTRATION (PPM)
NA		25
K	<	2.50
CA		14
MG		10
FE		0.75
AL	<	0.625
SI		31
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.7
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.07
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-		0.3
HCO_3^-		139.2
SO_4^-		25
T.D.S.		278
Corrected T.D.S		207

Temperature	18°C
pH	6.02
Salinity	0.00%
Specific Conductance	218 umoh/cm

CALISTOGA SET 6

147 G-147-80

ELEMENT		CONCENTRATION (PPM)
NA		74
K		8
CA		18
MG		11
FE		0.68
AL	<	0.625
SI		25
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.10
BE	<	0.005
B		3.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		68
F^-		0.3
HCO_3^-		269.9
$SO_4^=$	<	10
T.D.S.		509
Corrected T.D.S.		372

Temperature	21°C
pH	6.48
salinity	0.03 %
specific Conductance	550 µmoh/c

CALISTOGA SET 6

148 G-148-80

ELEMENT		CONCENTRATION (PPM)
NA		53
K		11
CA		16
MG		5
FE		1.69
AL	<	0.625
SI		36
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.6
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.07
BE	<	0.005
B		1.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		19
F^-		0.2
HCO_3^-		241
SO_4^-		14
T.D.S.		420

Corrected T.D.S. 297

Temperature	18°C
pH	6.41
salinity	0.02 %
Specific Conductance	400 µmoh/cm

CALISTOGA SET 6

149 G-149-80

ELEMENT		CONCENTRATION (PPM)
NA		27
K		8
CA		45
MG		9
FE		0.23
AL	<	0.625
SI		21
TI	<	0.125
P	<	0.625
SR		0.14
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		2.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		15
F^-		0.1
HCO_3^-		102.2
SO_4^-		29
T.D.S.		279

Corrected T.DS 227

Temperature	19°C
pH	6.10
Salinity	0.01 %
Specific Conductance	320 µmoh/cm

CALISTOGA SET 6

150 G-150-80

ELEMENT		CONCENTRATION (PPM)
NA		107
K		11
CA		15
MG		9
FE		1.02
AL	<	0.625
SI		25
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.27
BE	<	0.005
B		5.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		108
F^-		0.3
HCO_3^-		264.2
$SO_4^=$	<	10
T.D.S.		577

Corrected T.D.S. 443

Temperature	20°C
pH	6.42
Salinity	0.03 %
Specific Conductance	650 umoh/cm

CALISTOGA SET 6

151 G-151-80

ELEMENT		CONCENTRATION (PPM)
NA		46
K		7
CA		14
MG		8
FE		0.15
AL	<	0.625
SI		34
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.16
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.2
HCO_3^-		257
$SO_4^=$		10
T.D.S.		404

Corrected T.D.S. 274

Temperature	18°c
pH	6.32
Salinity	0.02 %
Specific Conductance	400 µmoh/cm

CALISTOGA SET 6

152 G-152-80

ELEMENT		CONCENTRATION (PPM)
NA		96
K		10
CA		21
MG		13
FE		0.20
AL	<	0.625
SI		30
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.8
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.16
BE	<	0.005
B		5.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		103
F^-		0.3
HCO_3^-		267.6
SO_4^-	<	10
T.D.S.		578

Corrected T.D.S. 442

Temperature	20°C
pH	6.08
Salinity	0.04%
Specific Conductance	710 µmoh/cm

CALISTOGA SET 6

153 G-153-80

ELEMENT		CONCENTRATION (PPM)
NA		87
K		6
CA		19
MG		15
FE		1.13
AL	<	0.625
SI		30
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.15
BE	<	0.005
B		5.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		106
F^-		0.4
HCO_3^-		249.3
$SO_4^=$	<	10
T.D.S.		549

Corrected T.D.S. 423

Temperature	15 °C
pH	6.28
Salinity	0.04 %
Specific Conductance	700 μmoh/cm

CALISTOGA SET 6

154 G-154-80

ELEMENT		CONCENTRATION (PPM)
NA		48
K		5
CA		25
MG		26
FE		0.56
AL	<	0.625
SI		26
TI	<	0.125
P	<	0.625
SR		0.16
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.7
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		2.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		62
F^-		0.2
HCO_3^-		294.3
SO_4^-		14
T.D.S.		525

Corrected T.D.S. 376

Temperature	18°C
pH	6.20
Salinity	0.04%
Specific Conductance	610 µmoh/cm

CALISTOGA SET 6

155 G-155-80

ELEMENT		CONCENTRATION (PPM)
NA		36
K		3
CA		33
MG		12
FE	<	0.025
AL	<	0.625
SI		19
TI	<	0.125
P	<	0.625
SR		0.16
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		37
F^-		0.2
HCO_3^-		241
$SO_4^=$		16
T.D.S.		419
Corrected T.D.S.		297

Temperature	18°C
pH	6.19
salinity	0.02 %
Specific Conductance	410 µmoh/

CALISTOGA SET 7

156 G-156-80

ELEMENT		CONCENTRATION (PPM)
NA		49
K	<	2.50
CA		22
MG		2
FE		0.19
AL	<	0.625
SI		16
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.2
HCO_3^-		216.6
SO_4^{-}		11
T.D.S.		346
Corrected T.D.S.		236

Temperature	30°C
pH	6.30
Salinity	0.07%
Specific Conductance	370 umoh/cm

CALISTOGA SET 7

157 G-157-80

ELEMENT		CONCENTRATION (PPM)
NA		9
K	<	2.50
CA		7
MG		2
FE		3.92
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		8
F^-	<	0.1
HCO_3^-		61.8
SO_4^-	<	10
T.D.S.		135

corrected T.D.S. 104

Temperature 28°C
pH 6.30
Salinity 0.01 %
Specific Conductance 160 µmoh/cm

CALISTOGA SET 7

158 G-158-80

ELEMENT		CONCENTRATION (PPM)
NA		13
K		9
CA		40
MG		14
FE		0.38
AL	<	0.625
SI		11
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		14
F^-		0.1
HCO_3^-		119
$SO_4^=$		51
T.D.S.		292
Corrected T.D.S		231

Temperature	18°C
pH	5.95
Salinity	0.02 %
Specific Conductance	410 µmoh/cm

CALISTOGA SET 7

159 G-159-80

ELEMENT		CONCENTRATION (PPM)
NA		16
K	<	2.50
CA		89
MG		22
FE		3.49
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.66
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR		0.2
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		12
F^-		0.3
HCO_3^-		390.4
SO_4^-		52
T.D.S.		618

Corrected T.D.S. 420

Temperature	18°C
pH	6.67
Salinity	0.03%
Specific Conductance	630 μmoh/cm

CALISTOGA SET 7

160 G-160-80

ELEMENT		CONCENTRATION (PPM)
NA		69
K		14
CA		18
MG		6
FE		2.78
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.0
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.10
BE	<	0.005
B		1.5
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		33
F^-		0.3
HCO_3^-		292
$SO_4^=$	<	10
T.D.S.		500
Corrected T.D.S.		352

Temperature	20°C
pH	6.72
Salinity	0.02 %
Specific Conductance	400 µmho/cm

CALISTOGA SET 7

161 G-161-80

ELEMENT		CONCENTRATION (PPM)
NA		63
K		17
CA		14
MG		3
FE		0.14
AL	<	0.625
SI		43
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.05
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.2
HCO_3^-		289.4
$SO_4^=$	<	10
T.D.S.		466

Corrected T.D.S. 320

Temperature	35°C
pH	6.78
Salinity	0.01 %
Specific Conductance	350 µmoh/cm

CALISTOGA SET 7

162 G-162-80

ELEMENT		CONCENTRATION (PPM)
NA		36
K		10
CA		17
MG		15
FE		0.07
AL	<	0.625
SI		30
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		2.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		17
F^-		0.2
HCO_3^-		204
$SO_4^=$		33
T.D.S.		385
Corrected T.D.S.		282

Temperature	14°C
pH	6.4
salinity	0.02 %
Specific Conductance	360 µmho/cm

CALISTOGA SET 7

163 G-163-80

ELEMENT		CONCENTRATION (PPM)
NA		58
K		14
CA		17
MG		13
FE		1.46
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.6
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.08
BE	<	0.005
B		1.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		46
F^-		0.2
HCO_3^-		250.9
$SO_4^=$		20
T.D.S.		464
Corrected T.D.S.		337

Temperature	15°C
pH	6.32
Salinity	0.03 %
Specific Conductance	410 umoh/cm

CALISTOGA SET 7

164 G-164-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K		5
CA		10
MG		6
FE		1.13
AL	<	0.625
SI		24
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		4.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		<0.1
HCO_3^-		113.6
$SO_4^=$	<	10
T.D.S.		209

Corrected T.D.S. 152

Temperature	20°C
pH	6.00
Salinity	0.00 %
Specific Conductance	155 µmoh/cm

CALISTOGA SET 7

165 G-165-80

ELEMENT		CONCENTRATION (PPM)
NA		17
K		7
CA		16
MG		9
FE		0.24
AL	<	0.625
SI		29
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.2
HCO_3^-		165.8
$SO_4^=$	<	10
T.D.S.		282

Corrected TDS. 198

Temperature	20°C
pH	6.00
Salinity	0.01 %
Specific Conductance	270 umoh/c

CALISTOGA SET 7

166 G-166-80

ELEMENT		CONCENTRATION (PPM)
NA		61
K		3
CA		144
MG		21
FE		0.10
AL	<	0.625
SI		18
TI	<	0.125
P	<	0.625
SR		0.22
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.2
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.13
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		12
F^-		0.2
HCO_3^-		221.1
SO_4^-		125
T.D.S.		629
Corrected T.D.S.		516

Temperature	20°C	
pH	5.91	
Salinity	0.07%	
Specific Conductance	1010	umoh/cm

CALISTOGA SET 7

167 G-167-80

ELEMENT		CONCENTRATION (PPM)
NA		21
K	<	2.50
CA		49
MG		9
FE		0.16
AL	<	0.625
SI		10
TI	<	0.125
P	<	0.625
SR		0.15
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.2
HCO_3^-		275.3
$SO_4^=$		85
T.D.S.		481

Corrected T.D.S. 341

Temperature	21°C
pH	6.15
Salinity	0.01 %
Specific Conductance	260 umoh/cm

CALISTOGA SET 7

168 G-168-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K	<	2.50
CA		10
MG		3
FE		1.20
AL	<	0.625
SI		12
TI	<	0.125
P	<	0.625
SR		0.04
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		2.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-	<	0.1
HCO_3^-		67.9
SO_4^-		20
T.D.S.		154
Corrected T.D.S.		120

Temperature	19°C
pH	5.99
Salinity	0.00%
Specific Conductance	115 μmoh/cm

CALISTOGA SET 7

169 G-169-80

ELEMENT		CONCENTRATION (PPM)
NA		54
K	<	2.50
CA		20
MG		3
FE	<	0.025
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		5
F^-		0.3
HCO_3^-		242.5
$SO_4^=$		31
T.D.S.		400
Corrected T.D.S.		277

Temperature	40°C
pH	6.10
salinity	0.01%
specific Conductance	370 umoh/c

CALISTOGA SET 7

170 G-170-80

ELEMENT		CONCENTRATION (PPM)
NA		37
K	<	2.50
CA		54
MG		10
FE		0.05
AL	<	0.625
SI		18
TI	<	0.125
P	<	0.625
SR		0.45
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.3
HCO_3^-		273.7
SO_4^-		49
T.D.S.		473

Corrected T.D.S. 334

Temperature	17°C
pH	6.24
salinity	0.01 %
Specific Conductance	490 umoh/cm

CALISTOGA SET 7

171 G-171-80

ELEMENT		CONCENTRATION (PPM)
NA		8
K		4
CA		4
MG		1
FE		1.08
AL		1.3
SI		23
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU		0.8
MO	<	1.25
PB	<	0.250
ZN		5.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-	<	0.1
HCO_3^-		41.2
SO_4^-		15
T.D.S.		132
Corrected T.D.S		111

Temperature	14°C
pH	6.20
salinity	0.00 %
Specific Conductance	94 umoh/

CALISTOGA SET 7

172 G-172-80

ELEMENT		CONCENTRATION (PPM)
NA		11
K	<	2.50
CA		17
MG		24
FE		1.93
AL	<	0.625
SI		12
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		8
F^-		0.1
HCO_3^-		217.3
SO_4^-		13
T.D.S.		328

Corrected T.D.S. 217

Temperature	17°C
pH	6.15
Salinity	0.01 %
Specific Conductance	310 umos

CALISTOGA SET 7

173 G-173-80

ELEMENT		CONCENTRATION (PPM)
NA		55
K	<	2.50
CA		16
MG		20
FE		0.76
AL	<	0.625
SI		16
TI	<	0.125
P	<	0.625
SR		0.10
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.28
BE	<	0.005
B		1.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		37
F^-		0.2
HCO_3^-		253.9
$SO_4^=$		21
T.D.S.		445
Corrected T.D.S.		316

Temperature 22°C
pH 6.32
Salinity 0.02 %
Specific Conductance 490 μmohs

CALISTOGA SET 7

174 G-174-80

ELEMENT		CONCENTRATION (PPM)
NA		61
K		11
CA		13
MG		10
FE		0.83
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.2
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.4
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		23
F^-		0.2
HCO_3^-		253.9
$SO_4^=$		26
T.D.S.		453
Corrected T.D.S.		324

Temperature	19°C
pH	6.15
Salinity	0.01 %
Specific Conductance	450 µmho/

CALISTOGA SET 7

175 G-175-80

ELEMENT		CONCENTRATION (PPM)
NA		40
K		12
CA		21
MG		11
FE		6.72
AL	<	0.625
SI		34
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.9
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.1
HCO_3^-		164.7
SO_4^-		68
T.D.S.		387

Corrected T.D.S. 303

Temperature 21°C

pH 6.20

Salinity 0.01 %

Specific Conductance 470

CALISTOGA SET 7

176 G-176-80

ELEMENT		CONCENTRATION (PPM)
NA		15
K		3
CA		64
MG		15
FE		0.13
AL	<	0.625
SI		9
TI	<	0.125
P	<	0.625
SR		0.32
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.0
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.2
HCO_3^-		218.4
$SO_4^{=}$		21
T.D.S.		374

Corrected T.D.S. 263

Temperature	18°C
pH	6.80
Salinity	0.01 %
Specific Conductance	210 µmoh/cm

CALISTOGA SET 7

177 G-177-80

ELEMENT		CONCENTRATION (PPM)
NA		10
K	<	2.50
CA		16
MG		19
FE	<	0.025
AL	<	0.625
SI		13
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-		0.1
HCO_3^-		150.6
CO_2^-		0
SO_4^-		19
T.D.S.		260

Corrected T.D.S. 183

Temperature	18°C
pH	6.70
Salinity	0.00 %
Specific Conductance	340 μ

CALISTOGA SET 8

178 G-178-80

ELEMENT		CONCENTRATION (PPM)
NA		38
K	<	2.50
CA		50
MG		11
FE		0.04
AL	<	0.625
SI		23
TI	<	0.125
P	<	0.625
SR		0.14
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.08
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		15
F^-		0.3
HCO_3^-		202
$SO_4^=$		39
T.D.S.		401
corrected T.D.S.		299

Temperature 30°C

pH 6.10

CALISTOGA SET 8

179 G-179-80

ELEMENT		CONCENTRATION (PPM)
NA		236
K		8
CA		15
MG		2
FE		0.36
AL	<	0.625
SI		37
TI	<	0.125
P	<	0.625
SR		0.03
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI		1.78
BE	<	0.005
B		12.7
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		194
F^-		11
HCO_3^-		207
SO_4^{2-}	<	10
T.D.S.		746
Corrected T.D.S.		644

Temperature 55° C

pH 6.45

CALISTOGA SET 8

180 G-180-80

ELEMENT		CONCENTRATION (PPM)
NA		162
K		7
CA		13
MG		5
FE		0.79
AL	<	0.625
SI		29
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.71
BE	<	0.005
B		7.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		105
F^-		4.7
HCO_3^-		228
$SO_4^=$	<	10
T.D.S.		583
Corrected T.D.S.		471

Temperature 55 °C

pH 6.30

CALISTOGA SET 8

181 G-181-80

ELEMENT		CONCENTRATION (PPM)
NA		121
K		4
CA		19
MG		18
FE		0.07
AL	<	0.625
SI		16
TI	<	0.125
P	<	0.625
SR		0.11
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.06
BE	<	0.005
B		8.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		107
F^-		1.7
HCO_3^-		225.7
$SO_4^=$	<	10
T.D.S.		541
Corrected T.D.S.		430

Temperature 20°C

pH 5.99

CALISTOGA SET 8

182 G-182-80

ELEMENT		CONCENTRATION (PPM)
NA		77
K		5
CA		16
MG		4
FE		1.17
AL	<	0.625
SI		31
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		8
F^-		0.2
HCO_3^-		240.2
SO_4		11
T.D.S.		414

Corrected T.D.S. 296

Temperature 18°C
pH 6.20

CALISTOGA SET 8

183 G-183-80

ELEMENT		CONCENTRATION (PPM)
NA		75
K		5
CA		21
MG		4
FE		1.08
AL	<	0.625
SI		31
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.2
HCO_3^-		240.6
SO_4		12
T.D.S.		417
Corrected T.D.S.		298

Temperature 16°C

pH 6.20

CALISTOGA SET 8

184 G-184-80

ELEMENT		CONCENTRATION (PPM)
NA		69
K		13
CA		25
MG		4
FE		7.95
AL	<	0.625
SI		46
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.4
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		6
F^-		0.2
HCO_3^-		238.3
SO_4^-		<10
T.D.S.		413

Temperature 20°C
pH 6.30

Corrected T.D.S. 296

CALISTOGA SET 8

185 G-185-80

ELEMENT		CONCENTRATION (PPM)
NA		128
K		15
CA		11
MG		3
FE		1.23
AL	<	0.625
SI		38
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.06
BE	<	0.005
B		0.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		25
F^-		0.3
HCO_3^-		335.9
SO_4		10
T.D.S.		589
Corrected T.D.S.		424

Temperature	20°C
pH	6.39
Salinity	N.D.
Specific Conductance	N.D.

CALISTOGA SET 8

186 G-186-80

ELEMENT		CONCENTRATION (PPM)
NA		100
K		11
CA		19
MG		9
FE		3.25
AL	<	0.625
SI		27
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.0
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W		0.1
LI	<	0.050
BE	<	0.005
B		0.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		18
F^-		0.4
HCO_3^-		313.4
SO_4		15
T.D.S.		538
Corrected T.D.S.		384

Temperature 20°C

pH 6.25

[redacted]

CALISTOGA SET 8

187 G-187-80

ELEMENT		CONCENTRATION (PPM)
NA		104
K		11
CA		16
MG		4
FE		0.10
AL	<	0.625
SI		43
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		11
F^-		0.4
HCO_3^-		287.6
SO_4		11
T.D.S.		509

Temperature 19°C

pH 6.50

Corrected T.D.S. 367

CALISTOGA SET 8

188 G-188-80

ELEMENT		CONCENTRATION (PPM)
NA		114
K		10
CA		19
MG		16
FE		0.27
AL	<	0.625
SI		26
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.7
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		2.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.08
BE	<	0.005
B		1.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		36
F^-		0.3
HCO_3^-		366.8
$SO_4^=$		410
T.D.S.		612

Temperature 19°C
pH 6.12

Corrected T.D.S. 431

CALISTOGA SET 8

189 G-189-80

ELEMENT		CONCENTRATION (PPM)
NA		50
K		8
CA		25
MG		22
FE		0.99
AL	<	0.625
SI		27
TI	<	0.125
P	<	0.625
SR		0.16
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		2.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		3.0
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		22
F^-		0.3
HCO_3^-		276.8
SO_4		15
T.D.S.		471
Corrected T.D.S.		335

Temperature 15°C

pH 6.21

CALISTOGA SET 8

190 G-190-80

ELEMENT		CONCENTRATION (PPM)
NA		55
K		8
CA		37
MG		41
FE		2.47
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.24
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		1.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		28
F^-		0.3
HCO_3^-		351.5
SO_4		27
T.D.S.		604
Corrected T.D.S.		431

Temperature 19°C
pH 6.11

CALISTOGA SET 8

191 G-191-80

ELEMENT		CONCENTRATION (PPM)
NA		31
K	<	2.50
CA		35
MG		56
FE		0.07
AL	<	0.625
SI		19
TI	<	0.125
P	<	0.625
SR		0.21
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.5
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		50
F^-		0.2
HCO_3^-		243.2
SO_4		31
T.D.S.		489
Corrected T.D.S.		369

Temperature 17°C
pH 6.20

CALISTOGA SET 8

192 G-192-80

ELEMENT		CONCENTRATION (PPM)
NA		110
K		12
CA		17
MG		10
FE		1.18
AL	<	0.625
SI		35
TI	<	0.125
P		0.7
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.6
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		11
F^-		0.4
HCO_3^-		331.7
SO_4		12
T.D.S.		552

Temperature 20°C
pH 6.51

Corrected T.D.S. 389

CALISTOGA SET 8

193 G-193-80

ELEMENT		CONCENTRATION (PPM)
NA		132
K		14
CA		27
MG		3
FE		2.12
AL	<	0.625
SI		35
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.8
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		25
F^-		0.2
HCO_3^-		338.2
SO_4^-		13
T.D.S.		611

Temperature 21°C

pH 6.30

Corrected T.D.S. 444

CALISTOGA SET 8

194 G-194-80

ELEMENT		CONCENTRATION (PPM)
NA		25
K		3
CA		17
MG		7
FE		3.92
AL		0.7
SI		25
TI	<	0.125
P	<	0.625
SR		0.07
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.5
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		13
F^-		0.1
HCO_3^-		75.9
$SO_4^=$		10
T.D.S.		201

Temperature 15°C
pH 6.28

Corrected T.D.S. 164

CALISTOGA SET 9

195 G-195-80

ELEMENT		CONCENTRATION (PPM)
NA		12
K		4
CA		12
MG		5
FE	<	0.025
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.8
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		8
F^-		0.1
HCO_3^-		106.8
SO_4	<	10
T.D.S.		201

Temperature 22°C
pH 5.64

Corrected T.D.S. 148

CALISTOGA SET 9

196 G-196-80

ELEMENT		CONCENTRATION (PPM)
NA		41
K		10
CA		26
MG		8
FE	<	0.025
AL	<	0.625
SI		22
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.4
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.6
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.3
HCO_3^-		236.4
$SO_4^=$		<10
T.D.S.		373

Corrected T.D.S. 257

Temperature 19°C

pH 6.18

CALISTOGA SET 9

197 G-197-80

ELEMENT		CONCENTRATION (PPM)
NA		31
K		10
CA		11
MG		8
FE	<	0.025
AL	<	0.625
SI		29
TI	<	0.125
P		0.8
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.9
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		7
F^-		0.4
HCO_3^-		192.5
$SO_4^=$		210
T.D.S.		310

Temperature 20°C
pH 6.10

Corrected T.D.S. 215

CALISTOGA SET 9

198 G-198-80

ELEMENT		CONCENTRATION (PPM)
NA		16
K	<	2.50
CA		23
MG		8
FE	<	0.025
AL	<	0.625
SI		21
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN		0.3
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		9
F^-		0.2
HCO_3^-		157.1
SO_4	<	10
T.DS.		257

Temperature 18°C

pH 6.20

Corrected T.DS. 180

CALISTOGA SET 9

199 G-199-80

ELEMENT		CONCENTRATION (PPM)
NA		37
K	<	2.50
CA		28
MG		12
FE	<	0.025
AL	<	0.625
SI		27
TI	<	0.125
P	<	0.625
SR		0.12
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		0.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		32
F^-		0.2
HCO_3		177.7
SO_4		25
T.D.S.		362
Corrected T.DS		274

Temperature 19°C

pH 6.00

CALISTOGA SET 9

200 G-200-80

ELEMENT		CONCENTRATION (PPM)
NA		33
K	<	2.50
CA		27
MG		6
FE	<	0.025
AL	<	0.625
SI		21
TI	<	0.125
P	<	0.625
SR		0.09
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		1.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		27
F^-		0.7
HCO_3^-		165.1
SO_4		17
T.D.S.		321
Corrected T.D.S.		240

Temperature 18°C

pH 5.90

CALISTOGA SET 9

201 G-201-80

ELEMENT		CONCENTRATION (PPM)
NA		173
K		11
CA		13
MG		5
FE	<	0.025
AL	<	0.625
SI		32
TI	<	0.125
P	<	0.625
SR		0.05
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.3
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		1.20
BE	<	0.005
B		10.1
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		191
F^-		7.5
HCO_3^-		229.5
SO_4^-	<	10
T.DS.		691
Corrected T.DS.		578

Temperature 33°C
pH 6.33

CALISTOGA SET 9

202 G-202-80

ELEMENT		CONCENTRATION (PPM)
NA		167
K		11
CA		13
MG		4
FE	<	0.025
AL	<	0.625
SI		27
TI	<	0.125
P	<	0.625
SR		0.06
BA	<	0.625
V	<	1.25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		0.2
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.73
BE	<	0.005
B		10.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		173
F^-		6.5
HCO_3^-		235.6
$SO_4^=$		<10
T.D.S.		668
CORRECTED T.D.S.		552

Temperature 27°C

pH 7.40

CALISTOGA SET 9

203 G-203-80

ELEMENT		CONCENTRATION (PPM)
NA		46
K		3
CA		16
MG		9
FE	<	0.025
AL	<	0.625
SI		19
TI	<	0.125
P	<	0.625
SR		0.08
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		3.1
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B		2.2
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		32
F^-		0.2
HCO_3^-		168.1
$SO_4^=$		< 10
T.DS.		319
Corrected T.D.S.		236

Temperature 18°C

pH 7.22

CALISTOGA SET 9

204 0-204-80

ELEMENT		CONCENTRATION (PPM)
NA		48
K	<	2.50
CA		98
MG		22
FE	<	0.025
AL	<	0.625
SI		11
TI	<	0.125
P	<	0.625
SR		0.35
BA	<	0.625
V	<	1.25
CR	<	0.050
MN	<	0.250
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN		1.7
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U		2
TE	<	1.25
SN	<	0.125
W	<	0.125
LI	<	0.050
BE	<	0.005
B	<	0.125
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		13
F^-		0,3
HCO_3^-		414.1
$SO_4^=$		17
TDS.		650
Corrected T.D.S.		446

Temperature N.A.

pH 7.40

[redacted]

CALISTOGA SET 9

205 G-205-80

ELEMENT		CONCENTRATION (PPM)
NA		51
K		8
CA		15
MG		8
FE	<	0.025
AL	<	0.625
SI		30
TI	<	0.125
P	<	0.625
SR		0.13
BA	<	0.625
V	<	[illegible].25
CR	<	0.050
MN		0.3
CO	<	0.025
NI	<	0.125
CU	<	0.063
MO	<	1.25
PB	<	0.250
ZN	<	0.125
CD	<	0.063
AG	<	0.050
AU	<	0.100
AS	<	0.625
SB	<	0.750
BI	<	2.50
U	<	6.25
TE	<	1.25
SN	<	0.125
W	<	0.125
LI		0.24
BE	<	0.005
B		0.3
ZR	<	0.125
LA	<	0.125
CE	<	0.250
TH	<	2.50
Cl^-		29
F^-		0.7
HCO_3^-		216.6
$SO_4^=$		12
T.D.S.		276
Corrected T.D.S.		169

Temperature 23° C

pH 8.00

CALISTOGA SET 9

206 G-206-80

ELEMENT	CONCENTRATION (PPM)
NA	186
K	7
CA	16
MG	2
FE	< 0.025
AL	< 0.625
SI	32
TI	< 0.125
P	< 0.625
SR	0.23
BA	< 0.625
V	< 1.25
CR	< 0.050
MN	< 0.250
CO	< 0.025
NI	< 0.125
CU	0.1
MO	< 1.25
PB	< 0.250
ZN	< 0.125
CD	< 0.063
AG	< 0.050
AU	< 0.100
AS	< 0.625
SB	< 0.750
BI	< 2.50
U	< 6.25
TE	< 1.25
SN	< 0.125
W	< 0.125
LI	1.46
BE	< 0.005
B	9.8
ZR	< 0.125
LA	< 0.125
CE	< 0.250
TH	< 2.50
Cl^-	229
F^-	10
HCO_3^-	152.9
$SO_4^=$	< 10
T.D.S.	667
Corrected T.D.S.	592

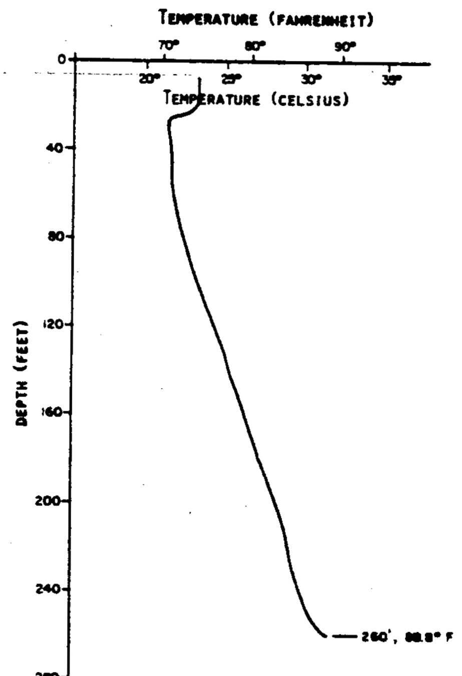
Temperature 55 °C

pH 6.35

APPENDIX B

CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

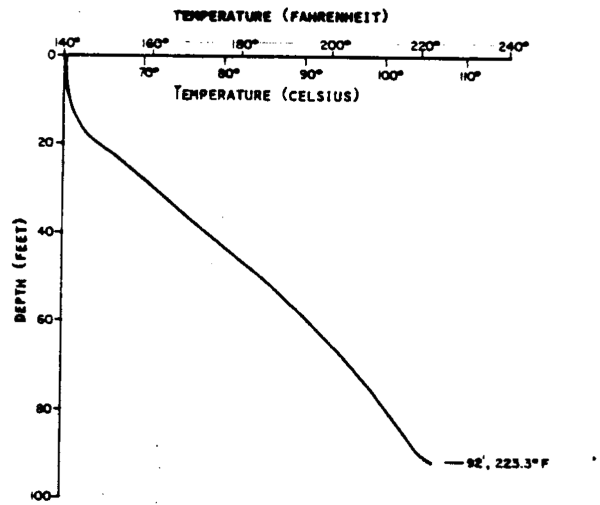
DATE 6/6/77 CDMG WELL NO. 1 (OCCIDENTAL WELL NO. 14)



*1 Redrafted after Occidental Geothermal, Inc. (1977).

CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

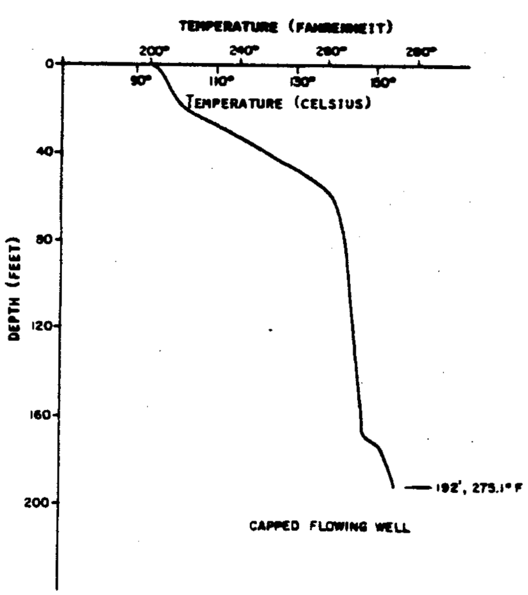
DATE 6/1/77 CDMG WELL NO. 2 (OCCIDENTAL WELL NO. 2)



*1 Redrafted after Occidental Geothermal, Inc. (1977).

CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

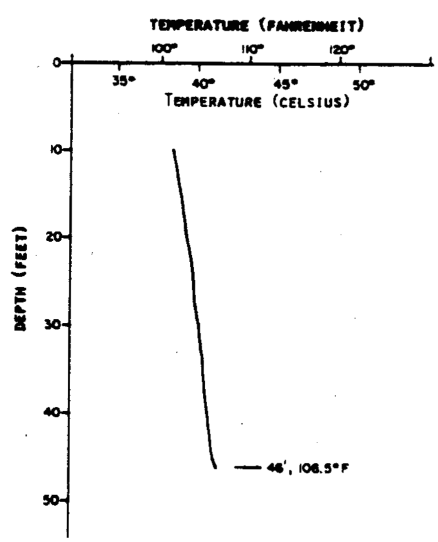
DATE 6/6/77 CDMG WELL NO. 3 (OCCIDENTAL WELL NO. 46)



*1 Redrafted after Occidental Geothermal, Inc. (1977).

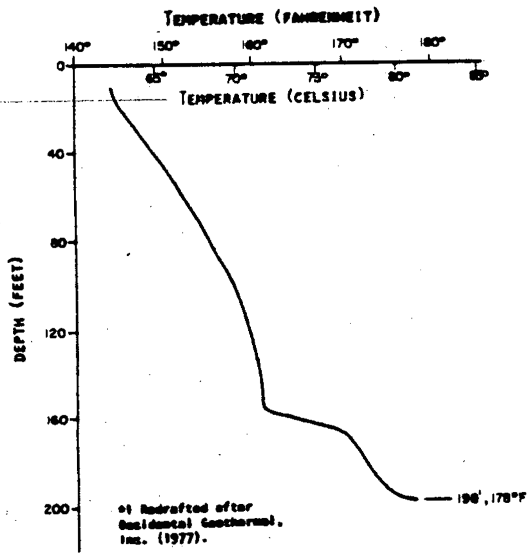
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/21/77 CDMG WELL NO. 4 (OCCIDENTAL WELL NO. 38)

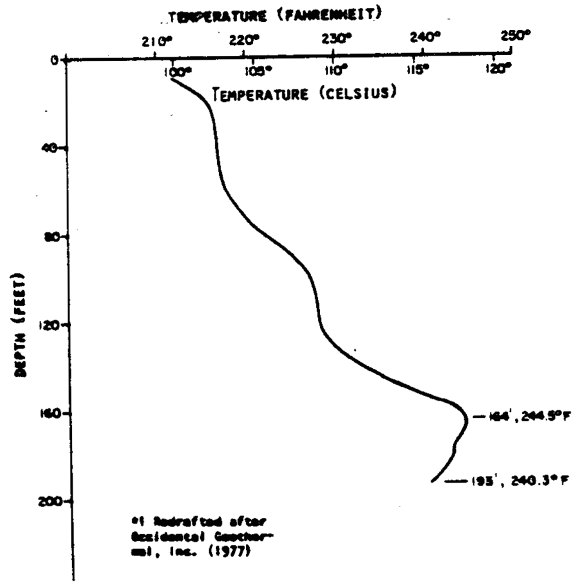


*1 Redrafted after Occidental Geothermal, Inc. (1977)

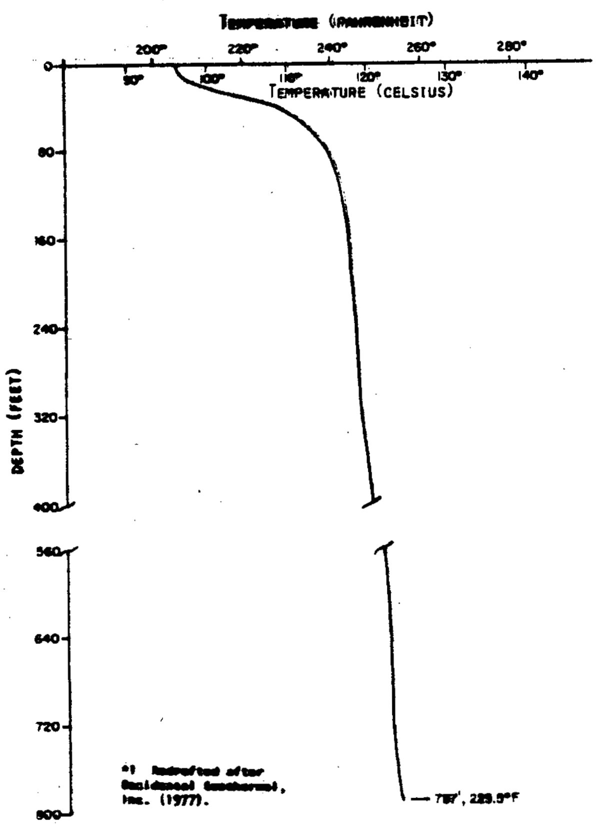
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1
DATE 6/4/77 CDMG WELL NO. 5 (OCCIDENTAL WELL NO. 7)



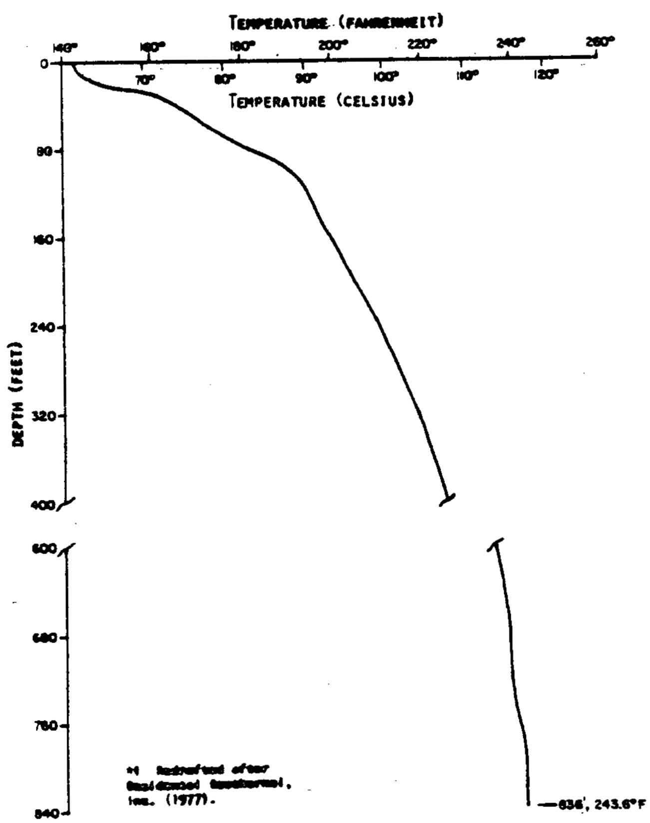
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1
DATE 6/5/77 CDMG WELL NO. 6 (OCCIDENTAL WELL NO. 13)



CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1
DATE 6/2/77 CDMG WELL NO. 7 (OCCIDENTAL WELL NO. 3)

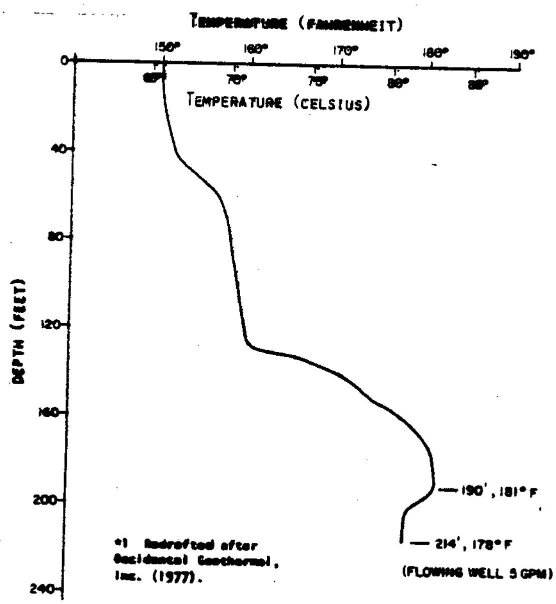


CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1
DATE 6/2/77 CDMG WELL NO. 4 (OCCIDENTAL WELL NO. 4)



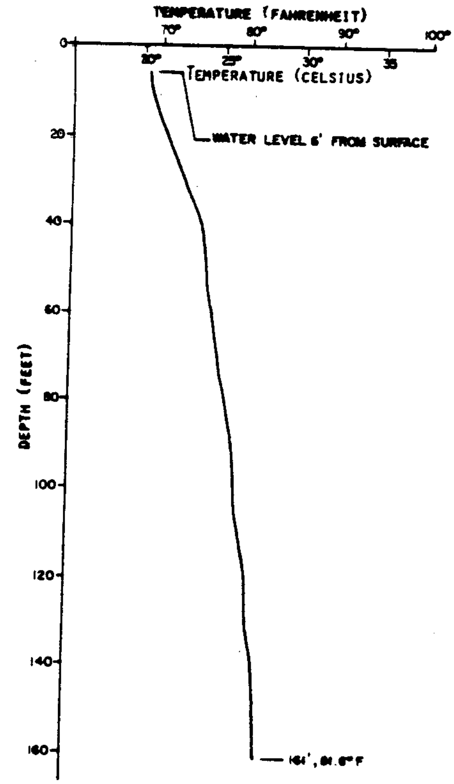
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/3/77 CDMG WELL NO. 9 (OCCIDENTAL WELL NO. 5)



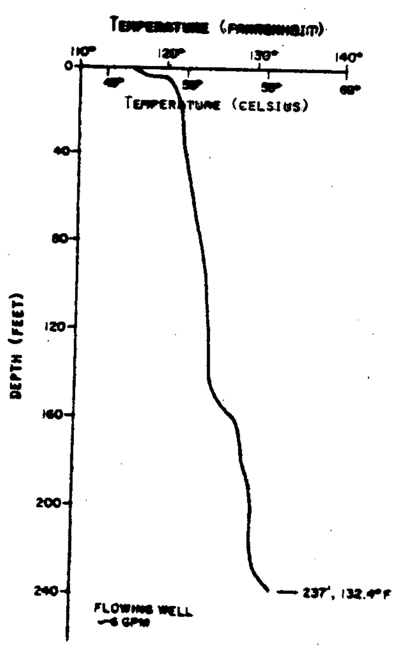
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG

DATE 4/17/80 CDMG WELL NO. 10



CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

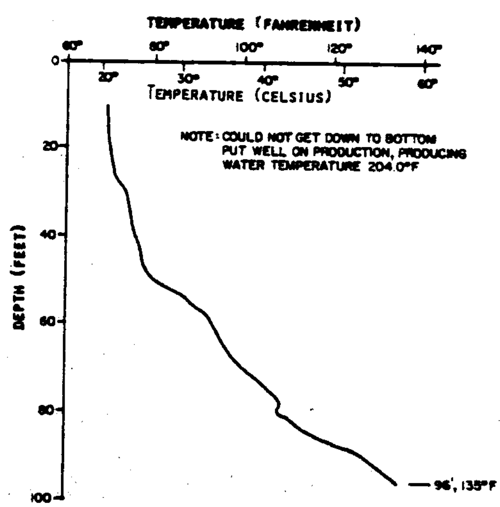
DATE 6/6/77 CDMG WELL NO. 11 (OCCIDENTAL WELL NO. 9)



*1 Redrafted after Occidental Geothermal, Inc. (1977).

CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

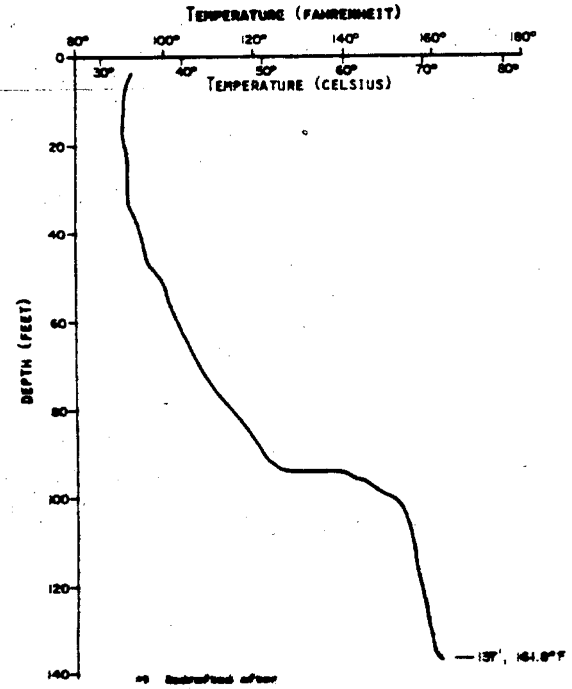
DATE 6/19/77 CDMG WELL NO. 12 (OCCIDENTAL WELL NO. 30)



*1 Redrafted after Occidental Geothermal, Inc. (1977).

CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

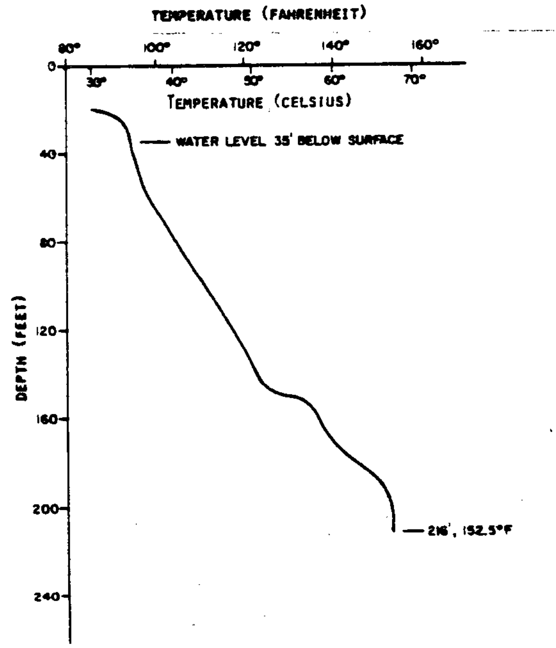
DATE 6/5/77 CDMG WELL NO. 13 (OCCIDENTAL WELL NO. 11)



*1 Redrafted after Occidental Geothermal, Inc. (1977).

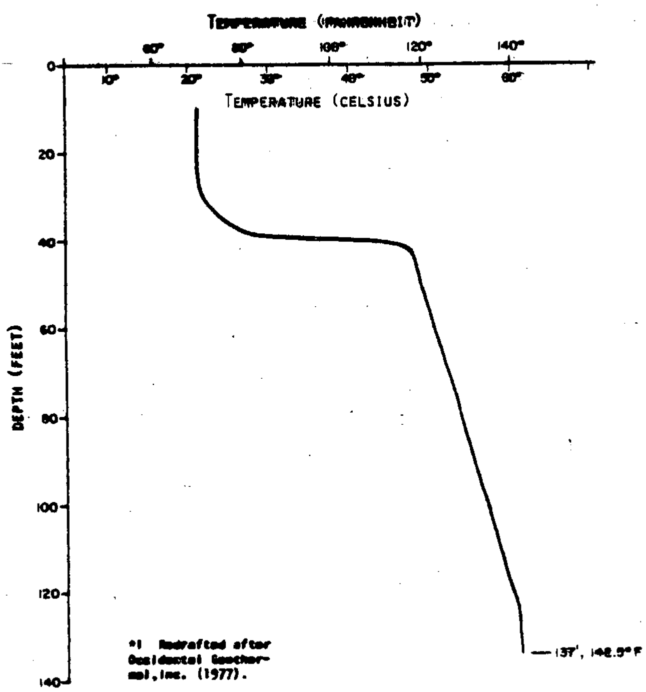
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG

DATE 4/10/80 CDMG WELL NO. 14



CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

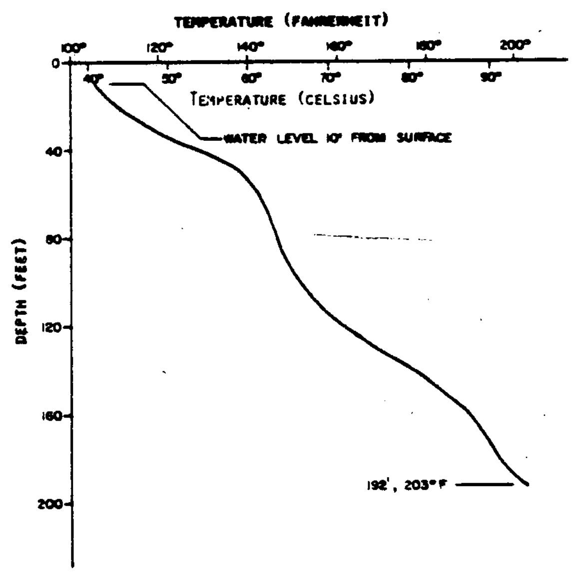
DATE 6/4/77 CDMG WELL NO. 15 (OCCIDENTAL WELL NO. 6)



*1 Redrafted after Occidental Geothermal, Inc. (1977).

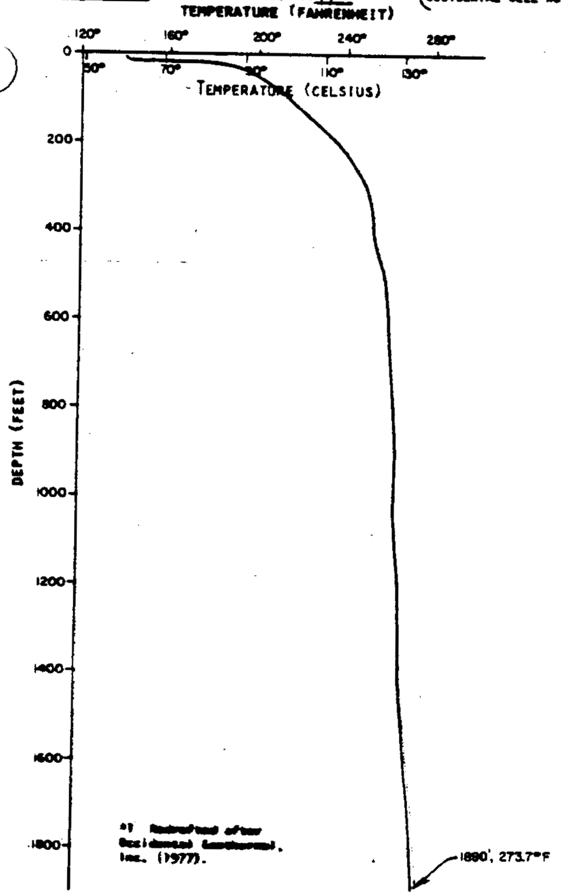
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG

DATE 6/22/80 CDMG WELL NO. 16



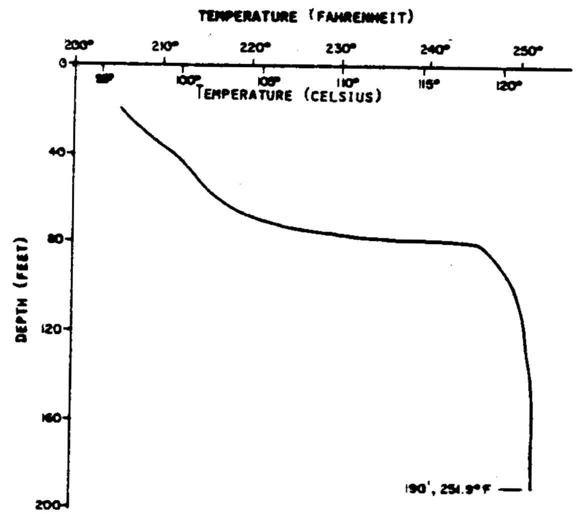
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/16/77 CDMG WELL NO. 17 (OCCIDENTAL WELL NO. 22)



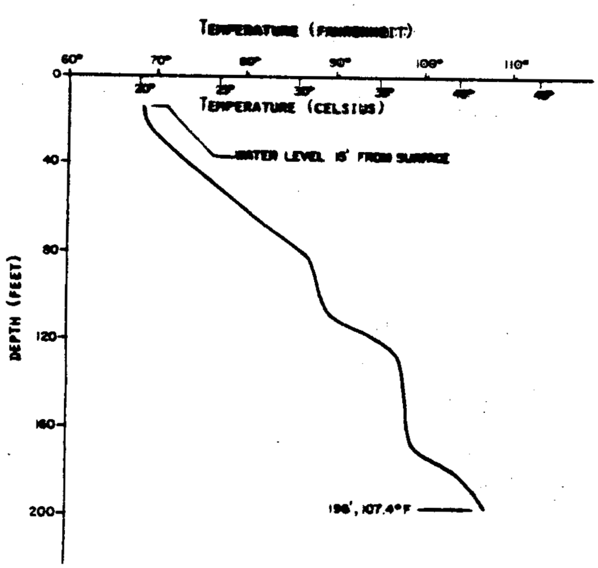
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG

DATE 4/16/80 CDMG WELL NO. 18



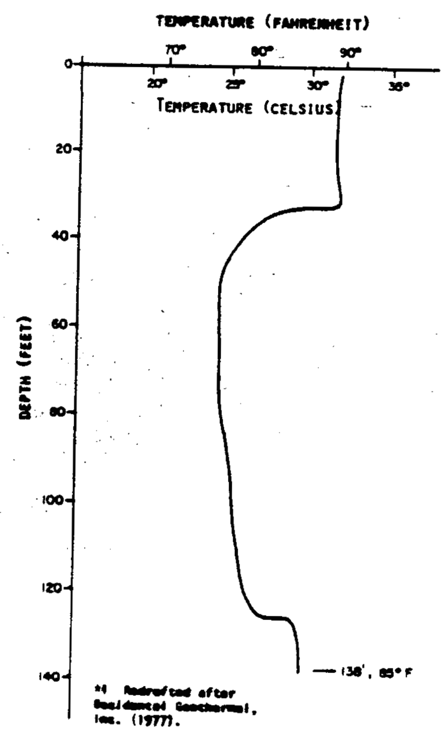
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG

DATE 6/10/80 CDMG WELL NO. 19



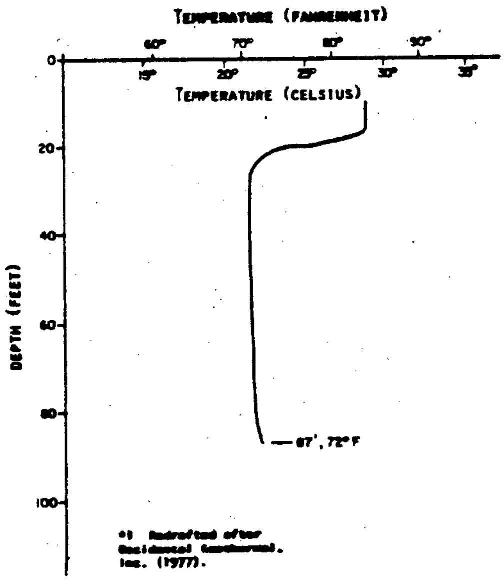
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/5/77 CDMG WELL NO. 20 (OCCIDENTAL WELL NO. 12)



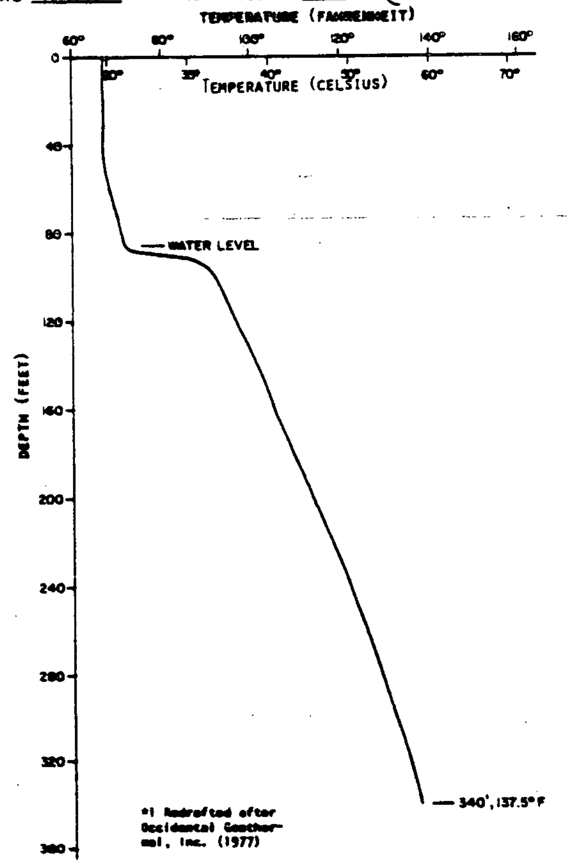
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/5/77 CDMG WELL NO. 21 (OCCIDENTAL WELL NO. 10)



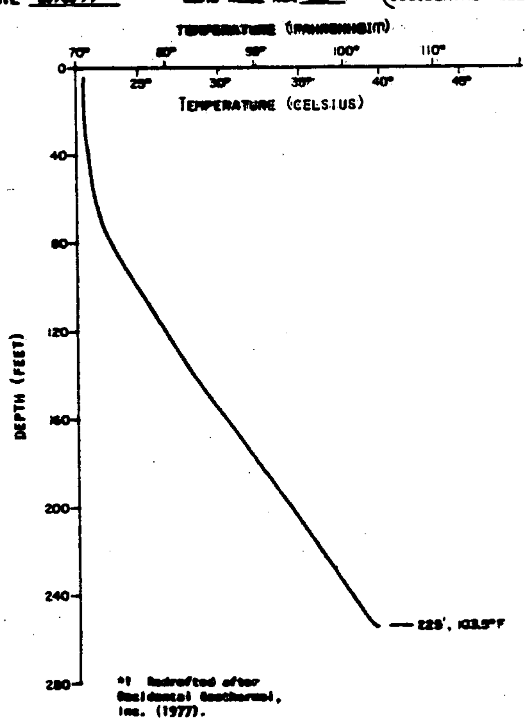
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/6/77 CDMG WELL NO. 22 (OCCIDENTAL WELL NO. 18)



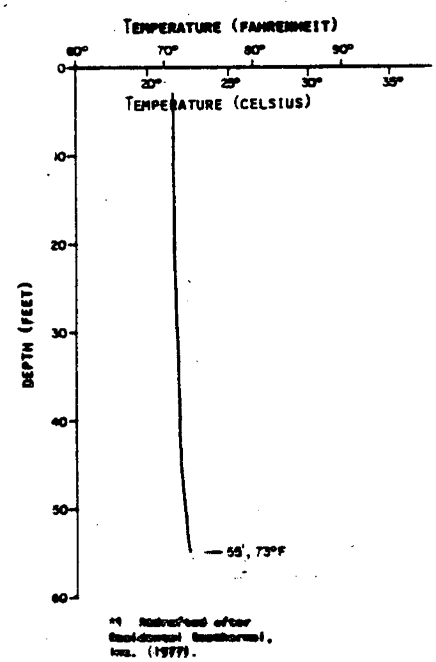
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/16/77 CDMG WELL NO. 23 (OCCIDENTAL WELL NO. 21)



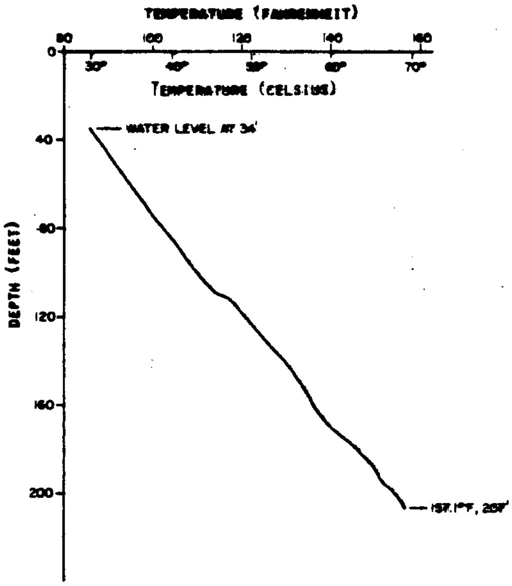
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/16/77 CDMG WELL NO. 24 (OCCIDENTAL WELL NO. 22)



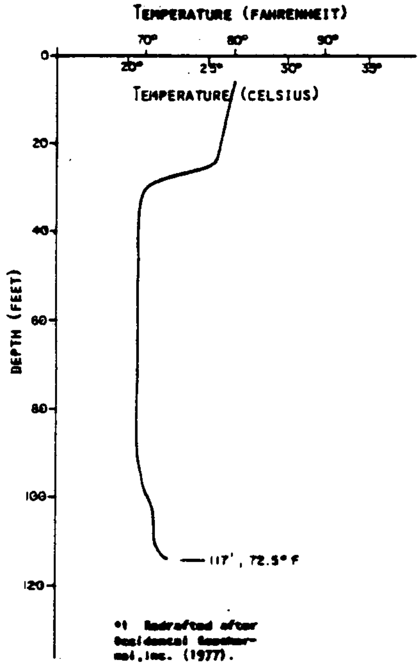
CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG

DATE 8/25/80 CDMG WELL NO. 26



CALIFORNIA DIVISION OF MINES AND GEOLOGY
TEMPERATURE LOG *1

DATE 6/6/77 CDMG WELL NO. 25 (OCCIDENTAL WELL NO. 15)

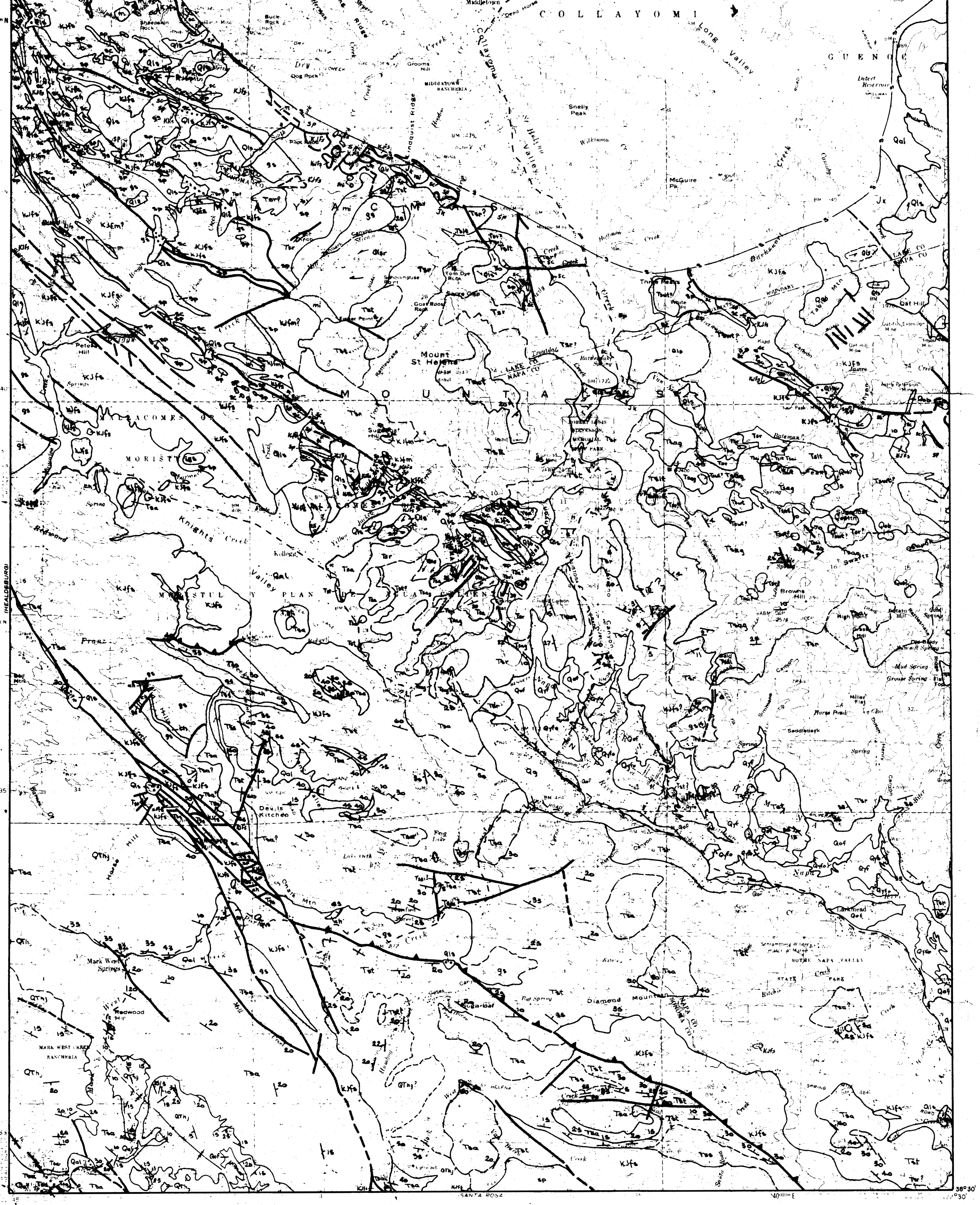


*1 Redrafted after Occidental Geothermal, Inc. (1977).

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

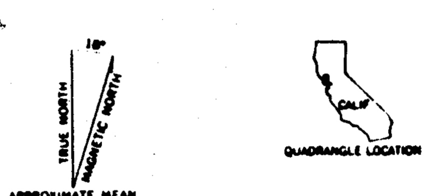
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

PLATE I



Base from U. S. Geological Survey, 1:62,500
St. Helena, 1960; Calistoga, 1959
All material photorevised in 1968

CONTOUR INTERVAL 80 FEET
DOTTED LINES REPRESENT 40-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL



APPROXIMATE MEAN DECLINATION, 1959

QUADRANGLE LOCATION

GEOLOGIC MAP OF CALISTOGA 15' QUADRANGLE

AFTER K. F. FOX, JR. ET AL (1973)

Pleistocene and Holocene — QUATERNARY

Qal | Qf | Qt | Qoal | Qyf | Qyfo | Qb | Qbm | Qof | Qodf

Surficial deposits

Qal, alluvium, sand, silt, clay, and gravel
Qf, fan deposits, gravel, sand, silt, and clay
Qt, terrace deposits, gravel, sand, silt, and clay
Qoal, older alluvium; sand, silt, clay, and gravel
Qyf, alluvial fan deposits grading headward to terrace deposits incised in unit Qof: consist of moderately sorted fine sand and silt, with gravel becoming more abundant toward fan heads
Qyfo, fluvial deposits at the outer edge of alluvial fans (Qyf); forms levees between basin deposits (Qb); characterized by fine, but variable, grain size; composed mainly of fine sand, silt, and silty clay

Qb, interfluvial marsh-like basin deposits; mainly poorly sorted dark clay and silty clay, both rich in organic matter
Qbm, bay mud
Qof, alluvial fan deposits bordering uplands; heads of fans incised by channels partly filled by terraced deposits of younger alluvium (Qb, Qyfo, and Qyf); outer margins of fans overlapped by younger alluvial deposits (Qb, Qyfo, and Qyf); also includes deposits on stream terraces in narrow canyons cut into uplands; mainly deeply weathered poorly sorted coarse sand and gravel
Qodf, alluvial fan deposits, moderately to highly dissected; consist of coarse to very coarse, highly weathered gravels

Qls | Qlse | Qlsr | Qlso

Landslide deposits

Qls, landslide, undifferentiated
Qlse, landslide, composed of andesitic and tuffaceous rocks derived mainly from Tsa
Qlsr, landslide, composed of rhyolitic rock derived from unit Tsri or unit Tsr
Qlso, older landslide(?), composed of irregular zones of fragmental older rock and areas of older rock with complex internal structure

Qr | Qg

Older surficial deposits

Qr, deposits of unconsolidated tuff, volcanic gravel containing large angular blocks of rhyolite derived from units Tsri; locally stratified
Qg, gravel deposits, poorly bedded

Qclt | Qob

Volcanic rocks of Clear Lake area

Qclt, tuff
Qob, olivine basalt

Pliocene (?) and Pleistocene — TERTIARY (?) AND QUATERNARY

QThg

Huichica (Pleistocene) and Glen Ellen (Pliocene(?) and Pleistocene) Formations

Fluviatile gravel, sand, silt, and clay; locally contains much interbedded tuff

QTc

Cache Formation (Pliocene or Pleistocene) of Anderson (1936)

Sand, silt, clay, and gravel; locally tuffaceous near top, with intercalated diatomite

Pliocene — TERTIARY

Tm

Merced(?) Formation

Massive fine-grained sandstone and siltstone with some pebbly layers; rare marine molluscan molds

Tp

Petaluma Formation

Claystone and siltstone with thick lenses of sandstone and pebble conglomerate, thin interbeds of tuff and tuffaceous siltstone, locally with thick beds of diatomite; contains fresh-water and brackish-water mollusks and rare mammalian remains; composed principally of material derived from the Franciscan assemblage with locally common pebbles of laminated siliceous shale, but commonly contains significant admixture of detritus derived from the Sonoma Volcanics and possibly from the Tolay Volcanics of Morse and Bailey (1935)

SONOMA VOLCANICS

Relative age between units and groups of units is unknown

Tsr | Tsri | Tsrs | Tsrp | Tsrb

Rhyolitic rocks

Tsr, rhyolitic lava flows, locally contains intercalated rhyolitic tuff
Tsri, rhyolitic plugs, dikes; may be in part extrusive
Tsrs, soda rhyolite flows; may be in part intrusive
Tsrp, perlitic rhyolite; includes flows and plugs
Tsrb, rhyolitic breccia

Tsa | Tsai | Tsfd

Basaltic, andesitic, and dacitic rocks

Tsa, andesitic to basalitic lava flows
Tsai, andesitic to dacitic plugs, or intrusive complex (area of abundant small plugs or dikes not separately mapped)
Tsfd, basaltic or andesitic lava flows, thinly interlayered with diatomite and unconsolidated fine-grained sedimentary rocks (present 4 miles west of Sonoma)

Tst | Tswt | Tstx | Tsag | Tslt | Tsft

Tuff and agglomerate

Tst, pumicitic ash-flow tuff, locally welded or partly welded; with intercalated bedded agglomeritic tuff, andesitic or basaltic lava flows, tuff breccia, bedded tuff, and pumicitic tuff
Tswt, welded ash-flow tuff, subordinate unwelded or partly welded ash-flow tuff
Tstx, tuff(?), welded, massive, hard, xenolithic (northeast of Napa)
Tsag, agglomerate; with volcanic breccia, tuff breccia
Tslt, tuff breccia; intercalated agglomerate, tuff
Tsft, tuff, similar to Tst; thinly interlayered with basaltic or andesitic lava flows

Tss | Tssd

Sedimentary deposits

Tss, sedimentary deposits; unconsolidated interbedded and intertonguing tuffaceous sand, silt, volcanic gravel; bedded tuff, clay, diatomite
Tssd, diatomite, with interbedded sand, gravel, and tuff

Miocene

Tn

Neroly(?) Sandstone

Coarse-grained bluish-gray sandstone with minor tuffaceous sandstone, shale, and pebbly sandstone

Tms

Sandstone, siltstone, and shale

Medium- to fine-grained white sandstone, siltstone, and sandy shale. Mapped as Monterey Shale by Weaver (1949)

Miocene (?)

Ts

San Ramon Sandstone

Medium-grained, bluish-gray to light-brown sandstone

Eocene

Td

Domengine Sandstone

Brown feldspathic quartz sandstone with minor thin mudstone interbeds

Tv

Vacaville Shale of Merriam and Turner (1937)

Brown and gray shale and arenaceous mudstone; glauconitic horizon at top in Vacaville area

JURASSIC AND CRETACEOUS

GREAT VALLEY SE[illegible]

CRETACEOUS

Kv

Venado Sandstone of K[illegible] [illegible]943)

Massive, medium- to coarse-graine[illegible] [illegible]sbedded lithic feldspathic wacke

JURASSIC AND CRETACEOUS

KJgvs | KJgvm | KJsp

Middle part of Great Valley sequen[illegible]

KJgvs, sandstone with minor mudstone and [illegible]hale
KJgvm, mudstone and siltstone wit[illegible] minor thin-bedded sandstone
KJsp, sedimentary serpentine member, [illegible]ueried where identification uncertain

JURASSIC

JK | Jsp

Knoxville Formation

Jk, massive clayey siltstone
Jsp, sedimentary serpentine within Knoxville Formation; queried where identification uncertain

IGNEOUS ROCKS LOCALLY PRESENT, PROBABLY AT BASE OF GREAT VALLEY S[illegible]

Jv

Basaltic pillow lava and breccia

[illegible]CAN ASSEMBLAGE

KJfm | KJfs

Sedimentary, igneous, and metamorphic rocks

KJfm, chiefly metagraywacke with minor metagreenstone and metachert; metagraywacke contains no detrital potassium feldspar
KJfs, sheared shale and sandstone that contains generally resistant masses of chert, "high-grade" metamorphic rock, variably shattered sandstone and greenstone, metagreenstone, and generally less resistant serpentinite (see table below for lithologies and map symbols); masses range in length from less than one foot to greater than 5 miles and constitute a variable, generally unknown proportion of the unit. Dominantly pervasively sheared Knoxville shale in Pope Canyon area

[illegible] That Occur as Discrete Masses

Serpentinite, including [illegible] ultramafic masses. Occurs as lense[illegible], sheets, and irregularly shaped masses, largely within and along boundaries of KJfs.	
Chert, including metachert. Shown to scale where possible, smaller masses omitted	ch
Greenstone, including pillow lava, volcanic breccia, tuff, minor intrusive varieties, and metagreenstone. Shown to scale where possible, smaller masses omitted	gs
Silica-carbonate rock. Shown to scale where possible, smaller masses omitted	sc
"High-grade" metamorphic rock, chiefly gneissic, including glaucophane schist, eclogite, and amphibolite	m
Mafic intrusive rocks, chiefly fine- to coarse-grained gabbro and diorite	mi

MAP SYMBOLS

Contact

Long dashed where uncertain; short dashed where gradational, dotted where concealed, dot-dashed where intertonguing (shown diagrammatically), direction and inclination of dip shown by arrow

Fault

Long dashed where approximately located, short dashed where uncertain, queried where doubtful, dotted where concealed, arrow shows direction and amount of dip where inclined, crossbar where vertical

Thrust fault

Dashed where approximately located, queried where doubtful. Sawteeth on upper plate

Active fault

Trace of recently active fault, dashed where uncertain, queried where doubtful. Indicated by topographic features which are inferred to be the product of fault displacement of the ground surface

Inclined | Horizontal | Vertical | Overturned | Horizontal | Inclined

Crumpled or undulatory

Strike and dip of bedding

Ball on dip bar indicates that direction of top of beds known from sedimentary structures

Inclined | Vertical | Undulatory

Strike and dip of flow banding

Plunging | Horizontal

Flow lineation

May be combined with other symbols

Dike

Arrow shows direction and amount of dip where known

Anticline | Syncline

Fold axes

Dashed where approximately located

Landslide deposit

Arrows show general direction of movement. Many additional landslides exist; areas not mapped as landslide deposits are not necessarily stable bedrock

Northern limit of mapped area

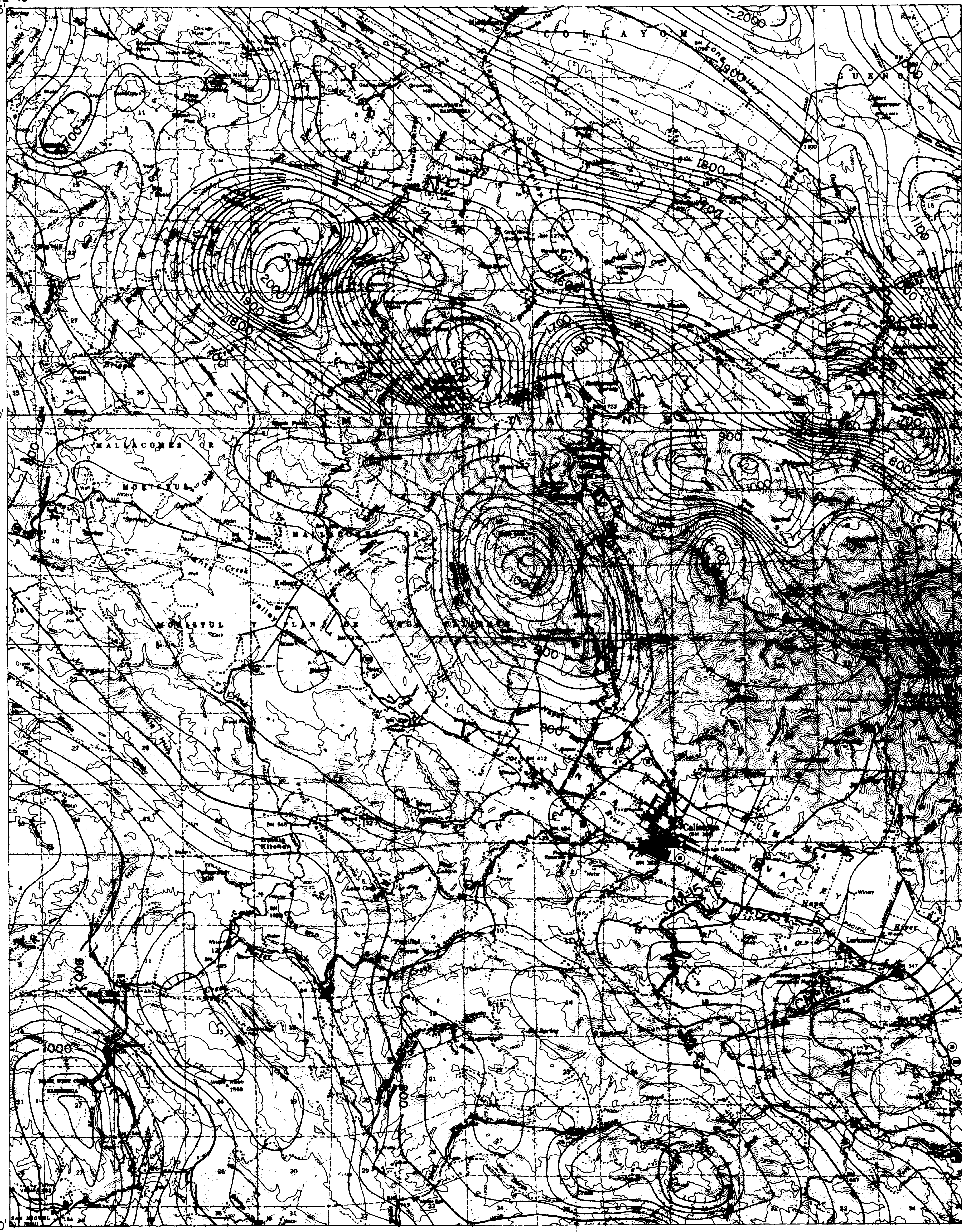
CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

PLATE 2

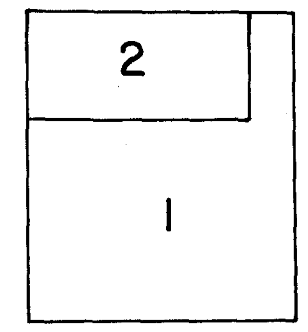
AEROMAGNETIC DATA FOR THE CALISTOGA 15' QUADRANGLE

COMPILED BY:
PAUL ANDERSON
1979



CONTOUR INTERVAL 20 GAMMAS

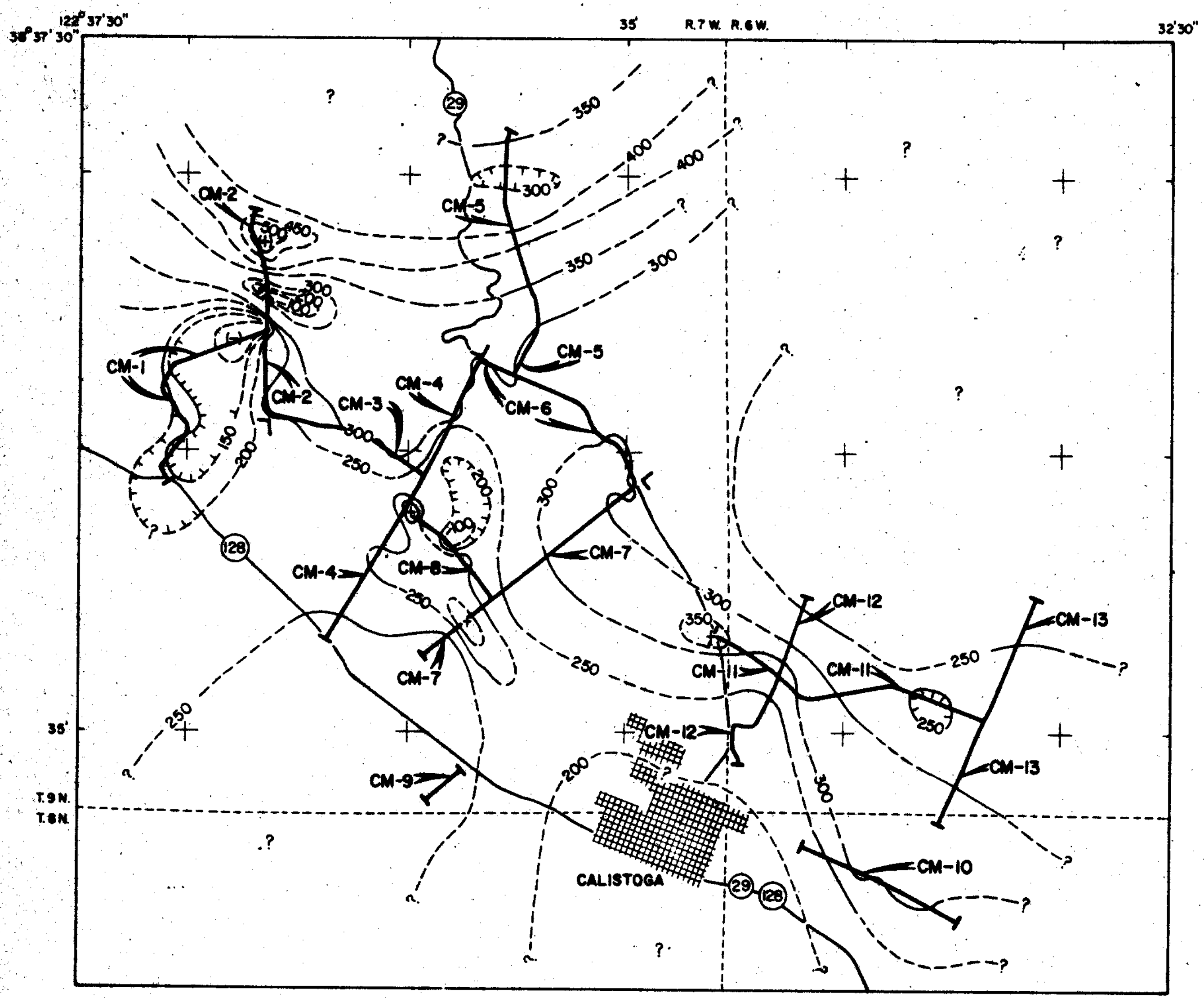
CM-14 GROUND MAGNETIC TRAVERSE



1. U.S. Geological Survey, 1973, Aeromagnetic map of the Clear Lake area, Lake, Sonoma, Napa, and Mendocino Counties, California: U.S. Geological Survey Open-file Report 73-299, scale 1:62,500. DMG (106)

2. U.S. Geological Survey, 1974, Aeromagnetic map of parts of the Santa Rosa and San Francisco 1° by 2° quadrangles, California: U.S. Geological Survey Open-file Report 74-81, scale 1:125,000. DMG (179)

1 0 1 MI.



GROUND MAGNETIC SURVEY NW PORTION OF THE CALISTOGA, CALIFORNIA 7 1/2' QUADRANGLE

BY

P. V. ANDERSON & L. G. YOUNGS

1979

0 1/2 1 MILE

0 2000 4000 FEET

0 .5 1 KILOMETER

EXPLANATION

CM-1

LOCATION OF GROUND MAGNETIC TRAVERSE AND TRAVERSE DESIGNATION NUMBER.

?

CONTOUR OF GROUND MAGNETIC DATA (CONTOUR INTERVAL-50 or 100 GAMMAS)

DASHED WHERE VALUES ARE INFERRED; QUERIED WHERE VALUES UNKNOWN.

ARBITRARY DATUM-51000 Gammas TOTAL INTENSITY

N

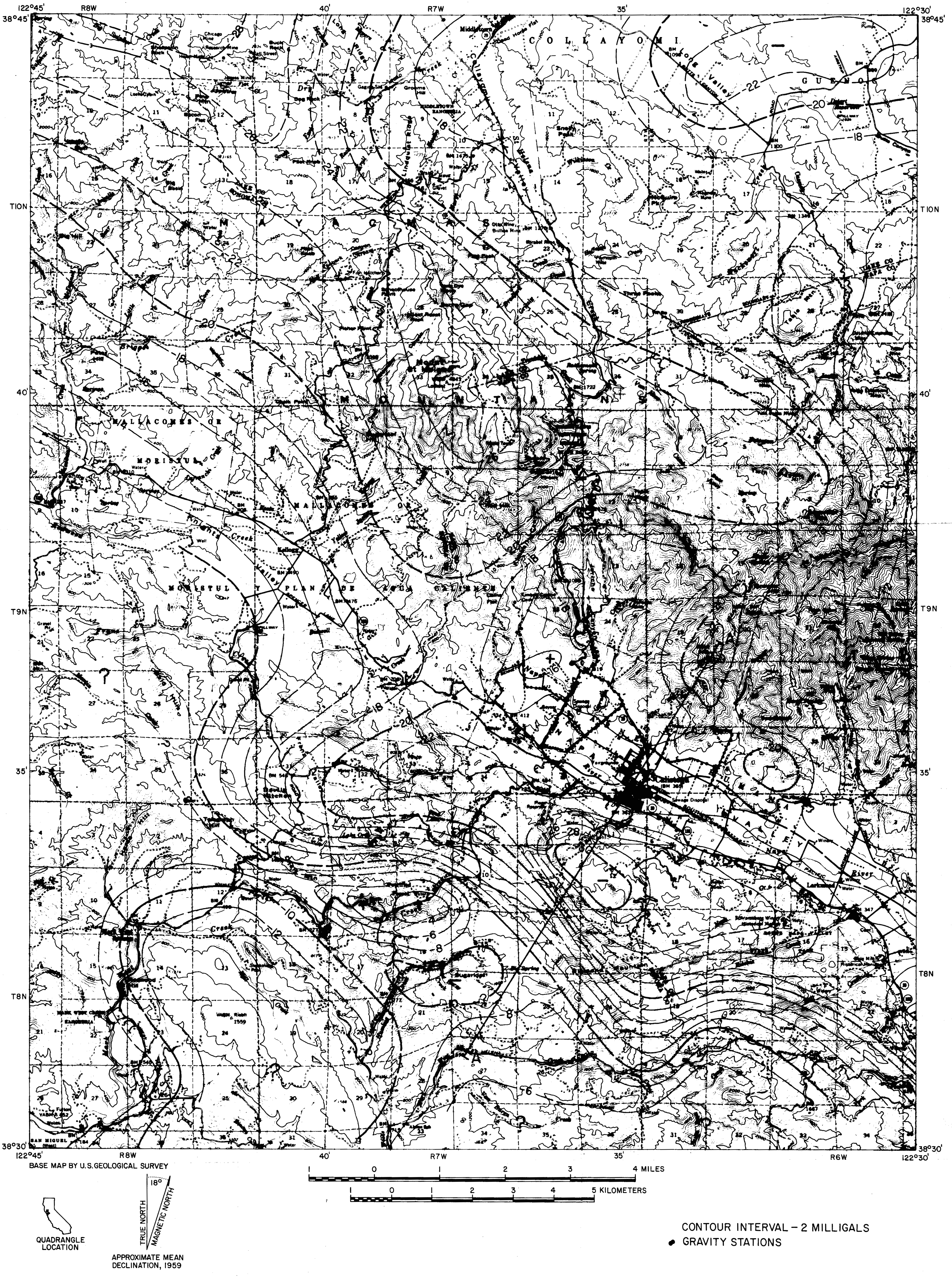
BASE MAP BY U.S.G.S

PLATE 3

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

PLATE 4

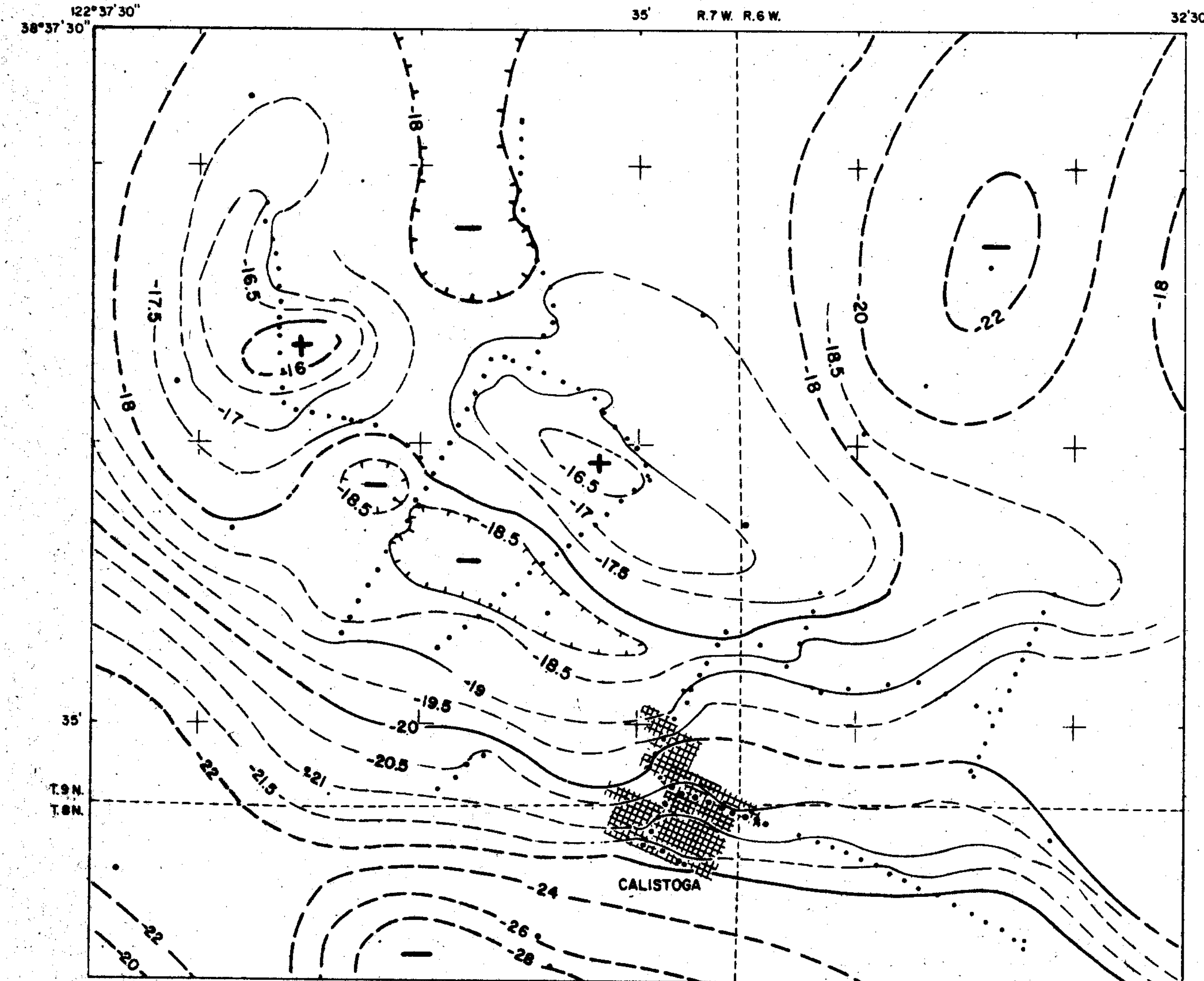


COMPLETE BOUGUER GRAVITY MAP OF THE CALISTOGA, CALIFORNIA 15' QUADRANGLE

by

LES YOUNGS, ROGER CHAPMAN, and GORDON CHASE

1980



COMPLETE BOUGUER GRAVITY MAP NW PORTION OF THE CALISTOGA, CALIFORNIA 7 1/2' QUADRANGLE

By Les Youngs
1979

0 — 1/2 — 1 MILE
0 — 2000 — 4000 FEET
0 — .5 — 1 KILOMETER

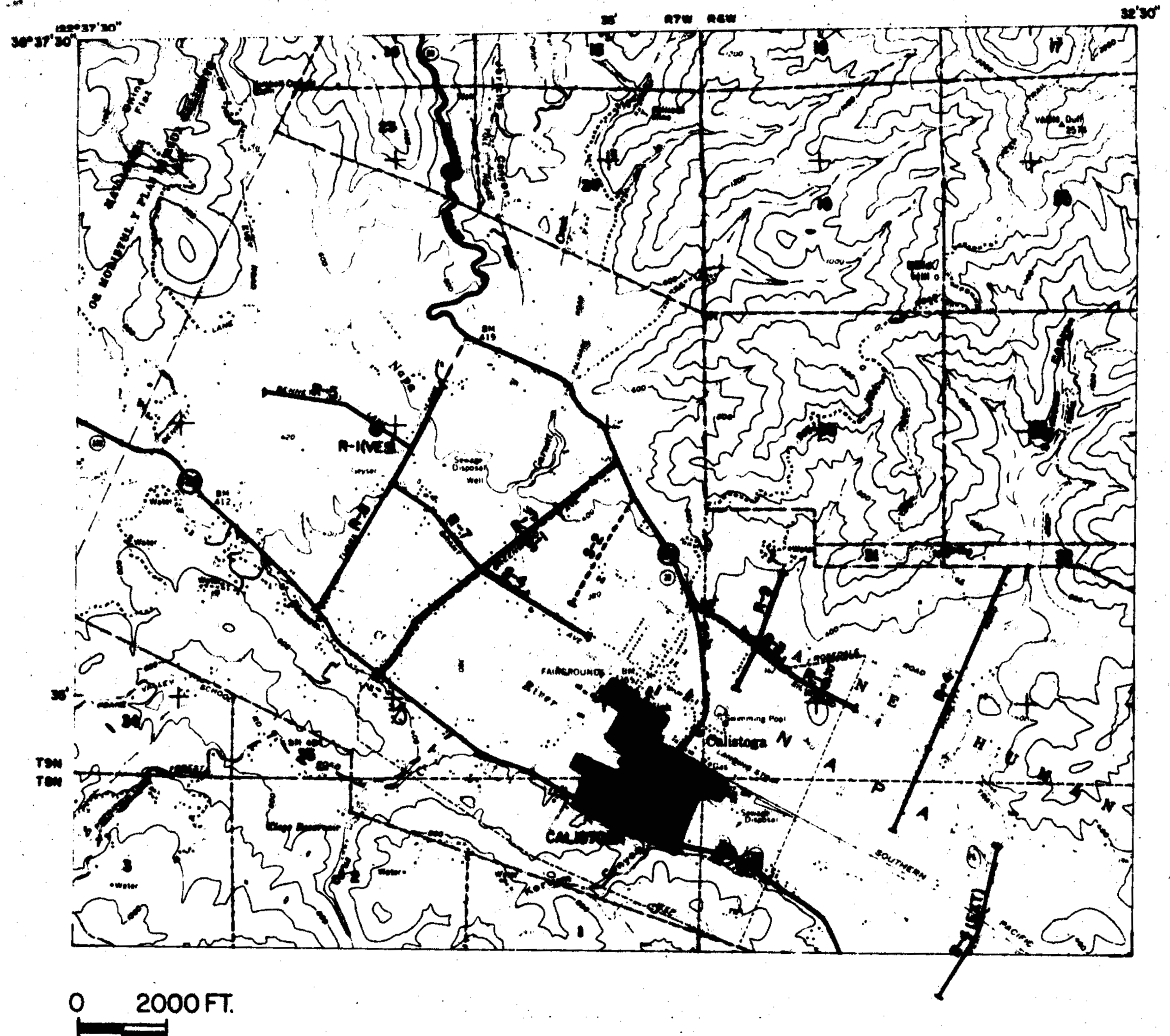
EXPLANATION

• GRAVITY STATION

CONTOUR INTERVAL: 0.5, 1.0, & 2.0 MILLIGALS

REDUCTION DENSITY— 2.67 g/cm^3

PLATE 5



SEISMIC AND RESISTIVITY LINE LOCATIONS CALISTOGA AREA

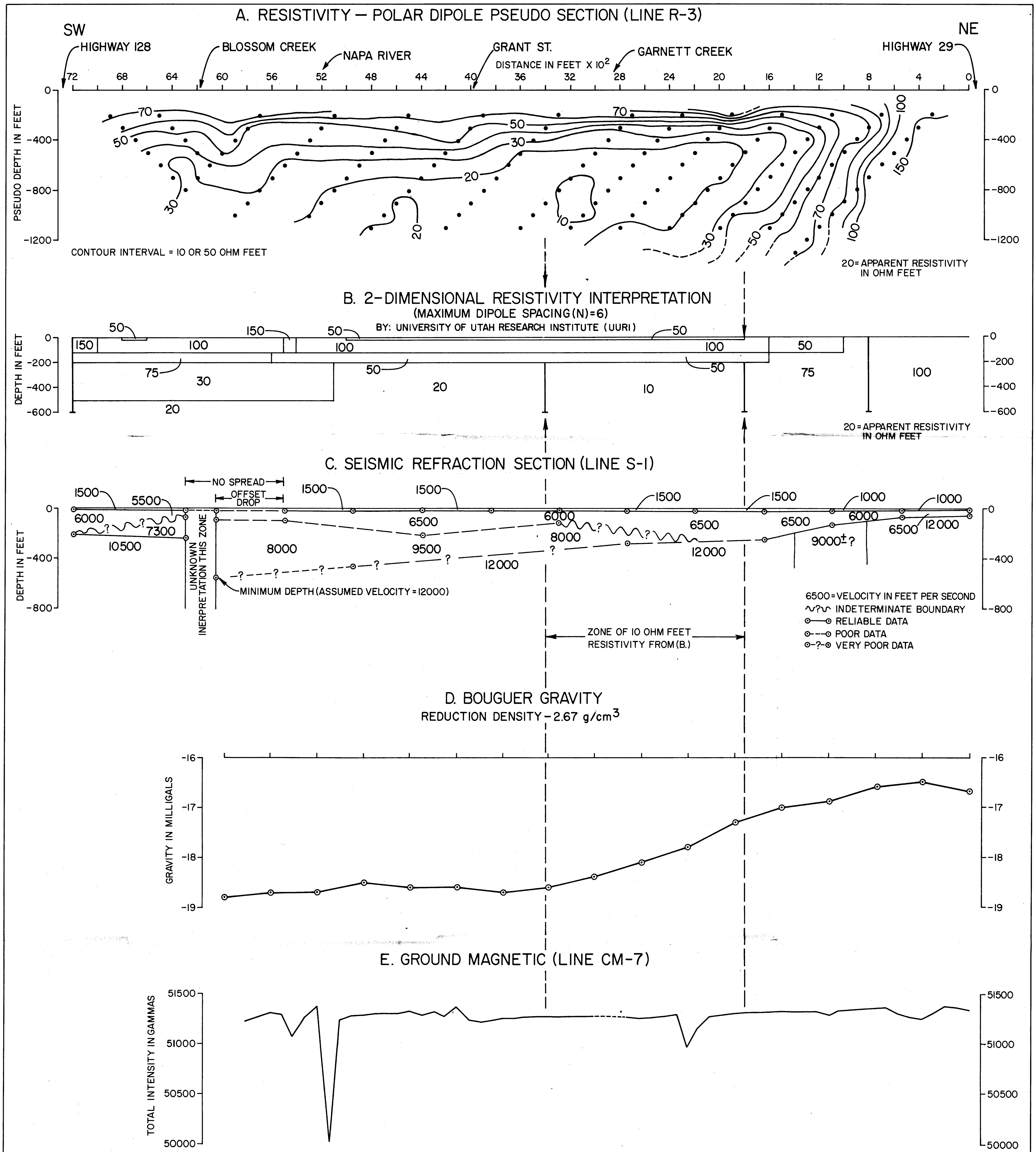
R — RESISTIVITY LINES

S -- SEISMIC REFRACTION LINES

⊗ V.E.S. RESISTIVITY LOCATION

BY
R. H. CHAPMAN

PLATE 6

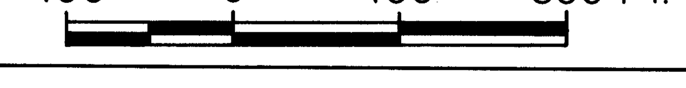


GEOPHYSICAL TRAVERSES

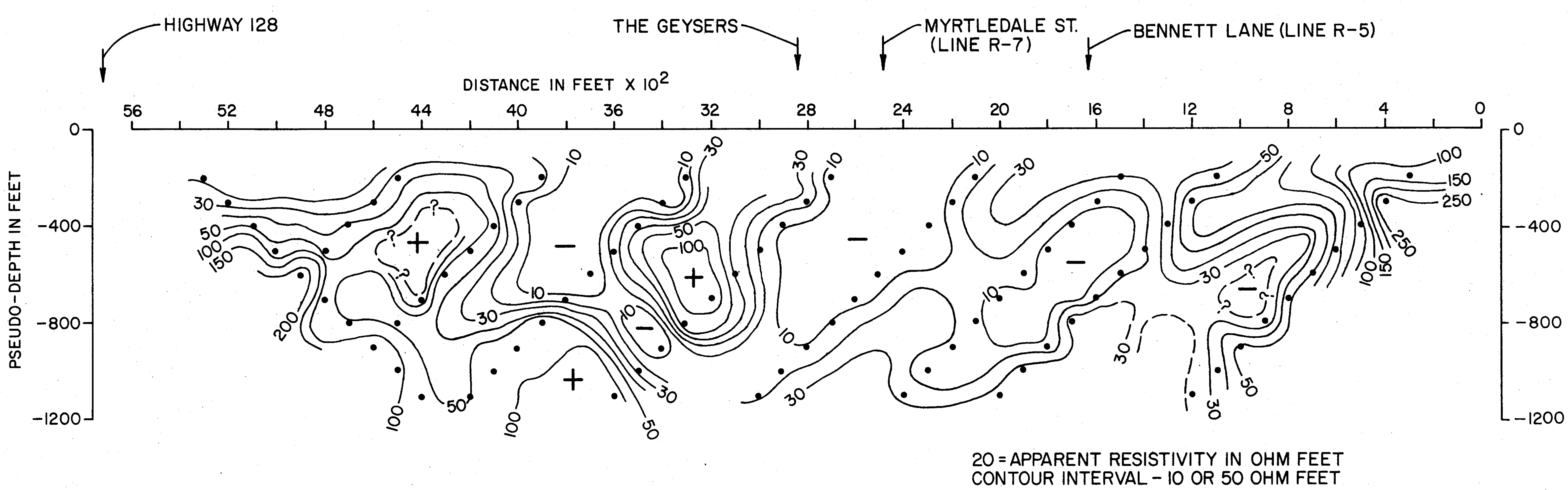
GREENWOOD AVENUE, CALISTOGA AREA, NAPA COUNTY, CALIFORNIA

BY

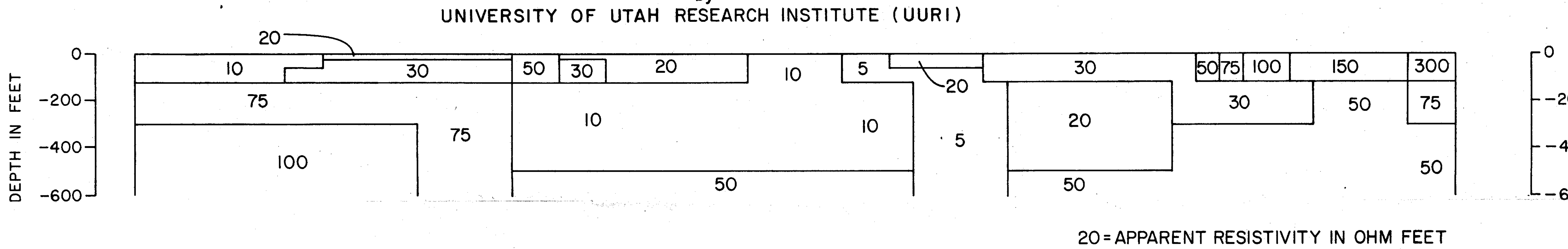
R. H. CHAPMAN, G. W. CHASE, L. G. YOUNGS



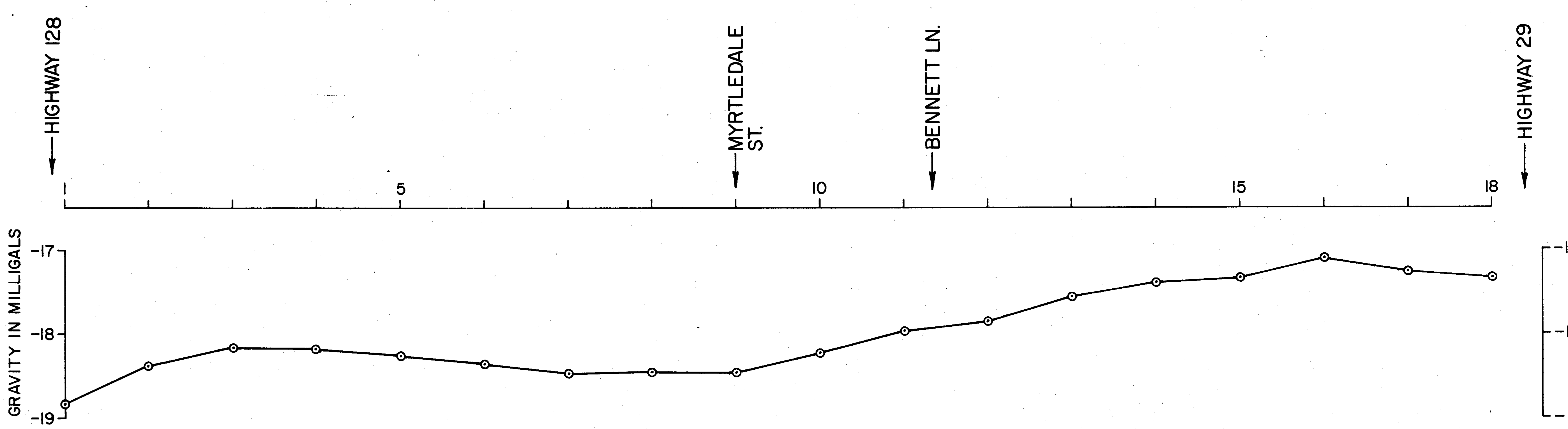
A. RESISTIVITY POLAR DIPOLE PSEUDO SECTION LINE R-8



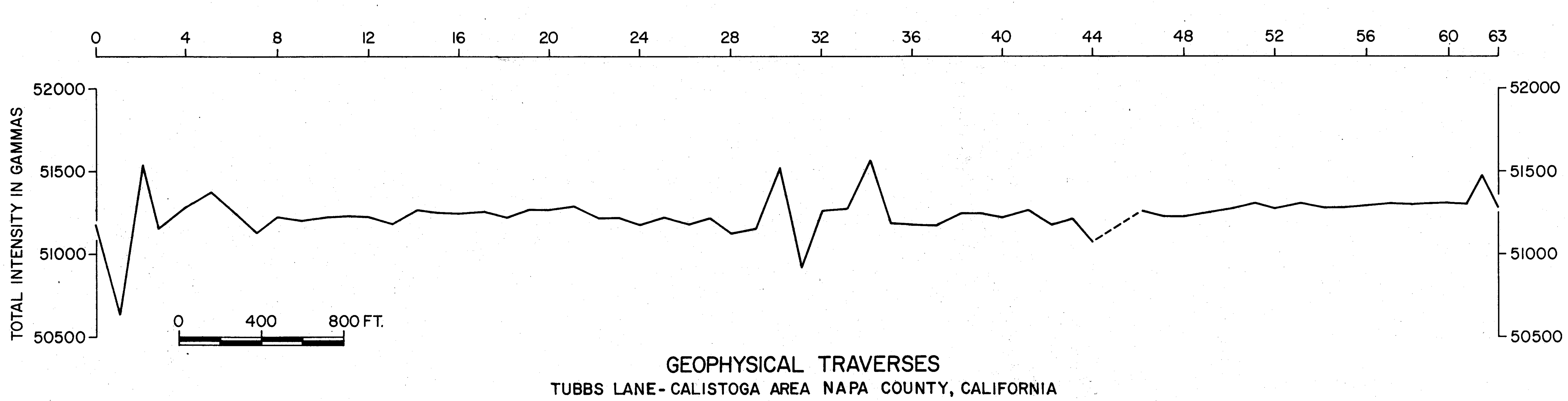
B. 2 DIMENSIONAL RESISTIVITY INTERPRETATION, MAXIMUM DIPOLE SPACING (N)=6 LINE R-8
by
UNIVERSITY OF UTAH RESEARCH INSTITUTE (UURI)



C. BOUGUER GRAVITY
(REDUCTION DENSITY = 2.67g/cm^3)



D. GROUND MAGNETIC PROFILE CM-4

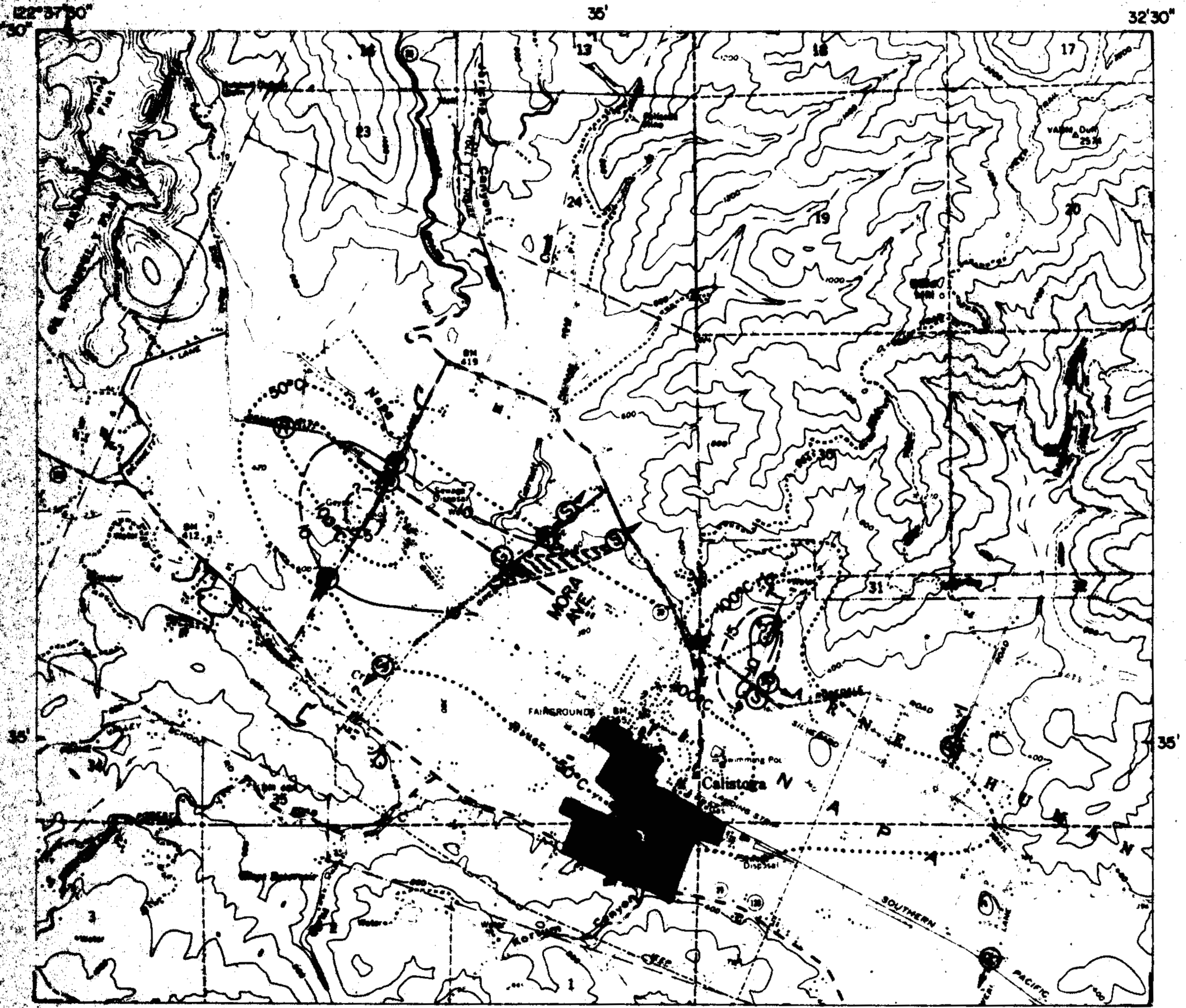


GEOPHYSICAL TRAVERSES

TUBBS LANE-CALISTOGA AREA NAPA COUNTY, CALIFORNIA

by

R. H. CHAPMAN, G. W. CHASE, L. G. YOUNGS



COMPOSITE GEOPHYSICAL ANOMALY MAP
CALISTOGA AREA
NAPA COUNTY, CALIFORNIA

2000 0 2000 4000 FT.

1 0 1 KM.

BY

R.H. CHAPMAN, G.W. CHASE, L.G. YOUNGS

EXPLANATION

- --Ⓖ-- BOUGUER GRAVITY GRADIENT ALIGNMENT
- —·—·— APPARENT RESISTIVITY CONTOURS (5, 10, AND 15 OHM FT.)
- Ⓡ→ APPROXIMATE APPARENT RESISTIVITY CONTACT, ARROW TOWARD HIGHER RESISTIVITY
- Ⓢ→ SEISMIC REFRACTION ANOMALY, ARROW TOWARD POSSIBLE UPTHROWN BLOCK WHERE APPLICABLE
- SEISMIC REFRACTION TERMINATION ZONE
- ······ CONTOURS OF MAXIMUM TEMPERATURES FROM WELLS AT DEPTHS OF 200-300 FEET (FROM PLATE NO.13 THIS REPORT)

BASE IS A REDUCTION FROM THE U.S. GEOLOGICAL SURVEY 7.5 MINUTE CALISTOGA TOPOGRAPHIC QUADRANGLE

PLATE 9

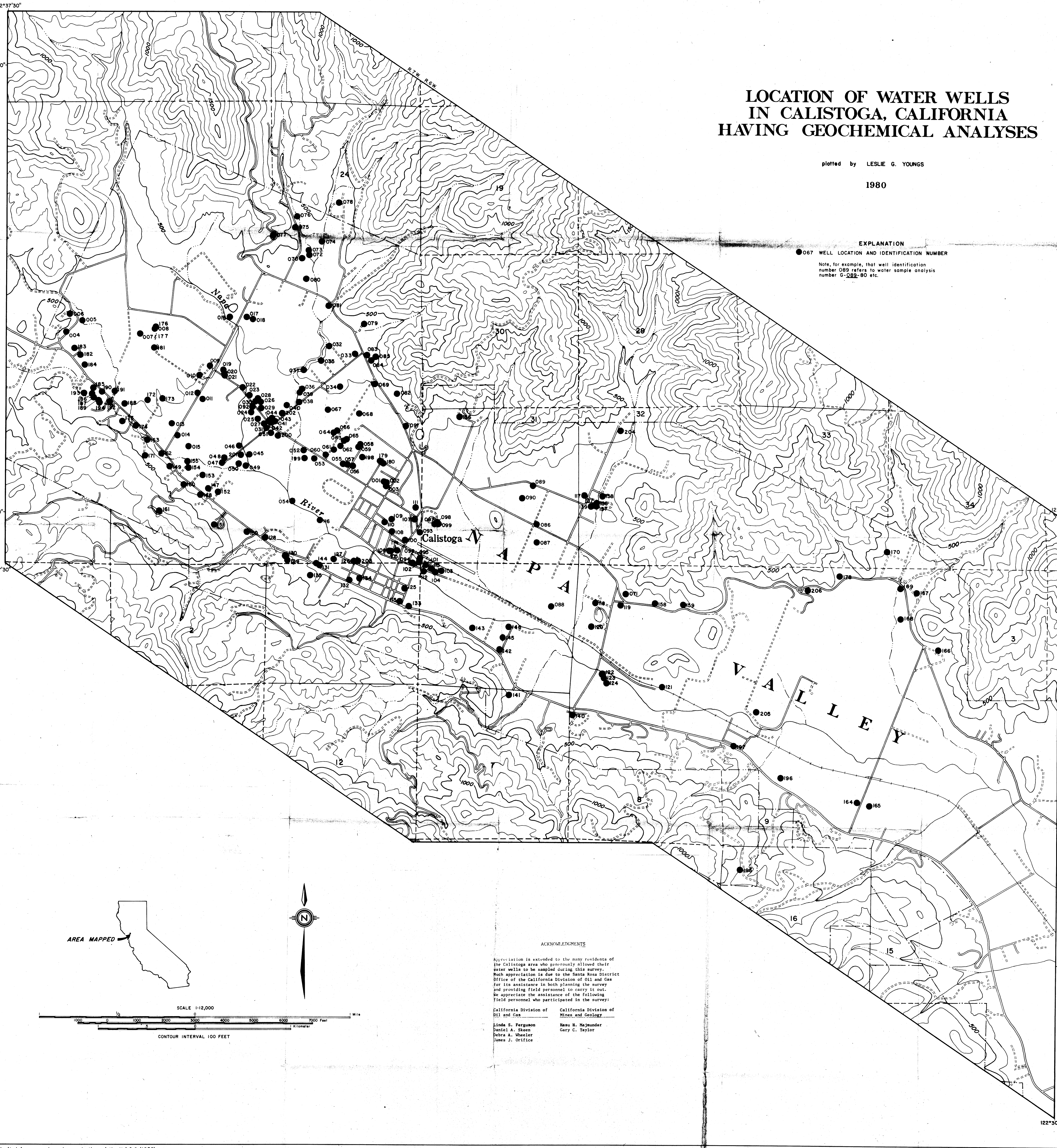
CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LOCATION OF WATER WELLS IN CALISTOGA, CALIFORNIA HAVING GEOCHEMICAL ANALYSES

plotted by LESLIE G. YOUNGS

1980



EXPLANATION

● 067 WELL LOCATION AND IDENTIFICATION NUMBER

Note, for example, that well identification number 089 refers to water sample analysis number G-089-80 etc.

SCALE 1:12,000

CONTOUR INTERVAL 100 FEET

ACKNOWLEDGMENTS

Appreciation is extended to the many residents of the Calistoga area who generously allowed their water wells to be sampled during this survey. Much appreciation is due to the Santa Rosa District Office of the California Division of Oil and Gas for its assistance in both planning the survey and providing field personnel to carry it out. We appreciate the assistance of the following field personnel who participated in the survey:

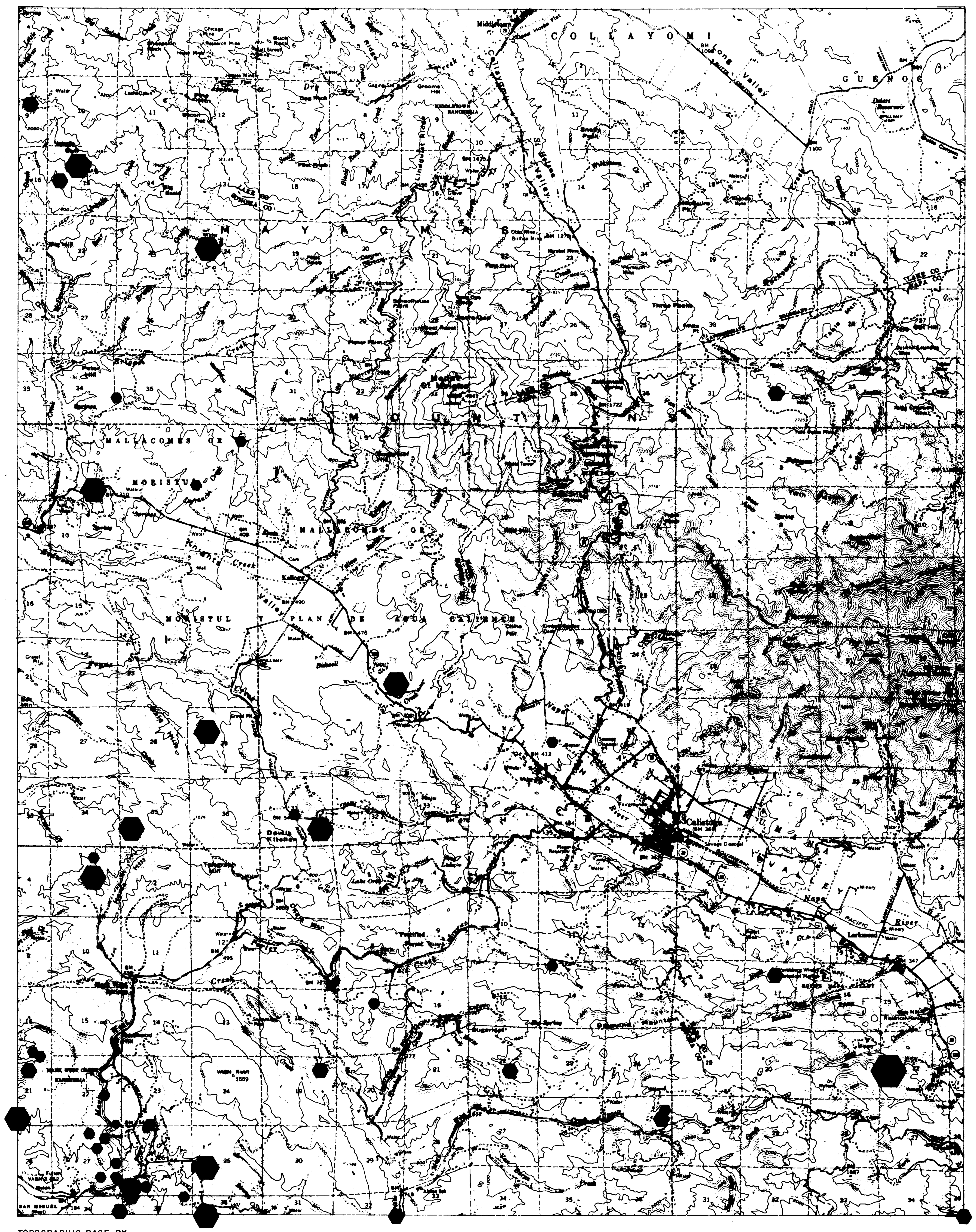
California Division of Oil and Gas	California Division of Mines and Geology
Linda S. Ferguson	Hasu H. Majmundar
Daniel A. Skeen	Gary C. Taylor
Debra A. Wheeler	
James J. Orifice	

Base map redrafted from an enlarged reproduction of the U.S.G.S. (1958) Calistoga, California 15 minute quadrangle topographic map.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

EARTHQUAKES IN THE CALISTOGA QUADRANGLE 1800 - 1974



MAGNITUDE

- 0.0 TO 0.9
- 1.0 TO 1.9
- 2.0 TO 2.9
- 3.0 TO 3.9
- 4.0 TO 4.9

DIGIT...... MAXIMUM REPORTED INTENSITY:
4...... MODIFIED MERCALLI

TOPOGRAPHIC BASE BY
U.S. GEOLOGICAL SURVEY

SCALE 1:62500

MILES
FEET (x 1000)
KILOMETERS

CONTOUR INTERVAL 80 FEET
DOTTED LINES REPRESENT 40-FT. CONTOURS
DATUM IS MEAN SEA LEVEL

18°
TRUE NORTH
MAG. NORTH
APPROX. MEAN
DECLINATION 1959

CA.
QUAD LOCATION

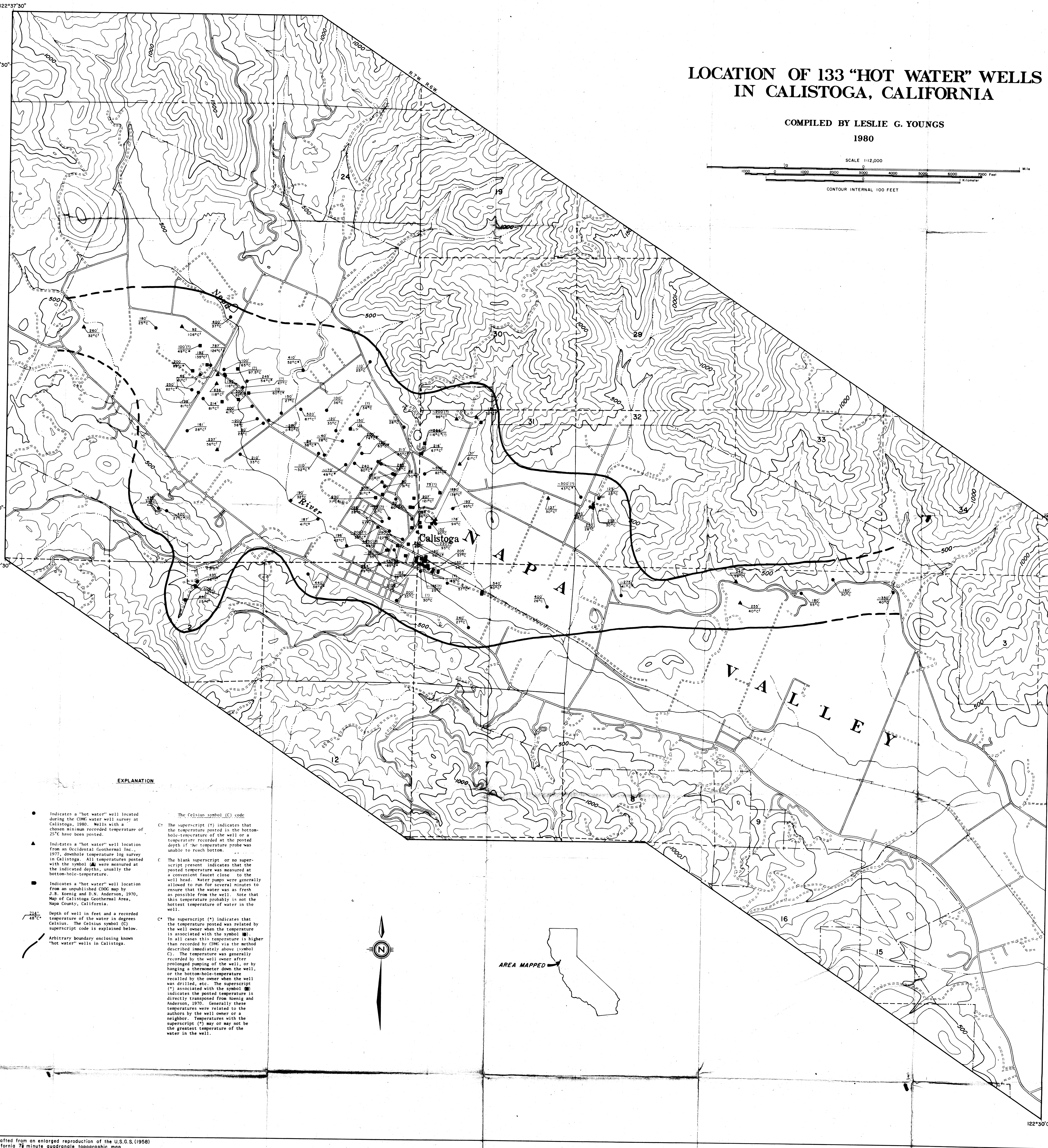
CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LOCATION OF 133 "HOT WATER" WELLS IN CALISTOGA, CALIFORNIA

COMPILED BY LESLIE G. YOUNGS

1980



EXPLANATION

● Indicates a "hot water" well located during the CDMG water well survey at Calistoga, 1980. Wells with a chosen minimum recorded temperature of 25°C have been posted.

▲ Indicates a "hot water" well location from an Occidental Geothermal Inc., 1977, downhole temperature log survey in Calistoga. All temperatures posted with the symbol (▲) were measured at the indicated depths, usually the bottom-hole-temperature.

■ Indicates a "hot water" well location from an unpublished CDOG map by J.B. Koenig and D.N. Anderson, 1970, Map of Calistoga Geothermal Area, Napa County, California.

214' / 48°C* Depth of well in feet and a recorded temperature of the water in degrees Celsius. The Celsius symbol (C) superscript code is explained below.

Arbitrary boundary enclosing known "hot water" wells in Calistoga.

The Celsius symbol (C) code

C† The superscript (†) indicates that the temperature posted is the bottom-hole-temperature of the well or a temperature recorded at the posted depth if the temperature probe was unable to reach bottom.

C The blank superscript or no superscript present indicates that the posted temperature was measured at a convenient faucet close to the well head. Water pumps were generally allowed to run for several minutes to ensure that the water was as fresh as possible from the well. Note that this temperature probably is not the hottest temperature of water in the well.

C* The superscript (*) indicates that the temperature posted was related by the well owner when the temperature is associated with the symbol (●). In all cases this temperature is higher than recorded by CDMG via the method described immediately above (symbol C). The temperature was generally recorded by the well owner after prolonged pumping of the well, or by hanging a thermometer down the well, or the bottom-hole-temperature recalled by the owner when the well was drilled, etc. The superscript (*) associated with the symbol (■) indicates the posted temperature is directly transposed from Koenig and Anderson, 1970. Generally these temperatures were related to the authors by the well owner or a neighbor. Temperatures with the superscript (*) may or may not be the greatest temperature of the water in the well.

Base map redrafted from an enlarged reproduction of the U.S.G.S. (1958) Calistoga, California 7½ minute quadrangle topographic map.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
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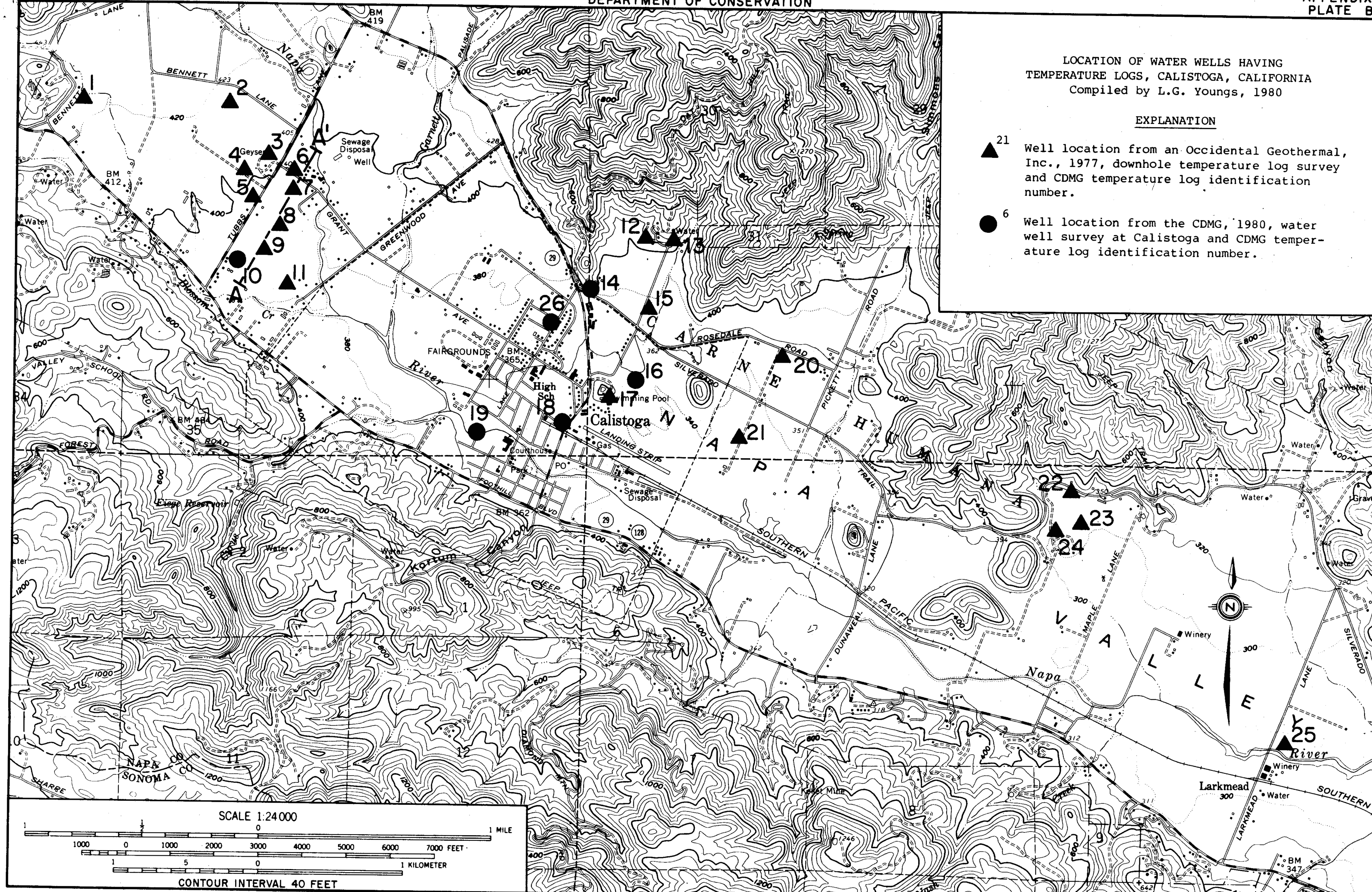
APPENDIX B
PLATE B-1



Base from the U.S.G.S. (1958) Calistoga, Calif. 7½ min. quandrangle.