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GEOTHERMAL RESOURCES OF NEW MEXICO -- A SURVEY OF WORK TO DATE

Technical Completion Report

New Mexico Energy Research and Development Program

ERB Project No. 76-210

SOLAR • GEOTHERMAL • WIND • WASTE CONVERSION

NEW MEXICO ENERGY INSTITUTE

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FOREWORD

The era of cheap and plentiful fuels is over; alternate sources of energy and fuel to take the place of oil and gas must be developed if the standard of living and quality of life are to be maintained. New Mexico's once large reserves of hydrocarbon resources will not last forever, and while the state is blessed with enormous quantities of solar energy, geothermal energy, wind energy and uranium ore, the technology to tap many of these sources is still being perfected. These must be wisely developed and invested if the state is to earn a fair, equitable and permanent return on its resources. New Mexico's economic future may well rest with the judicious development of its alternative energy resources.

The overall goal of the state energy research and development program is to develop solutions to the fuel and energy problems of the citizens of New Mexico. The program is designed to respond to state needs and to fill in the gaps where the national program is not responsive to unique state needs, to work with other programs when its aims coincide with state needs, to develop information and technology to the point that industry and commercialization are attracted to New Mexico and to continually review New Mexico work so state efforts can be directed to the best effect.

Creation of the three New Mexico Energy Institutes signalled a beginning at accelerating energy research and development in a programmatic way while still leaving the door open for innovative, individually initiated and developed projects. Funded by the State of New Mexico through the Energy Resources Board, the Institutes are responsible for working toward the development and conduct of state wide programs. As planning and coordinating agencies, the Institutes represent all the university, nonprofit entities and citizens of the State of New Mexico. To organize the research efforts, each Institute is assigned different areas of technical responsibility.

The New Mexico Energy Institute at New Mexico State University is resonsible for the areas of solar energy, wind energy, geothermal energy and energy from waste conversion. Within each of these four areas, the Institute attempts to develop and promote projects which confront such aspects as assessment and resource availability, research, conceptual system analysis, component and subcomponent development, testing, complete system development, demonstrations, environmental and institutional problems, performance analysis of complete systems and commercialization, among others. In all developments, the needs of low income citizens, the public sector and regional problems are specifically considered.

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INTRODUCTION

Problem and Purpose

Much work has been done on the geothermal resources of New Mexico but much more needs to be done before significant development can begin. Results of this previous work have been published in various places and no single comprehensive document exists which summarizes the location and natural setting of target areas as well as the status of exploration, leasing, and drilling in the state. This report was prepared in the belief that such a document would be valuable in planning future work. The specific purposes of this report are: 1) to define the areas of geothermal energy potential in the state, 2) to survey the various published information relating to these potential geothermal resource areas, 3) to summarize the various development efforts to date, and 4) to identify and describe current research projects on the geothermal resources of New Mexico.

Approach and Methods

Our approach was twofold consisting of a search of the scientific literature and a survey of current research projects in the state. It was decided that because of the proprietary nature of some data only those published or released to the open files of state or federal agencies would be used. In many areas where considerable previous work had been done, only works published since 1950 were cited and thus the reference list accompanying this report is not to be taken as exhaustive. Works published prior to 1950 may be located in the bibliography by Burks and Schilling (1955). Other bibliographies to which the reader is referred include: Schilling and Schilling (1956 and 1961), Cash (1971) and, Koehn and Koehn (1973) as well as the 2 annual summaries of geoscience research in New Mexico by Foster and Meyer (1972) and Olsen and Foster (1973). Two particular works by Summers (1972 and 1976) were invaluable in locating thermal springs, wells, and discharge sites. The geologic map of New Mexico by Dane and Bachman (1965) and the tectonic map of the Rio Grande Rift by Woodward and others (1975) were also useful in the completion of this project.

To learn of on-going work in the state we sent a one-page questionnaire to all persons known to be actively engaged in research on New Mexico's geothermal resources. Thirty-three questionnaires were sent out to New Mexico and other universities, various state and federal agencies, and research laboratories based in the state (Appendix). Results of this survey are discussed at the end of this report under "On-Going Research."

An explanatory note is in order regarding the computer plots of leasing and drilling activity presented herein. These plots are purely schematic for two reasons. First, it will be noted that the location of leases or wells is given only to the nearest 1/4 section. Where multiple locations exist within a 1/4 section the symbol on the plot is shown as solid or filled in. Second, it will be noted that the computer-generated land grids are always perfect (no offsets, truncations of sections, etc.); in reality this grid is rarely perfect. As no attempt was made to duplicate actual imperfections, the plots are schematic in this regard as well.

Using This Report

The material on New Mexico's geothermal resources contained in this report is organized first by geographic or target area, then by topic. General target areas discussed are listed in the table of contents and are shown on Fig. 1. To determine what specific thermal springs, wells, and discharge sites are included in a given target area, see the geographical index (Table 1). To determine what target area a specific thermal spring, well, or discharge site is described under, see the alphabetical index (Table 2).

The text for each target area includes an introductory statement giving location, geologic setting, and geothermal indicia; a survey of available geologic, geophysical, hydrogeologic, and hydrochemical data; and a summary of leasing and drilling activity. The target areas are discussed in the order that they would be encountered if the state were scanned from west to east by means of adjoining north-south strips approximately 75 miles wide.

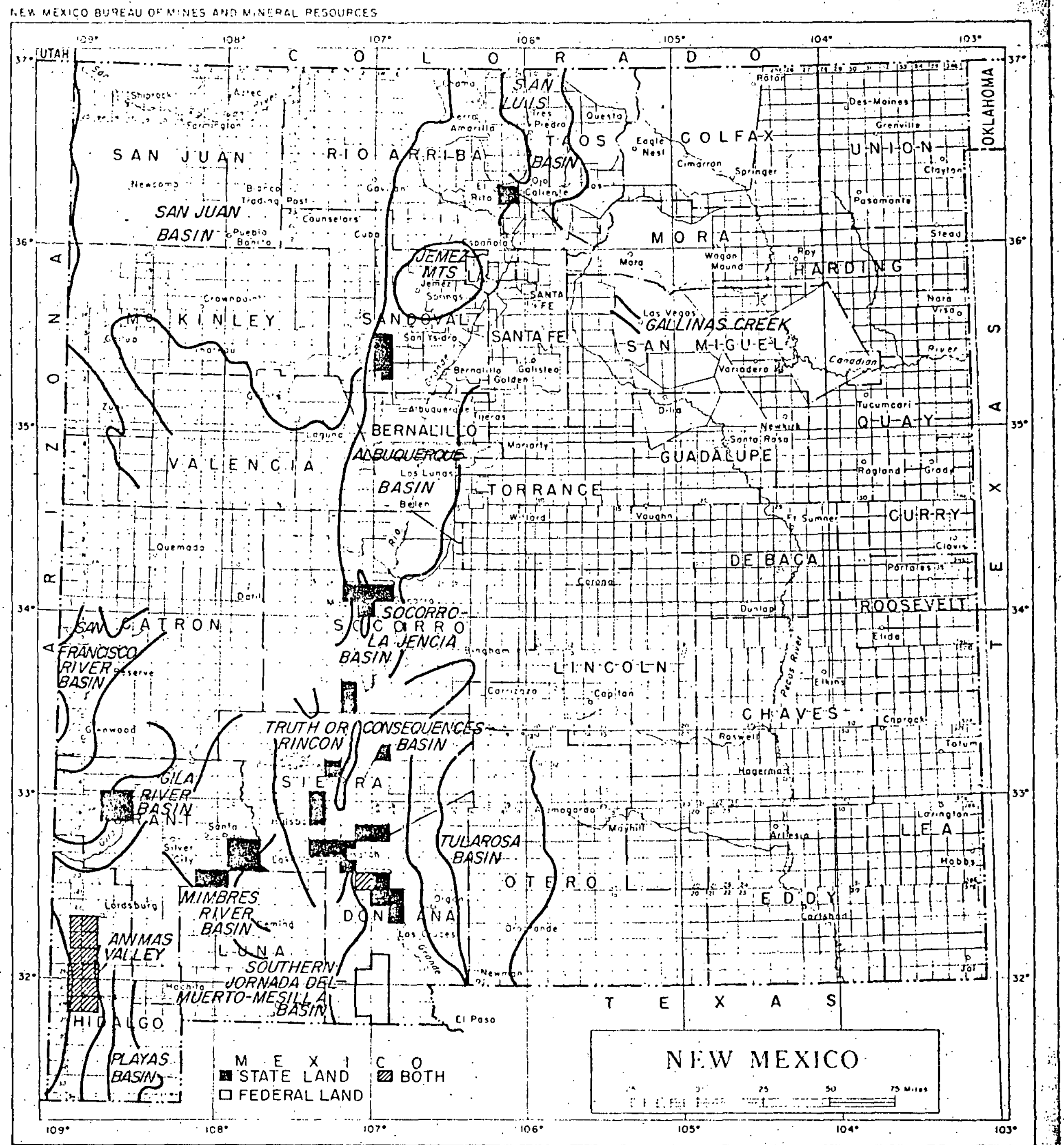

FIGURE 1--Location of target areas discussed in this report and townships in which geothermal resource lands have been leased. Solid areas = townships in which only State land leased, blank areas = townships in which only Federal land leased, stippled areas = townships in which both State and Federal lands leased.

Starting at the northwest corner of the state, the first such strip includes the San Juan Basin in the north through the Animas Valley and Playas Basin in the south. The second strip corresponds roughly to the Rio Grande Rift and the third includes the 1 remaining target area east of the rift: Gallinas Creek.

Numbering of Wells and Springs

The system of numbering used in this report is that used by the New Mexico State Engineer and is based on the township, range, and section land grid (Fig. 2). In this system each well or spring has a unique location number consisting of four parts separated by periods: 5N.10E.24.213. The first part (on the left) refers to the township, the second designates the range and the third part identifies the section (Fig. 2a). The fourth locates the well or spring within the section to the nearest 10-acre tract as follows (Fig. 2b): each section is divided into quarters which are assigned numbers such that the northwest quarter is number 1, the northeast quarter is number 2, the southwest quarter is number 3, and the southeast quarter is number 4. Each quarter section is then divided into quarters which are numbered in the same manner. Each quarter-quarter section is similarly divided and numbered. If the location of a well or spring cannot be determined to quarter-quarter section or quarter-quarter-quarter section, a zero is used in the appropriate position in the right hand or

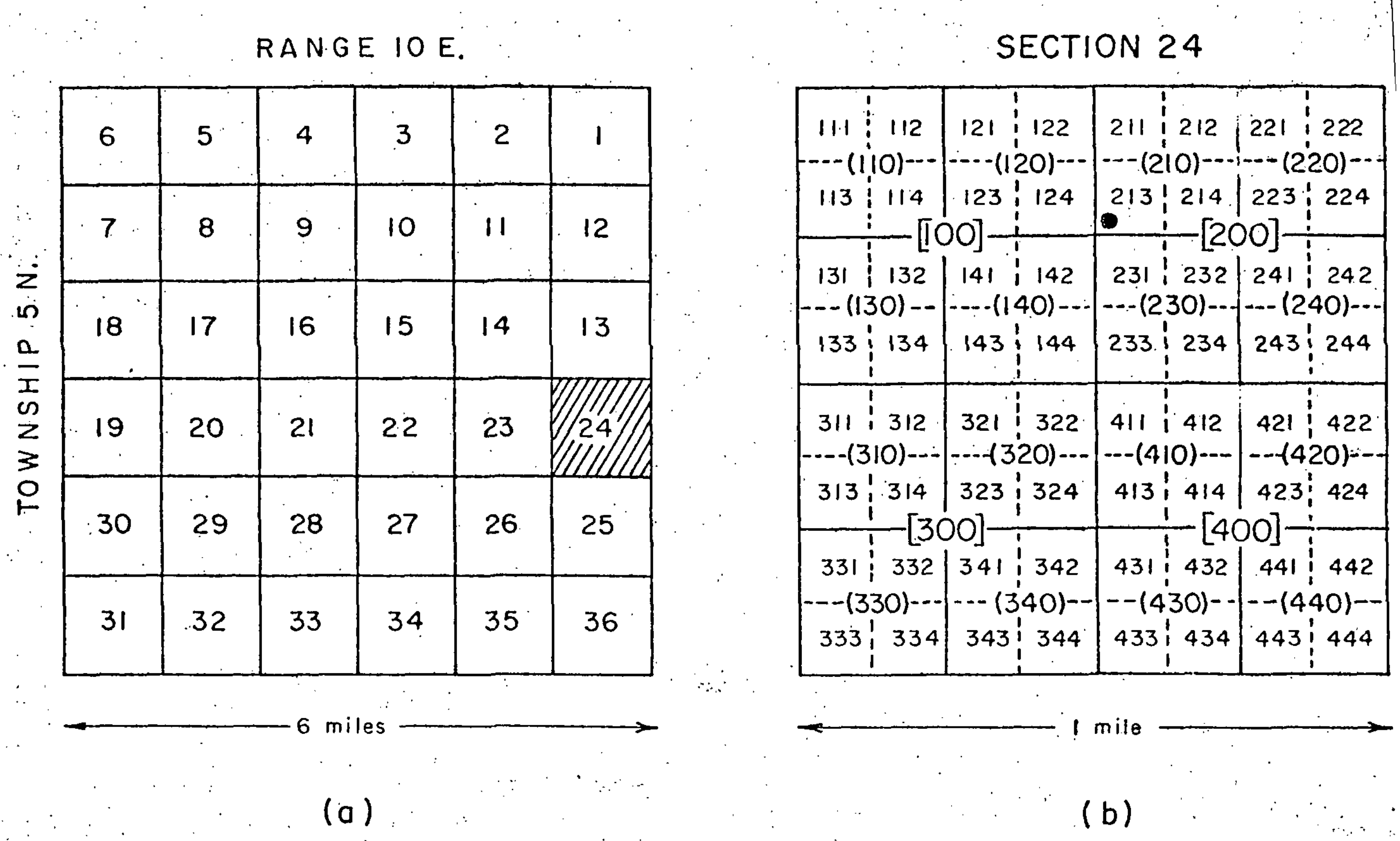

FIGURE 2--Method of numbering wells and springs: a) subdivision of a township into sections, b) subdivision of a section into quarter-quarter-quarter section blocks (dot indicates location of a well numbered 5N.10E.24.213).

fourth part of the number. A well designated 5N.10E.24.213 is located in the SW¼, NW¼, NE¼, Sec. 24, T5N, R10E (Fig. 2). A spring located in the NW¼, Sec. 31, T2S, R1W would be numbered 2S.1W.31.100. In unsurveyed areas locations were approximated by constructing a township grid on the best available map.

Acknowledgments

This project was funded by the New Mexico Energy Institute at New Mexico State University, Las Cruces.

We also wish to thank Steve Mizell, Terry Wallace, and Frank Caravella for their assistance in preparing the schematic computer plots of geothermal leasing and drilling activity used in this report.

GEOTHERMAL RESOURCES: OVERVIEW

Nature of Geothermal Resources

Much energy in the form of heat is stored within the earth, however, most of this heat is associated with the earth's core and mantle and thus is too deep to ever be tapped. According to White (1965, p. 2) approximately 10^{24} BTU's (British Thermal Units; 1 BTU is the heat required to raise the temperature of 1 lb. of water 1°F at 39.2°F) of heat are stored within the upper 6 miles of the earth's crust; although this zone is accessible to drilling, most of this heat is probably too diffuse to be utilized. Only local concentrations of this energy in "hot spots" or "geothermal reservoirs" are economically significant. Godwin and others (1971, p. 6) defined "geothermal reservoir" as a zone in porous rock containing water and/or steam of high temperature (>150°F).

Such reservoirs are associated with one of three general types of geothermal systems: 1) hydrothermal convection systems, 2) hot igneous systems, or 3) regional conductive systems. White and Williams (1975) described these in detail; the following general statements concerning them are drawn from their report. Hydrothermal convective systems occur to depths of about 2 mi and include: vapor-dominated systems with temperatures of about 470°F or hot-water-dominated systems with high (>300°F), intermediate (195-300°F), or low (<195°F) temperatures.

Hot igneous systems occur at depths between 0 and .5 mi and consist of molten material with temperatures >1200°F or nonmolten but very hot material with temperatures <1200°F. Regional conductive systems occur at depths between 0 and 6 mi and have temperatures generally ranging from 60°F to about 575°F.

Thermal springs are a useful preliminary exploration tool in locating potential geothermal resource areas as they may be surface manifestations of underlying hot spots or geothermal reservoirs. Thermal springs are merely those yielding thermal water, and thermal water is simply that having a temperature appreciably above the mean annual air temperature (Gary and others, 1974, p. 735). In exploration the question arises, what constitutes anomalously thermal water or how hot is "hot"? The boundary between thermal and anomalously thermal water temperatures (or warm and hot springs) may be selected somewhat arbitrarily. For example, Meinzer (1923, p. 54) used the temperature of the human body (98.6°F) to distinguish between warm and hot springs. Summers (1965b, p. 3) preferred a dividing point of 90°F because it was noted to coincide with the approximate breaking point on a plot of frequency of New Mexico thermal springs versus temperature.

In view of the fact that the temperature of the earth increases regularly with depth, a less arbitrary approach to defining anomalously thermal water temperatures is based on the relationship between originating depth of water versus observed water temperature. The normal rate of temperature increase with depth, or the average geothermal gradient, is about 1.5°F/100 ft of depth. Normal or warm thermal water may therefore be defined as that having a temperature which would be expected on the basis of the local mean annual air temperature and a normal geothermal gradient. Conversely, anomalously thermal water may be defined as that having (or suspected to have cooled from) a temperature surpassing such expected values. Summers (1976, p. 9) suggested that anomalously thermal water temperatures be defined as those equal to or greater than the temperature calculated as follows:

$$A + 4.0 + 0.027\ Z,$$

where A = mean annual air temperature (about 50°F for New Mexico),

4.0 = a constant based on the observation by Collins (1925) that ground water temperatures within upper 100 ft of earth are warmer than mean annual air temperature by about 4°F,

0.027 = °F/ft for a geothermal gradient of 1.5 times normal (assumes normal gradient is 1.8°F/100 ft; value of 0.025 would be used for usually cited normal gradient of 1.5°F/100 ft),

Z = average depth of contributing interval in well (also probable maximum depth of circulation of flow system discharging at a spring).

Exploitation Factors

The following requirements, presented by Godwin and others (1971, p. 6) must generally be met by a geothermal reservoir to warrant its exploitation for generating electricity: 1) temperatures in the range 150-400°F, 2) depth not greater than about 10,000 ft, 3) sufficient permeability to permit the heat transfer fluid(s) (water, steam) to flow continuously to a well at a high rate, and 4) sufficient fluid recharge to the reservoir to maintain production over many years. Kruger and Otte (1973) pointed out that an adequate reservoir volume is also essential (>3 mi^3). In addition to these physical factors, the feasibility of exploiting a geothermal reservoir also has economic constraints. Geothermal resources are defined as stored heat recoverable by current or near-current technology and may be divided into 3 categories on the basis of recovery cost (White and Williams, 1975, p. 1): 1) submarginal geothermal resources - those recoverable only at a cost which is more than twice the current price of competitive energy, 2) paramarginal geothermal resources - those recoverable at a cost between 1 and 2 times the current price of competitive energy, and 3) geothermal reserves - those resources recoverable at a cost competitive now with the current price of other energy sources.

Classification of Public Lands

The Geothermal Steam Act of 1970 expanded the authority and responsibility of the U.S. Geological Survey in classifying public lands for the development of natural resources to include classification of lands as valuable for development of geothermal steam and associated resources. Godwin and others (1971) outlined criteria used in this new classification; the following brief summary is based on their report. For purposes of retention of Federal rights to geothermal resources, public lands must be defined as a <u>geothermal resource province</u> (GRP). One or more of the following conditions are necessary for the classification of lands as a GRP: 1) evidence of volcanism of late Tertiary or Quaternary age (about 10 million years old); 2) presence of geysers, fumaroles (volcanic vents from which gases and vapors are emitted), mud volcanoes, or thermal springs producing water with temperatures at least 9°F hotter than the average ambient temperature; and 3) a subsurface geothermal gradient exceeding twice the normal gradient.

Lands are classified as a <u>known geothermal resource area</u> (KGRA) when the indications of potential geothermal resources in the area are strong enough to warrant expenditures of money for that purpose. The designation of an area as a KGRA is based on evaluation of all available geologic, geochemical, and geophy[illegible] of competitive interests in the area (filing of lease applications which overlap by at least 50 percent); close relationship to other discoveries; and any other pertinent engineering or economic data.

History of Development: United States

Numerous hot springs in the United States have long been developed as mineral-bath resorts. The first geothermal test wells, however, were drilled in the 1920's at the Geysers (about 75 miles north of San Francisco) and Niland (about 100 miles east of San Diego), California. Although, low-pressure steam was found, no market existed for this resource at that time. In the 1920's and 1930's other fumaroles were drilled in the United States, notably in the Yellowstone area, Wyoming. From 1933-1954, carbon dioxide associated with geothermal fields in the Imperial Valley, California, was produced for dry ice. Also in the Imperial Valley mineral recovery from brines was attempted for several years but the process proved uneconomical and was terminated. Geothermal fluids are presently being utilized for space heating by means of heat exchangers at Klamath Falls, Oregon.

The first major electrical-power generation plant utilizing geothermal resources in the United States was a 12.5 mw (megawatt) pilot plant constructed at the Geysers, California in 1960. In 1975 the Geysers had a cumulative plant capacity (11 generating units) of approximately 502 mw; the anticipated 1977 capacity is 908 mw (15 generating units). The U.S. Bureau of Reclamation has sponsored fabrication of a geothermally-powered desalinization pilot plant at their East Mesa test site in the Imperial Valley, California.

NEW MEXICO'S POTENTIAL FOR UTILIZATION OF GEOTHERMAL ENERGY

Regional Setting

General discussions of New Mexico's potential for utilization of geothermal resources have been given by Summers (1968a, b), Reiter and Stone (1976), and Hatton (1977). The geologic setting of the state is the key to its geothermal resources. New Mexico includes parts of 4 geologic provinces: The Basin and Range in the southwest and central part, the Colorado Plateau in the northwest corner, the Rocky Mountains in the north central part, and the Great Plains in the eastern half (Fig. 3). The geothermal potential differs from province to province. One way of comparing the potential of the provinces is heat flow. Heat is constantly escaping from the earth and heat flow is simply the rate of escape. The worldwide average heat flow is 1.5 HFU (heat flow units; 1 HFU = 1 $\mu cal/cm^2$- sec) and the "normal" range of heat flow values may be considered to be 0.8 to 2.0 HFU (White, 1973). The Colorado Plateau and Great Plains generally have heat flow values $\leq$ 1.5 HFU; the Basin and Range and Rocky Mountains provinces generally have heat flow values of 2-2.5 HFU or greater (Figs. 3 and 4).

The north-south trending belt of high heat flow values shown on Fig. 4 is associated generally with the geologic structure known as the Rio Grange Rift (Fig. 5). It is interesting to note that this structure spans 2

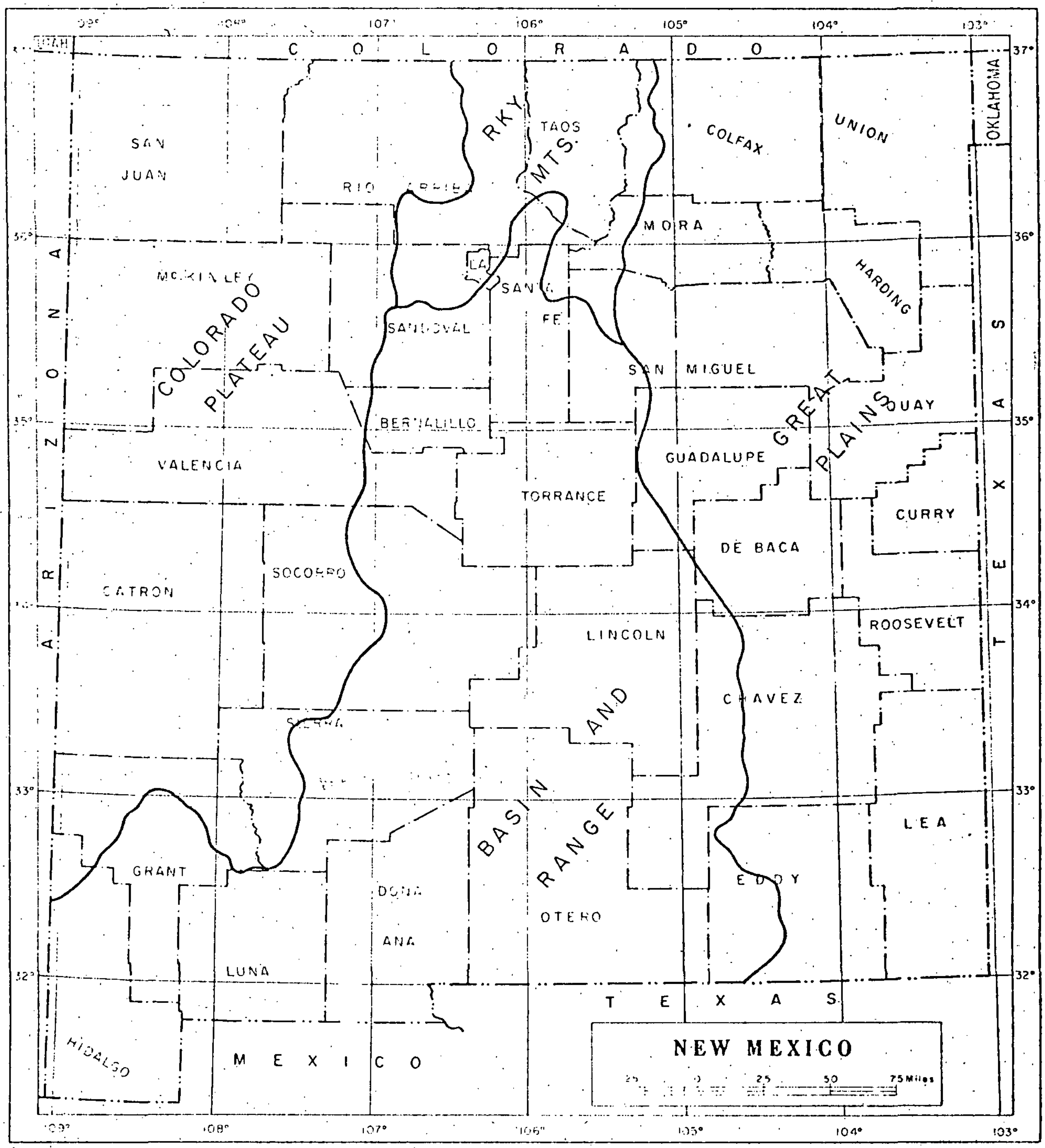

FIGURE 3--Geologic provinces in New Mexico (modified from Fenneman, 1962).

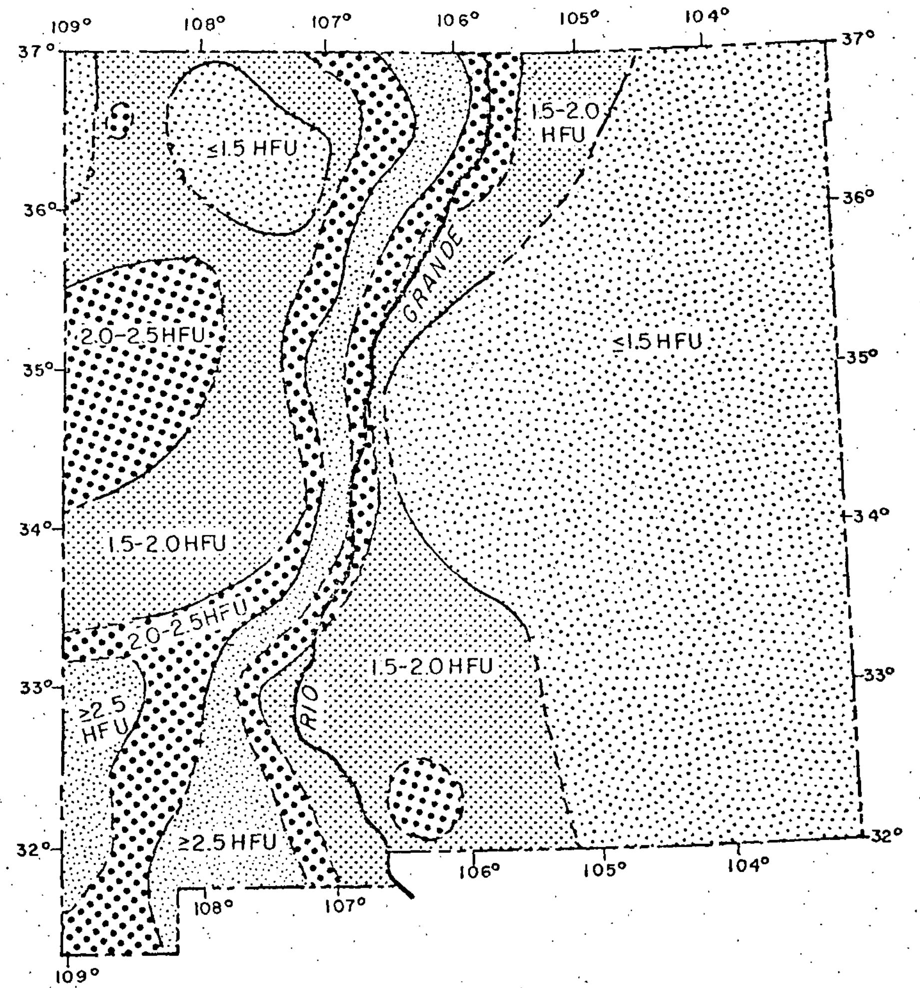

FIGURE 4--Terrestrial heat-flow contour map of New Mexico. Contour interval = 0.5 hfu (modified from Reiter and others, 1975).

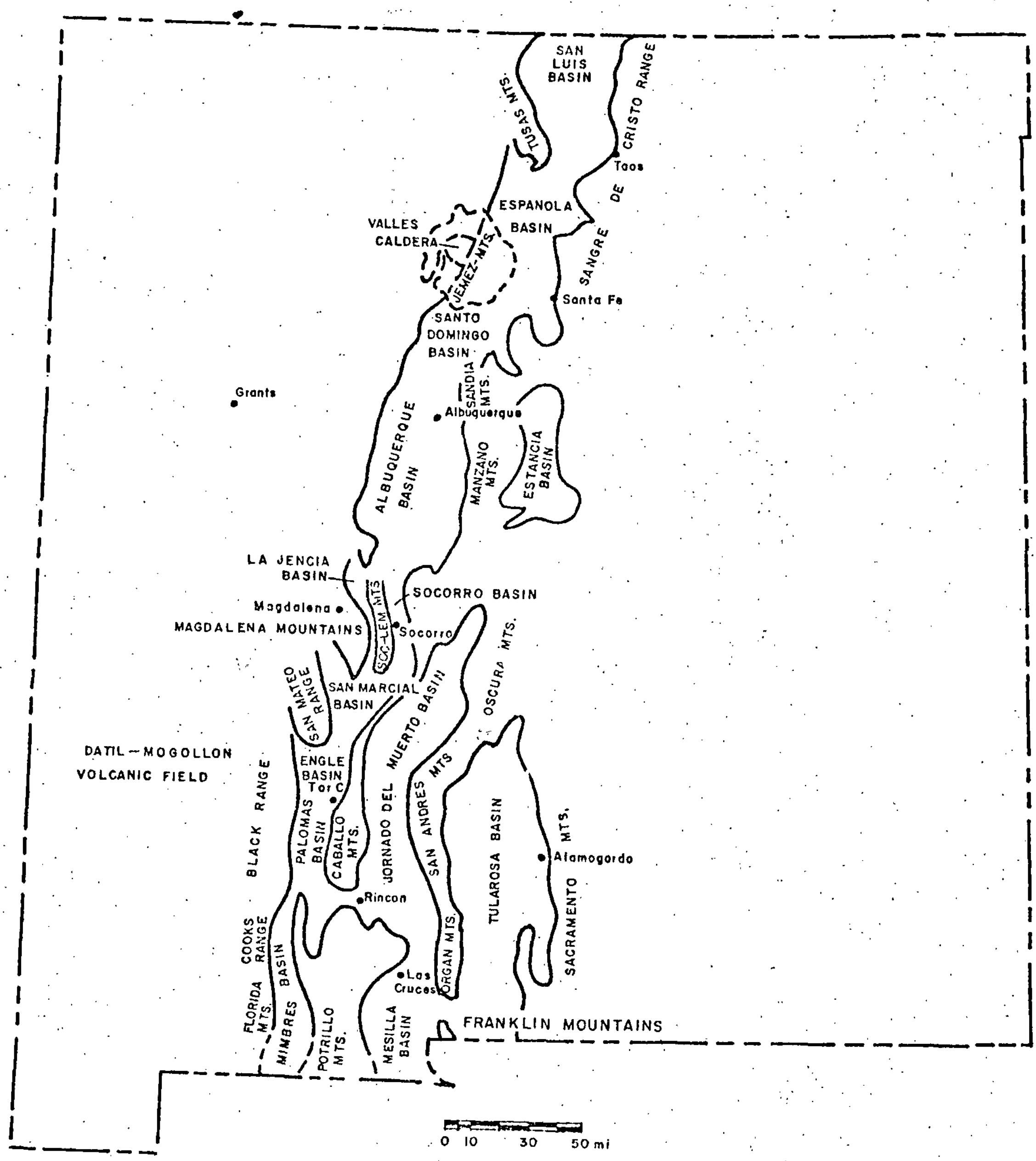

FIGURE 5--Generalized map of the Rio Grande Rift (modified from Chapin, 1971).

geologic provinces: the Rocky Mountains province in the north and the Basin and Range province in the south. Two other areas of high heat flow lie to the west of the rift along the Arizona border (Fig. 4). The southernmost of these is clearly within the Basin and Range province but the northern one may coincide with the transition zone between the Basin and Range province and the Colorado Plateau province (Reiter and others, 1975, p. 811).

Known Geothermal Resource Areas and Leasing

To date, the U.S. Geological Survey has designated 8 KGRA's in New Mexico: Baca Location No. 1 (168,761 ac), Radium Springs (9,812 ac), Kilbourne Hole (25,133 ac), Lightning Dock (23,552 ac), Gila Hot Springs (3,201 ac), Lower Frisco Hot Springs (5,760 ac), Socorro Peak (89,715.81 ac), and San Ysidro (1,915 ac) (Fig. 6). These were designated largely on the basis of competitive interest.

Within New Mexico, leases for geothermal development are currently being granted on state (Table 3), federal (Table 4), and private lands. The state of New Mexico conducted geothermal lease sales in August 1974, March 1975, October 1975, and July 1975. As of January 31, 1977, 903,773.92 ac had been leased. Federal geothermal leases were granted in May 1975, June 1975, and May 1976. As of January 31, 1977, there were 74 noncompetitive leases totalling 135,846 ac and 18 competitive leases covering 32,564.45 ac. Geothermal-resource lands have been leased

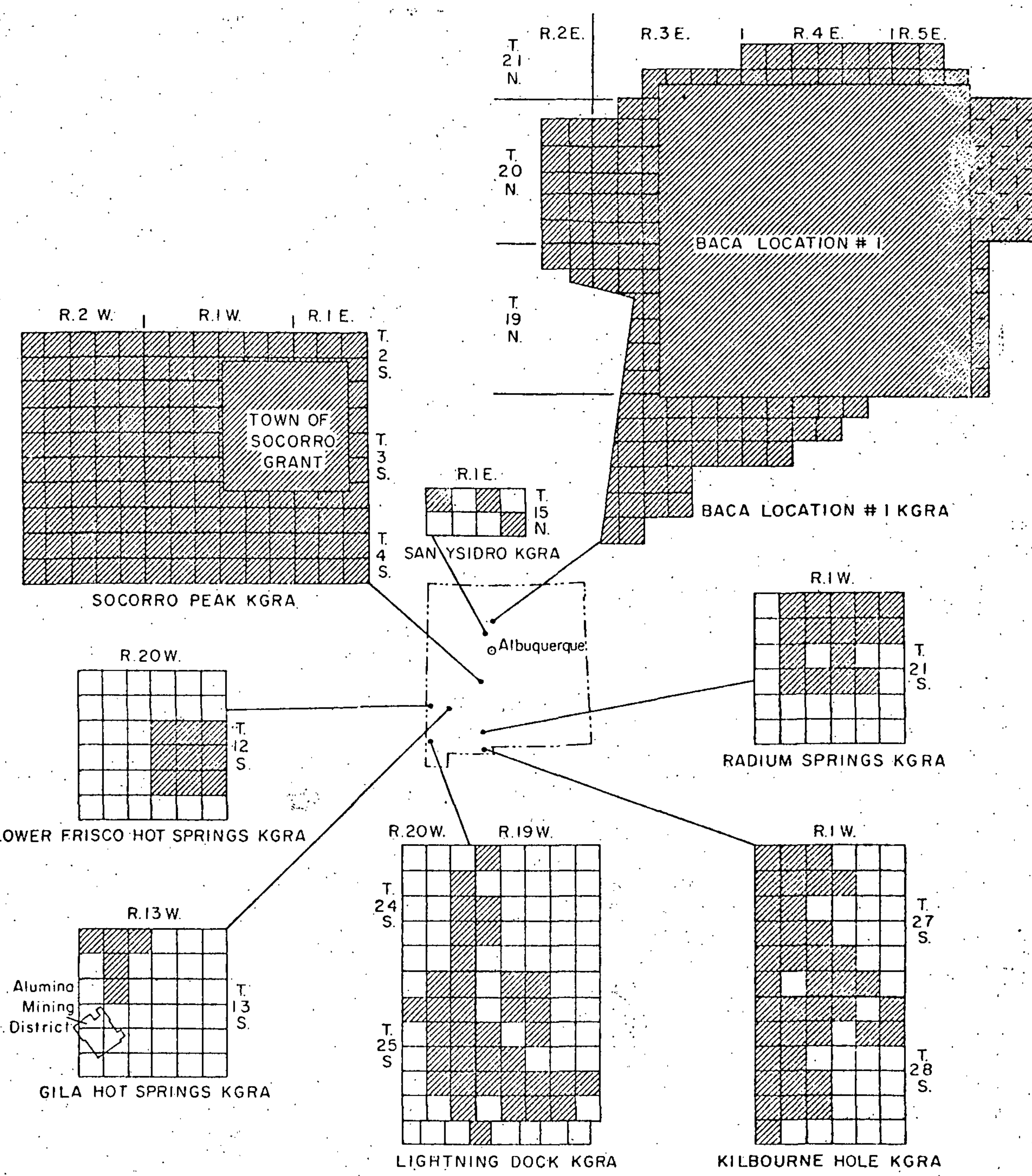

FIGURE 6--Known Geothermal Resource Areas (KGRA's) recognized in New Mexico.

in the following counties: Doña Ana, Grant, Hidalgo, Rio Arriba, Sandoval, Sierra, and Socorro. No information is available on geothermal leasing of private lands. The locations of specific leases are given with the discussions of target areas. Townships in which geothermal resource lands have been leased are shown in Fig. 1.

History of Development: New Mexico

Numerous thermal springs occur in New Mexico, primarily along the Rio Grande rift (Plate I). These have been utilized as hot baths since their discovery by some of the earliest inhabitants of the state. No commercial power generation from geothermal energy has yet been undertaken in New Mexico.

The most significant industrial activity to date is that being conducted by Union Oil Company in the Valles Caldera, an ancient volcano in the Jemez Mountains (Baca Location No. 1 KGRA). The wells drilled by Union Oil range in depth from 6,000 to 9,000 ft. and cost from $500,000 to 1,000,000 per well. Of the 16 tests drilled to date, 6 are reported to have produced hot water and/or wet steam with temperatures of about 195°F. The water has a brine content of about 1/4 that of sea water, and contains much silica as well as carbonates and sulfates. Union would need to prove a 30-year production capacity from their wells in order to attract a 55-mw electric-generating complex.

Other drilling activity in the state includes that by Sunoco Development Company in the Jemez Mountains and on fee lands west of Albuquerque and that by Amax Exploration and Chevron Oil in the vicinity of the Lightning Dock KGRA south of Lordsburg. Other companies known to be involved with geothermal-resource exploration in New Mexico are: Aminoil U.S.A., Anadarko Production, Burmah Oil, Calvert Geothermal Resources, Cherokee and Pittsburg Coal, Deuterium Geothermal, Earth Power, Gulf Oil, Phillips Petroleum, Southern Union Production, and Thermal Resources (Tables 3, 4, and 5).

Target Areas

As indicated above, two regions in New Mexico have high potential for the development of geothermal resources: the Rio Grande Rift and the region encompassing the west-central and southwestern parts of the state (Fig. 4). For purposes of describing these and other regions in detail, the state has been subdivided into smaller target areas. Although only some of these areas are presently recognized as targets for development of geothermal resources, all may be considered targets for further exploration and research.

The target areas have natural boundaries, that is, they are structural basins, drainage basins, or convenient portions or combinations thereof. Individually, each target area represents a somewhat unique set of geologic, hydrogeologic, or geomorphic conditions. Collectively, the target areas cover and characterize the regions of known geothermal activity in New Mexico. The location of all target areas within the state is shown in Fig. 1. The relationship of a given thermal spring, well, or discharge area to local landmarks is shown on the location map (Plate I) in the pocket at the back of this report.

SAN JUAN BASIN

Introduction

The San Juan Basin is a structural depression at the eastern edge of the Colorado Plateau covering about 10,000 sq mi of northwestern New Mexico and Southeastern Colorado (Figs. 1 and 3). The bulk of the basin lies in New Mexico and includes all of San Juan County, most of McKinley County, the northeastern part of Valencia County, and the western parts of Bernalillo, Sandoval, and Rio Arriba Counties (Fig. 1). Although the Colorado Plateau is generally cool geothermally, numerous thermal springs are known in the San Juan Basin (Table 1, Plate I). Three wells in the San Juan Basin have also reportedly (Summers, 1976) yielded thermal waters (Plate I): the Ft. Wingate Army Depot Well (15N.16W.30.3443), Pure Oil Company's Navajo No. 1 (19N.17W.29.000), and the Pure Oil No. 3 (19N.17W.22.000). In addition to these occurrences of thermal water, the presence of Tertiary volcanic necks together with igneous plugs and dikes at various places in the Basin are also indications of at least local geothermal activity.

Data Available

Because of the important occurrences of coal, petroleum, and uranium in northwestern New Mexico, much has been written about the geology of the San Juan Basin. The following publications address only specific aspects of the geologic setting of the Basin but also make reference to the more significant general works as well: Kelley (1963), Shomaker and others (1971), and O'Sullivan and others (1972). The guidebooks of the 1st, 2nd, and 18th field conferences of the New Mexico Geological Society also contain important papers on this target area; the 28th guidebook will also be devoted to the San Juan Basin.

Various types of geophysical data have undoubtedly been collected by industry but because of their confidential nature few have been published. Reiter and others (1975) reported heat-flow measurements from the San Juan Basin.

Regional hydrogeologic studies of the Basin include those by Berry (1959), Cooper and Trauger (1967), Cooley and others (1969), and Brimhall (1973). A study of the hydrogeology and water resources of the San Juan Basin is presently being conducted by the New Mexico Bureau of Mines and Mineral Resources in cooperation with the U.S. Geological Survey. Preliminary results of that study have been presented by Stone and Kelly (1975), Stone (1976), and Shomaker and Stone (1976).

Two chemical analyses of water from the Pure Oil Navajo No. 1 well (19N.17W.29.000) were given by Summers (1976). Chemical data for nonthermal waters are included in most of the hydrogeologic reports cited above.

Leasing and Drilling

No geothermal resource leasing or drilling is known for this area.

SAN FRANCISCO RIVER BASIN

Introduction

The San Francisco River Basin lies within the Datil section of the Colorado Plateau in an area known as the Mogollon Plateau (Figs. 1 and 3). This target area mainly occupies western Catron County but extends across the extreme northwestern part of Grant County as well. Summers (1976) reported 3 thermal springs in this area (Plate I): upper Frisco Hot Springs (55.19W.35.100), Freiborn Canyon Spring (7S.21W.8.442), and lower Frisco Hot Springs (12S.20W.23.120). Although it lies some distance to the north (Plate I), Zuni Salt Lake (35.18W.18.000) is included in this target. The large volumes of Tertiary volcanic rock covering the surface in this region also attest to considerable thermal activity there in fairly recent geologic time and thus the potential for geothermal resources.

Data Available

Two 30-minute geologic quadrangle maps by Weber and Willard (1959a,b) cover the areas of geothermal interest. Elston (1965) published results of studies of the volcanic rocks of this region. The geology of the Zuni Salt Lake area was mapped by Cummings (1968). Trauger (1960) reported on the availability of ground water and mapped the water table in the southern half of this target area. Summers (1976) gave chemical data for thermal waters in the San Francisco River Basin. Reiter and others (1975) included this area on their heatflow map of New Mexico.

Leasing and Drilling

No geothermal resource leasing or drilling is known for this target area even though it contains the Lower Frisco Hot Springs KGRA.

GILA RIVER BASIN

Introduction

The setting of this target area is similar to that of the San Francisco River Basin, that is, it is located on the Mogollon Plateau within the Datil Section of the Colorado Plateau. It covers parts of Grant and Catron Counties (Figs. 1 and 3). Thermal waters discharge at numerous sites along the middle and east forks of the Gila River as well as in adjacent areas (Table 1 and Plate I). Geothermal activity is also indicated by the large volume of volcanic rock at the surface in the area.

Data Available

The geology of the Gila River Basin is shown on maps by Elston (1960) and Willard and others (1961). Hewitt (1959) discussed the geology of the Big Burro Mountains-Redrock area. Other geologic data on the area were given by Gillerman (1964), Elston (1965) and Ratté and others (1972).

Reiter and others (1975) gave heat flow data for this area. The inventory of mineral resources of the Gila Wilderness area by Ratté and others (1972) included aeromagnetic and gravity surveys.

Trauger and Doty (1965) discussed the occurrence of ground water in southwestern New Mexico. Hydrogeologic data for the Gila River Basin are included in a water-resource report of Grant County by Trauger (1972). Summers (1976) compiled chemical data for the thermal waters of this target area.

Leasing and Drilling

Only state geothermal resource lands have been leased in this target area (Fig. 7; Table 3). It is interesting to note that leasing to date has been concentrated near Cliff rather than the Gila Hot Springs KGRA to the northwest (Figs. 1, 6, and 7). No drilling activity is known in the Gila River basin target area.

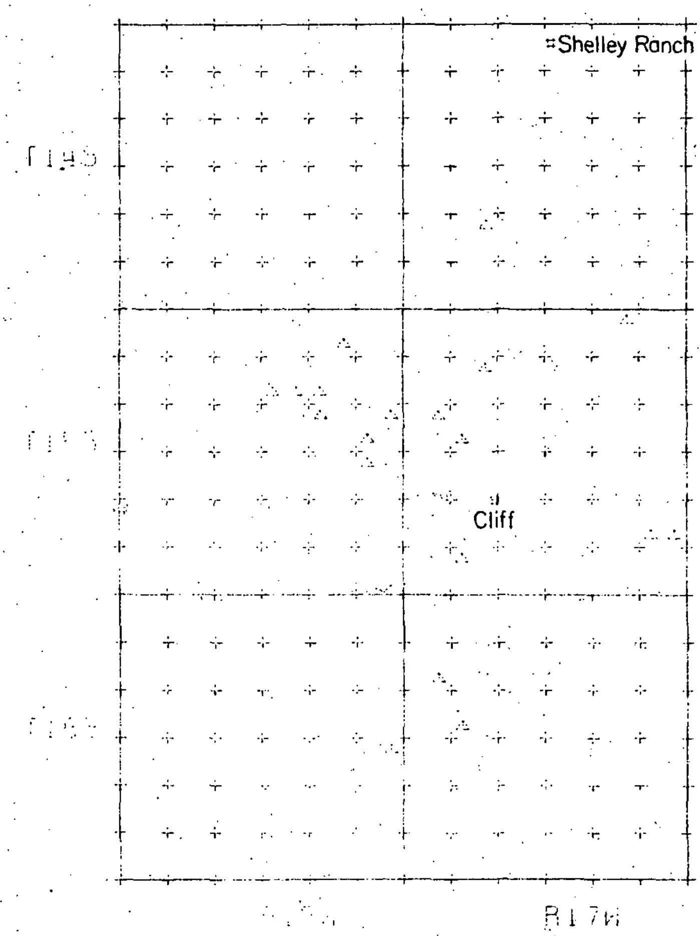

FIGURE 7--State lands leased for geothermal resources, Gila River Basin target area (triangles give location to ¼ section).

MIMBRES RIVER BASIN

Introduction

This target area occurs at the border between the Colorado Plateau and Basin and Range provinces (Figs. 1 and 3). It includes parts of Grant, Luna, and Sierra Counties. Thermal waters discharge naturally at four places in the Mimbres River Basin: Apache Tejo Warm Spring (19S.12W.19.300), Faywood Hot Springs (20S.11W.20.243), Kennecott Warm Springs (20S.11W.18.310), and Mimbres Hot Springs (18S.10W.13.113). Two wells (19S.12W.12.000; 24S.7W.5.100) also yield thermal waters (Plate I). Although not as dominant a part of the landscape in this target area as in the San Francisco and Gila River Basins, Tertiary volcanic rocks are present at the surface, indicating that the tremendous outpouring of molten material that characterized those 2 areas extended into the Mimbres River Basin area as well.

Data Available

Geologic and mineral-resource information was presented by Elston (1957 and 1965) and Schilling (1967). Jones and others (1964) published an aeromagnetic map of the Silver City mining area. Ground-water data for the area were given by Bushman (1955) and Trauger and Doty (1965). Hydrochemical data were presented by Bushman (1955), Elston (1957) and Summers (1976).

Leasing and Drilling

Only state geothermal resource lands have been leased in the Mimbres River Basin (Fig. 8; Table 3). No drilling is known for this area.

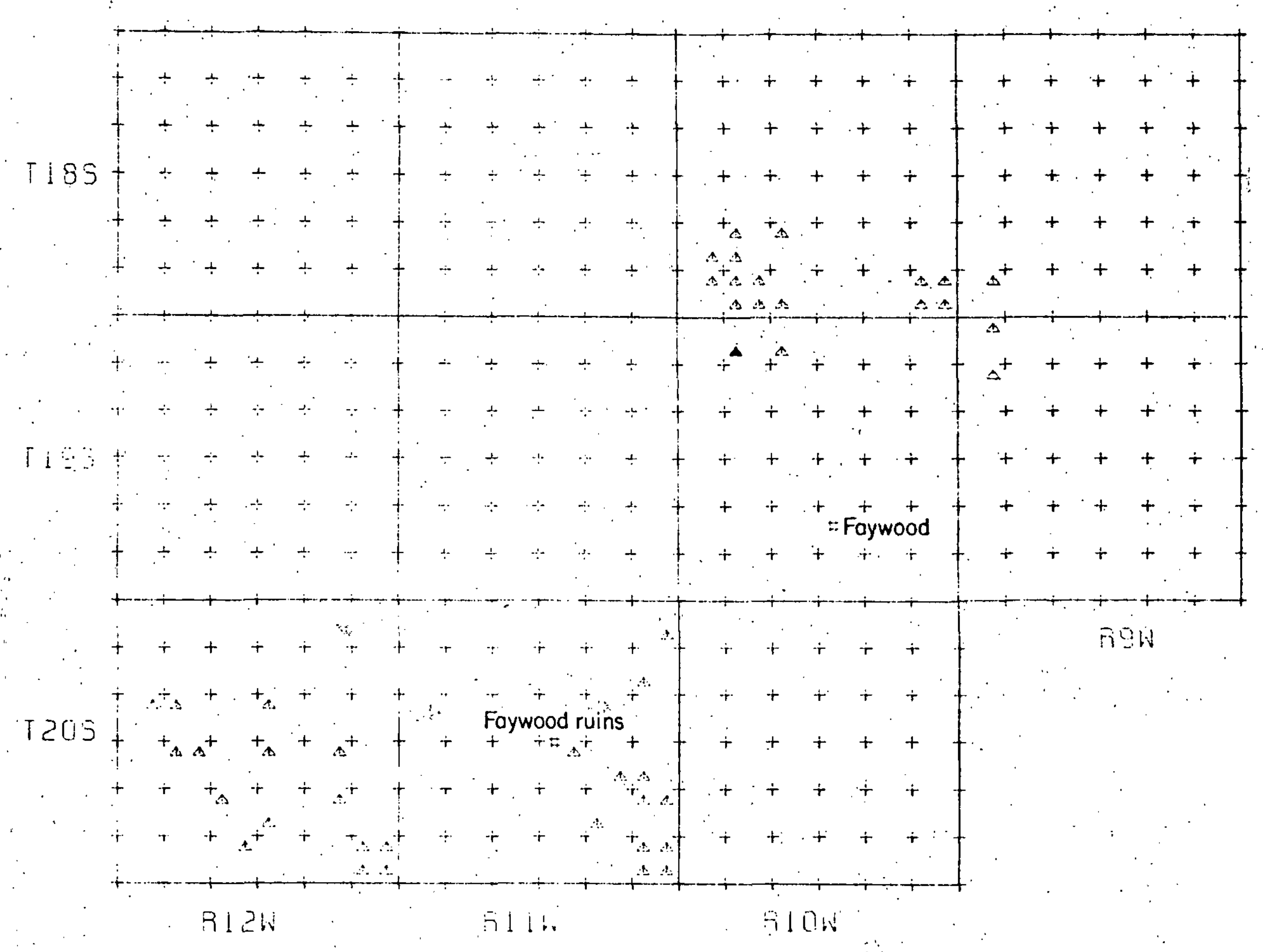

FIGURE 8--State geothermal resource lands leased in Mimbres River Basin target area (triangles give location to ¼ section; solid triangle indicates multiple leasing in ¼ section).

ANIMAS VALLEY

Introduction

The Animas Valley target area lies wholly within the Basin and Range province and central Hidalgo County (Figs. 1 and 3). Hot water has been produced from wells in 22S.21W.3.312 and 255.19W.7.000 (Plate I). In the absence of natural hot springs, the only evidences that geothermal anomalies might be encountered in this region include the Tertiary volcanic rocks in the adjacent mountain ranges and a Quaternary basalt flow resting directly on the valley fill in the southern part of the valley.

Data Available

The geology of this region has been compiled by Schwennesen (1918), Reeder (1957), Gillerman (1958), and Flege (1959). A master's thesis in progress (New Mexico Tech) by Louis H. Fleischhauer deals with the Quaternary geology of the Lower Animas Valley. Preliminary results of this study were given by Fleischhauer (1976 and 1977).

Strangway and Holmes (1966) reported on an airborne infrared survey they made of T25S,R19W. Kintzinger (1955 and 1956) presented a temperature profile for the hot wells in T25S,19W. Detailed gravity data were reportedly obtained in the vicinity of wells at 255.19W.7.133 and 255.19W.7.234 (Summers, 1976). Jiracek and Smith (1976) gave deep resistivity data for the Lightning Dock KGRA.

Reiter and others (1975) made heat-flow measurements in the Animas Valley.

Hydrogeologic data on the target area were given by Schwennesen (1918) and Reeder (1957). Summers (1976) tabulated existing chemical data for the Animas Valley hot wells including radioactivity measurements by Scott and Barker (1962) for a well in 25S.19W.7.234.

Leasing and Drilling

In terms of leasing and drilling, this target area has perhaps received more attention than any other in the state. This is based on the fact that both federal and state lands have been leased and considerable drilling has been conducted (Fig. 9; Tables 3, 4, and 5). This activity is closely associated with the Lightning Dock KGRA (Fig. 6).

PLAYAS BASIN

Introduction

The Playas Basin lies wholly within the Basin and Range province (Figs. 1 and 3). It is situated largely in Hidalgo County but extends northward into Grant County as well. As was the case with the Animas Valley target area, there is little indication that a geothermal anomaly exists in the Playas Basin. However, according to Summers (1976), an anomalous geothermal gradient was recorded in an oil well there (Plate I): Humble No. 1 State AB (32S.16W.25.210).

Data Available

Geologic information on the Playas Basin area has been given by Zeller (1958a,b,c, 1962, 1965, 1970, 1975), and Zeller and Alper (1965). No sources of geophysical data are known. Hydrogeologic data were presented by Schwennesen (1918) and Doty (1960). Hydrochemical data are available for nonthermal waters only.

Leasing and Drilling

No geothermal resource leasing or drilling is known for this area.

SAN LUIS BASIN

Introduction

The target area herein called the San Luis Basin is actually the New Mexico portion of a larger basin by that name that spans the Colorado-New Mexico Border. It consists of a complexly faulted graben located at the northern extremity of the New Mexico portion of the Rio Grande Rift in the Rocky Mountains province (Figs. 3 and 5). The target area covers western Taos County and part of eastern Rio Arriba County (Fig. 1). It is bounded on the east by a major fault system at the edge of the Sangre de Cristo Mountains and on the west by the Ojo Caliente Uplift. Four thermal springs occur in this target area (Plate I): No Name Spring (27N.12E.36.411), Mamby's (American) Hot Springs (26N.11E.1.120), Ponce de Leon Hot Springs (24N.13E.7.000), and Ojo Caliente or Joseph's Hot Springs (24N.8E.24.110).

Data Available

Geologic data on this region have been given by Atwood and Mather (1932), Kelley (1956), McKinley (1956 and 1957), Baltz (1965), Bingler (1968), Lipman (1969), Lipman and Mehnert (1969), and Belcher (1975).

Seismic data are included in a report on the entire Rio Grande Rift by Sanford and others (1972). Cordell (1970 and 1976) gave gravity and aeromagnetic data on this area. Results of an aeromagnetic survey flown by the

U.S.G.S. are on open-file at the New Mexico Bureau of Mines and Mineral Resources (Map No. 129U). Heat-flow data for this target area are among those published by Reiter and others (1975).

McKinley (1956 and 1957) made general statements concerning the hydrogeology of adjacent areas to the north. Summers (1976) tabulated chemical data for the thermal waters of the target area.

Leasing and Drilling

Leasing within the San Luis Basin target area has been confined to state geothermal resource lands north of Ojo Caliente (Fig. 10; Table 3). No drilling is known in this area.

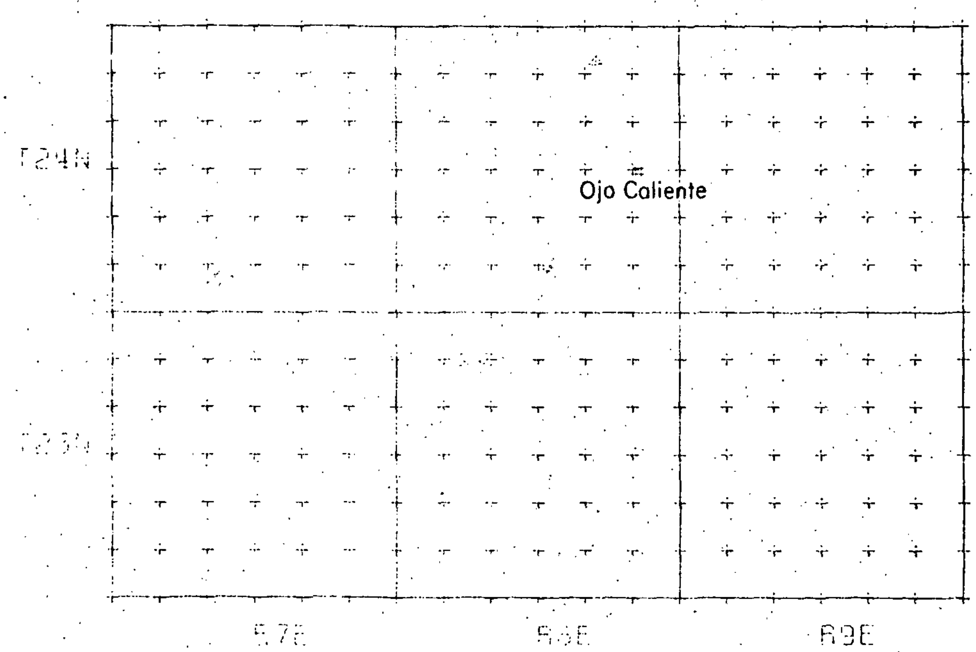

FIGURE 10--State geothermal resource lands leased in San Luis Basin target area (triangle gives location to ¼ section).

JEMEZ MOUNTAINS

Introduction

The Jemez Mountains lie within the Rocky Mountains Province west of the Rio Grande Rift (Figs. 1, 3, and 5). It covers northern Sandoval County and most of Los Alamos County. Numerous hot springs occur within this target area (Table 1 and Plate I). Four wells have also yielded thermal waters: the 2 Los Alamos Scientific Laboratory (LASL) Fenton Hill or Granite Test wells and the 2 Kaseman oil wells listed in Table 1. Valles Caldera, remnant of a large volcano which is the dominant feature of the landscape in this area, is also evidence of intense geothermal activity in this area about 40,000 years ago.

Data Available

Varicus aspects of the geology of this area have been presented by Smith and others (1961), Ross and others (1961), Bailey and others (1969), Smith and others (1970), West (1973a), Kudo (1974), Woodward (1974), Woodward and Ruetschilling (1976), and Bridwell (1976). In conjunction with the Dry-Hot-Rock Project conducted by LASL, Perkins (1973), Purtyman (1973), and Purtyman, West, and Pettit (1974) have extensively studied the geology of the test site north of La Cueva, New Mexico.

Seismic data for this target area have been given by Sanford (1965), Sanford and Cash (1969), Toppozada and Sanford (1972 and 1973), and Sanford and others (1972).

Jiracek (1974) presented the results of resistivity studies in the Jemez Mountains. Cordell (1970 and 1973) presented results of gravity and aeromagnetic surveys of this region. Potter (1973) and Reiter and others (1976) gave heat-flow data for the target area. Kelly and Anspach (1913), Harrington (1948), Titus (1961), Conover and others (1963), Griggs (1964), Cushman (1965), Purtyman and Cooper (1969), West (1973b), Purtyman and Johansen (1974), Purtyman, West, and Adams (1974), and Trainer (1974a, b, and 1975) have all given hydrogeologic information for various parts of this target area. Hydrochemical data are available in Summers (1976) as well as most of the hydrogeologic reports.

Leasing and Drilling

Leasing and drilling activity in the Jemez Mountains target area is centered around the Baca Location No. 1 KGRA and the San Ysidro KGRA (Figs. 1, 6, 11; Tables 3 and 5). Presently only state geothermal resource lands have been leased but Federal lands are available for leasing. Drilling has been confined to private or fee lands. Union Oil terminated its recent drilling program in 1975; Sunoco has just begun drilling.

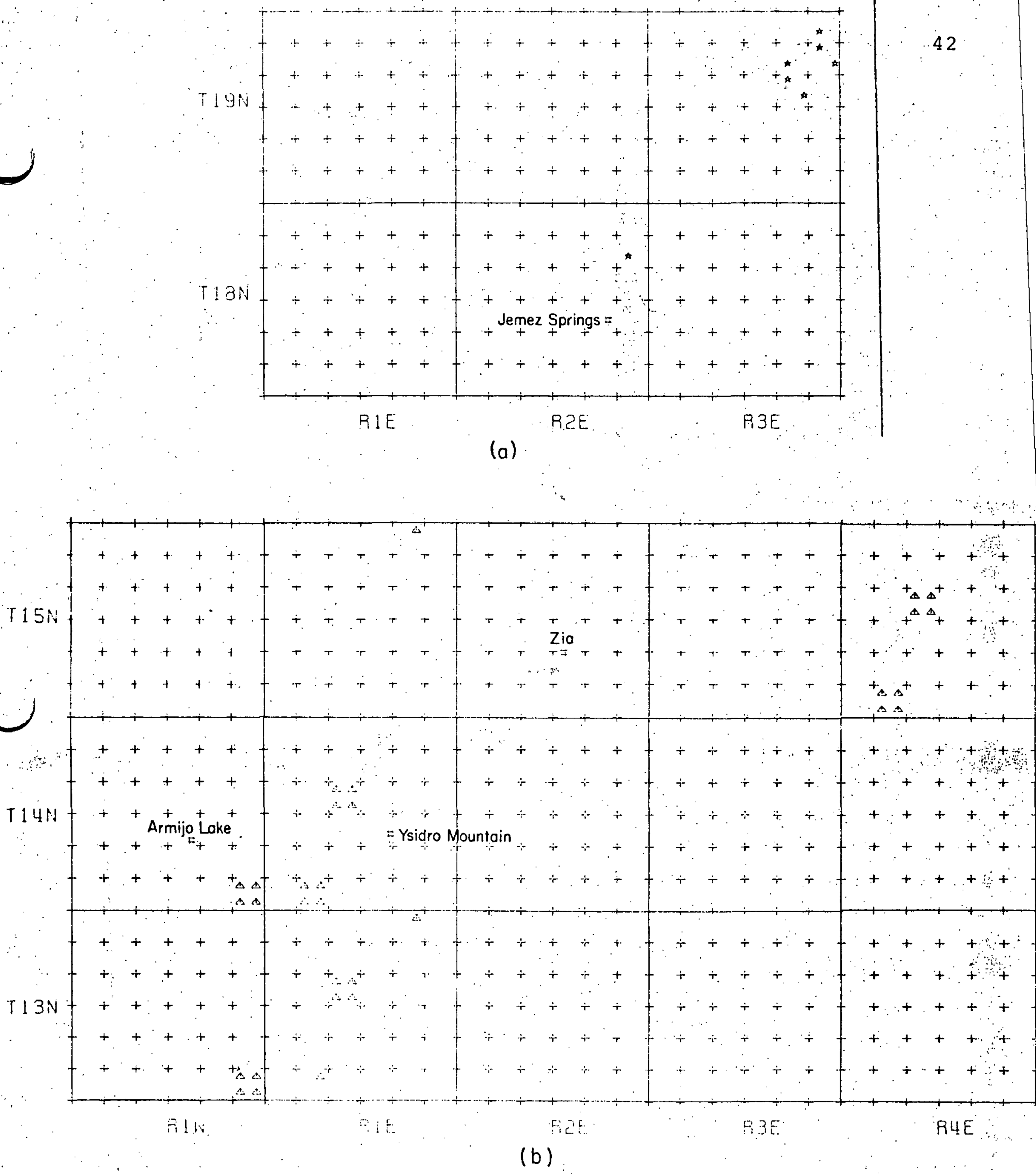

FIGURE 11--Geothermal resource leasing and drilling activity in the Jemez Mountains target area: a) drilling activity (stars give location to ¼ section; solid stars indicate multiple locations in ¼ section), b) state lands leased (triangles give location to ¼ section).

ALBUQUERQUE BASIN

Introduction

The Albuquerque Basin is the largest structural basin within the Rio Grande Rift (Fig. 5). It lies fully within the Basin and Range province covering parts of Valencia and Bernalillo Counties (Figs. 1 and 3). Aside from the Quaternary basalt flows capping mesas along the Rio Grande near Albuquerque, the main evidence of geothermal activity in this part of the rift has come from three wells which reportedly yield thermal water located at 9N.4E.24.1, 6N.3E.5.234, and 10N.2W.21,343 (Plate I).

Data Available

Geologic information on this target area has been published by Kelley (1952, 1970, 1974, and in press), Anonymous (1961), Joesting and others (1961), Kelley and Northrop (1975), Black and Hiss (1974), and Belcher (1975). Gravity and aeromagnetic data were presented by Cordell (1970 and 1976). Heat-flow data for the Albuquerque Basin have been given by Edwards and others (1973) and Reiter and others (1975). Hydrogeologic data include those presented by Bjorklund and Maxwell (1961), Reeder and others (1967), Hiss and others (1975), and West and Broadhurst (1975). Hydrochemical data from the area were presented by Hiss and others (1975).

Leasing and Drilling

No federal or state geothermal resource lands have been leased in the Albuquerque Basin. Drilling activity shown on Fig. 12 and listed in Table 5 is associated only with private or fee lands.

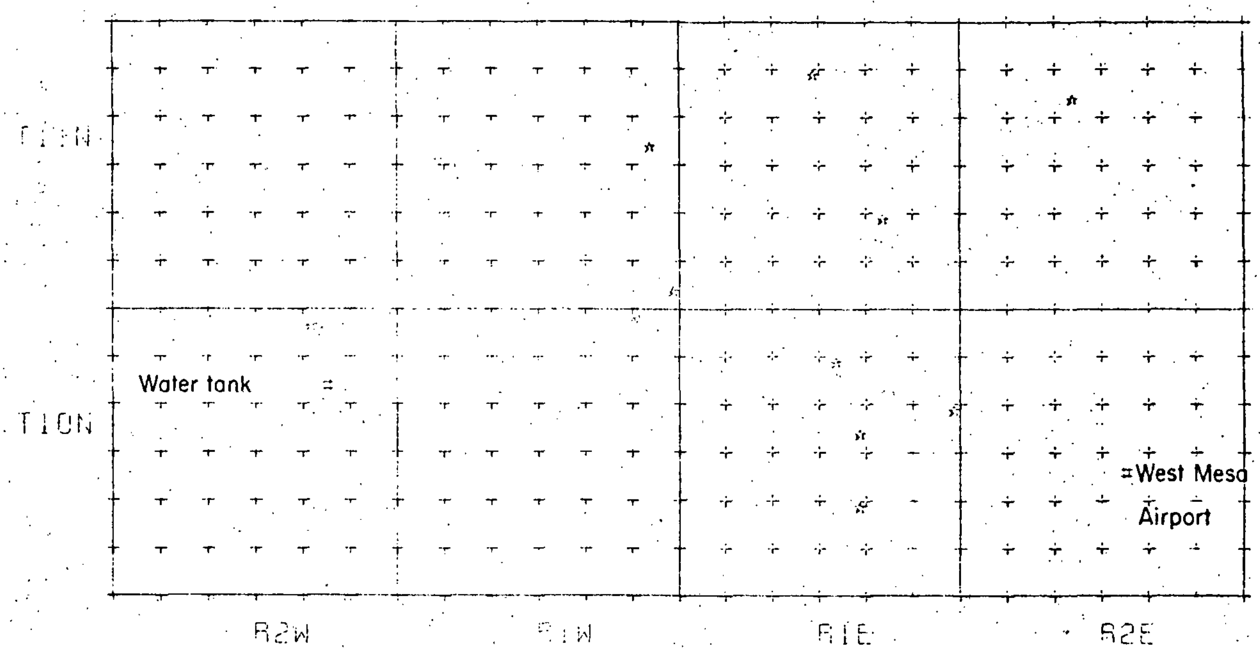

FIGURE 12--Geothermal resource drilling activity on fee lands, Albuquerque Basin target area (stars give location to ¼ section).

SOCORRO - LA JENCIA BASIN

Introduction

This target area consists of two semiparallel basins separated by the Socorro-Lemitar-Chupadera Mountains (Figs. 1 and 5). They may actually be remnants of a larger single basin split by a northwest-trending intrarift horst (Chapin, 1971). The Socorro-La Jencia Basin straddles the boundary between the Basin and Range Province and the Colorado Plateau province as shown on Figs. 1 and 3. Woodward and others (1975) would place the western edge of the Basin and Range Province and the Rio Grande Rift farther west than shown in Fig. 3.

Thermal waters discharge at 3 springs in this target area (Plate I); infiltration galleries have been constructed at each: Cook Gallery (3S.1W.15.313), Evergreen Gallery (3S.1W.22.131), and Socorro Gallery (3S.1W.22.113). Hot water has also been encountered in a well in Blue Canyon (3S.1W.16.323). In addition to these discharges of thermal waters, Tertiary volcanic rocks occur in the vicinity further attesting to the geothermal activity localized here.

Data Available

Geologic data for this target area have been given by DeBrine and others (1963), Smith (1963), Weber (1963), Chapin (1971), Bruning (1973), Belcher (1976), Seimers (1976), and Mott (1976). Work on the geology of this area is continuing by Chapin and his students (New Mexico Tech).

Results of a Bouger gravity investigation of the target area was published by Sanford (1968). Several aeromagnetic maps covering this area, prepared by the USGS, are on open-file with the NMBM&MR (No's 247, 248, 93U, 271, 272, 273, 295, 296, 319, 321, 76U-1, 76U-2). A detailed magnetic study of the southern Socorro Mountains was conducted by Ramananto-Andro (1965). Reiter and others (1975) included results of heat-flow studies in this area in their regional report. Seismic data for the Socorro-La Jencia Basin have been given by Sanford and Holmes (1962), Budding and others (1971), Sanford and others (1972, 1973, and 1976a,b), Singh and Sanford (1972), Sanford (1963), Sanford and Long (1965), Caravella (1976), and Schuleski (1976).

Hydrogeologic information on the area has been published by Bushman (1963), Hall (1963), Holmes (1963), Clark and Summers (1968), Summers and others (1972), and Summers (1976). Most of these reports contain hydrochemical data as well.

Leasing and Drilling

In anticipation of the designation of the Socorro Peak KGRA, considerable state lands have been leased (Fig. 13; Table 12). No drilling is known in this target area.

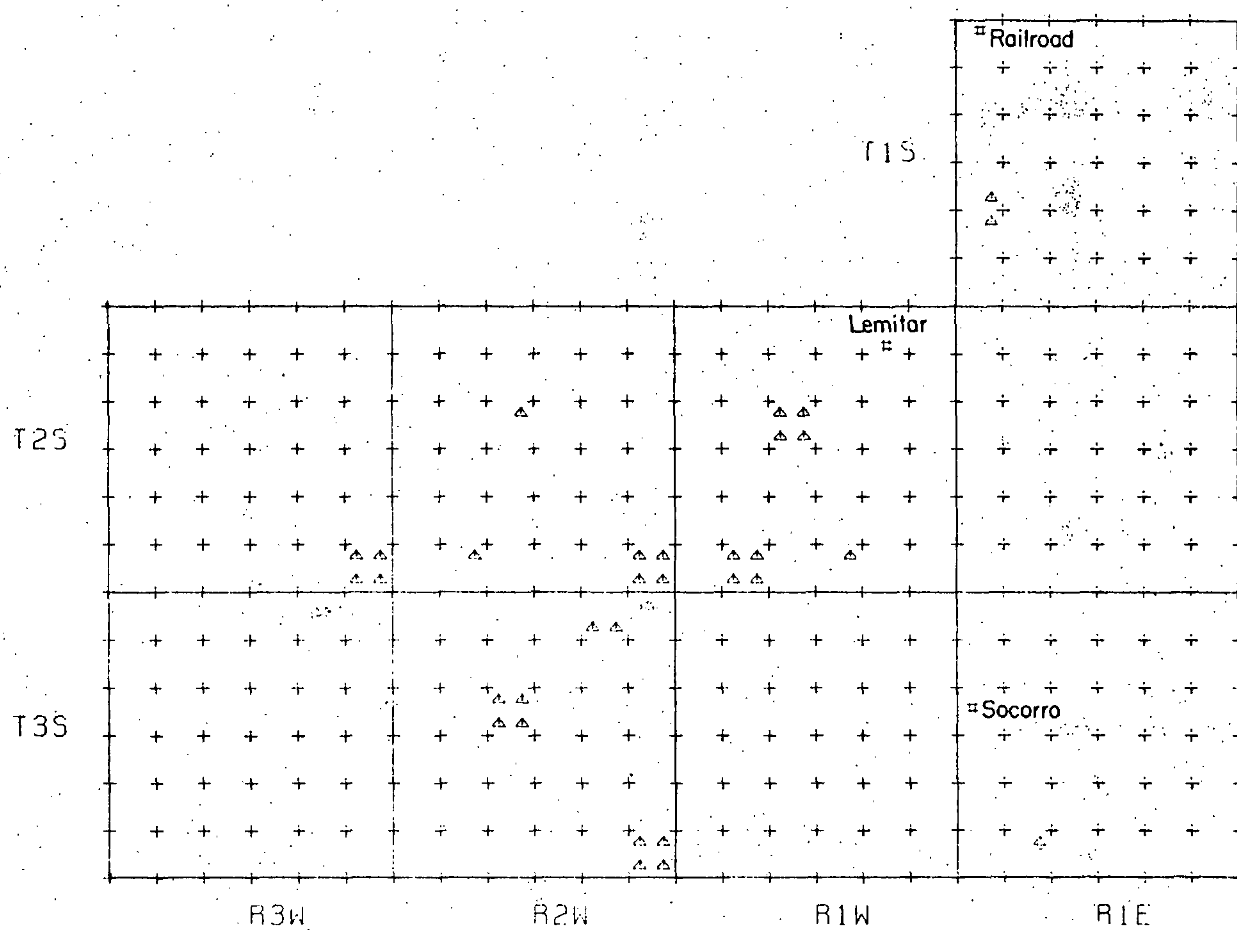

FIGURE 13--State geothermal resource lands leased in Socorro-La Jencia Basin target area (triangles give location to ¼ section).

TRUTH OR CONSEQUENCES - RINCON BASIN

Introduction

This target area is situated at the western edge of the Basin and Range Province and includes the portion of the Rio Grande Rift extending southward from Truth or Consequences in the Engle Basin, through the eastern part of the Palomas Basin to Rincon in the central part of the Jornada del Muerto Basin (Figs. 1, 3, and 5). The area lies within Sierra County.

Thermal springs in the area (Plate I) include: those within the town of Truth or Consequences, (formerly called Hot Springs), and Derry Warm Springs (17S.4W.29.340). Two wells in the area yield thermal waters also (Summers, 1976): the Barney Iorio No. 1 Fee (14S.5W.25.410) and Rincon Well (19S.2W.9.120).

Data Available

Geologic data on this area have been compiled chiefly by Kelley and Silver (1952), Hawley and others (1969), Chapin (1971), Seager and Hawley (1973), and Belcher (1975). Geologic information is also given in the hydrogeologic reports listed below. Gravity studies have been conducted in adjacent parts of the Rio Grande Rift: Sanford (1968) and Decker and others (1975). Heat-flow data for this area were presented by Reiter and others (1975). Hydrogeologic and hydrochemical data were given by: Minton (1941), Theis and others (1941), Conover and others (1955), Murry

(1959), Cox and Reeder (1962); Summers (1965a, b; 1976), and King and others (1971).

Leasing and Drilling

The Truth or Consequences-Rincon Basin target area has been the focus of considerable leasing of state geothermal resource lands (Figs. 14 and 15; Table 3). No drilling for geothermal resources is known for this area.

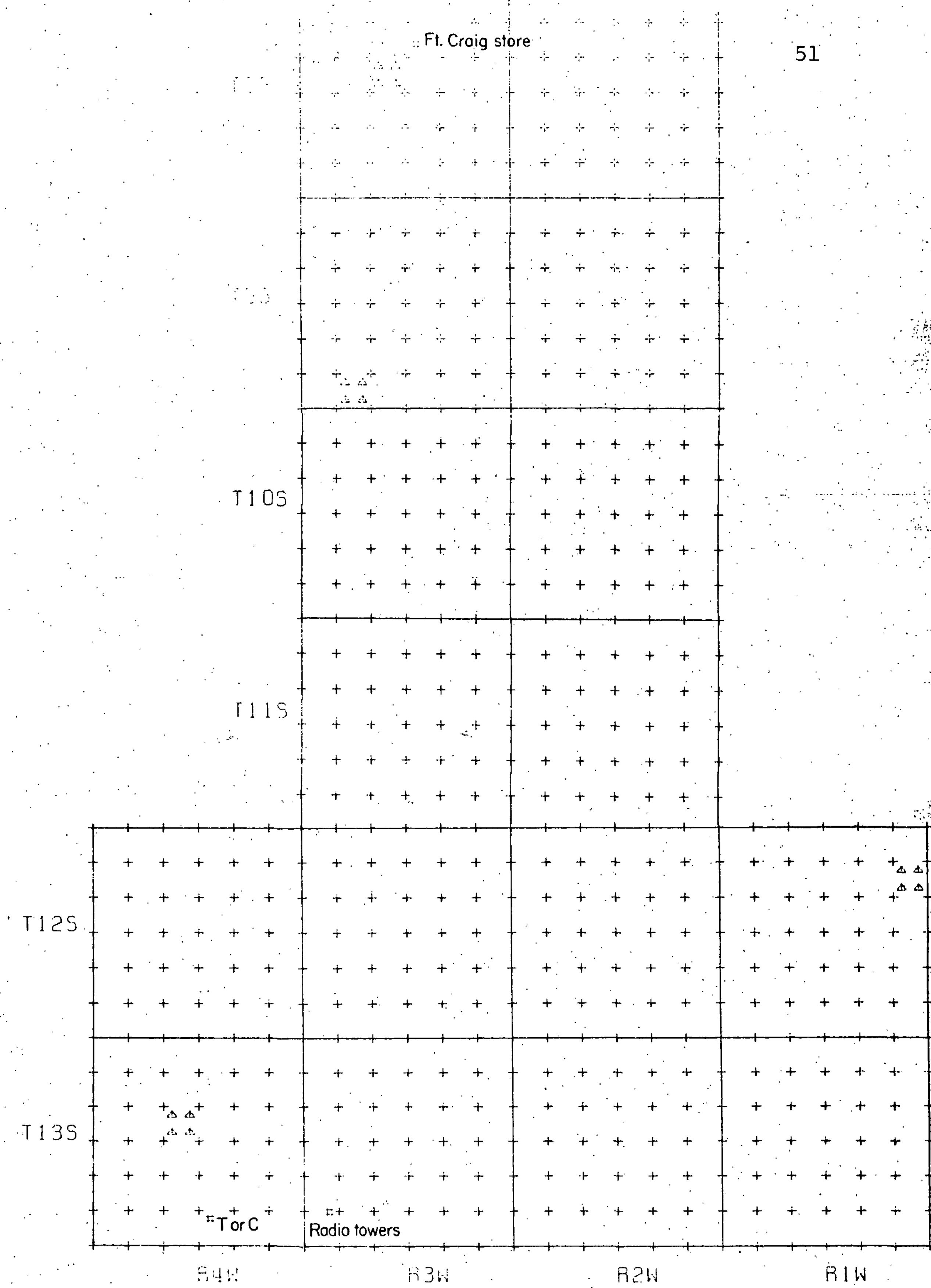

FIGURE 14--State geothermal resource lands leased in northern part of Truth or Consequences - Rincon target area (triangles give location to ¼ section).

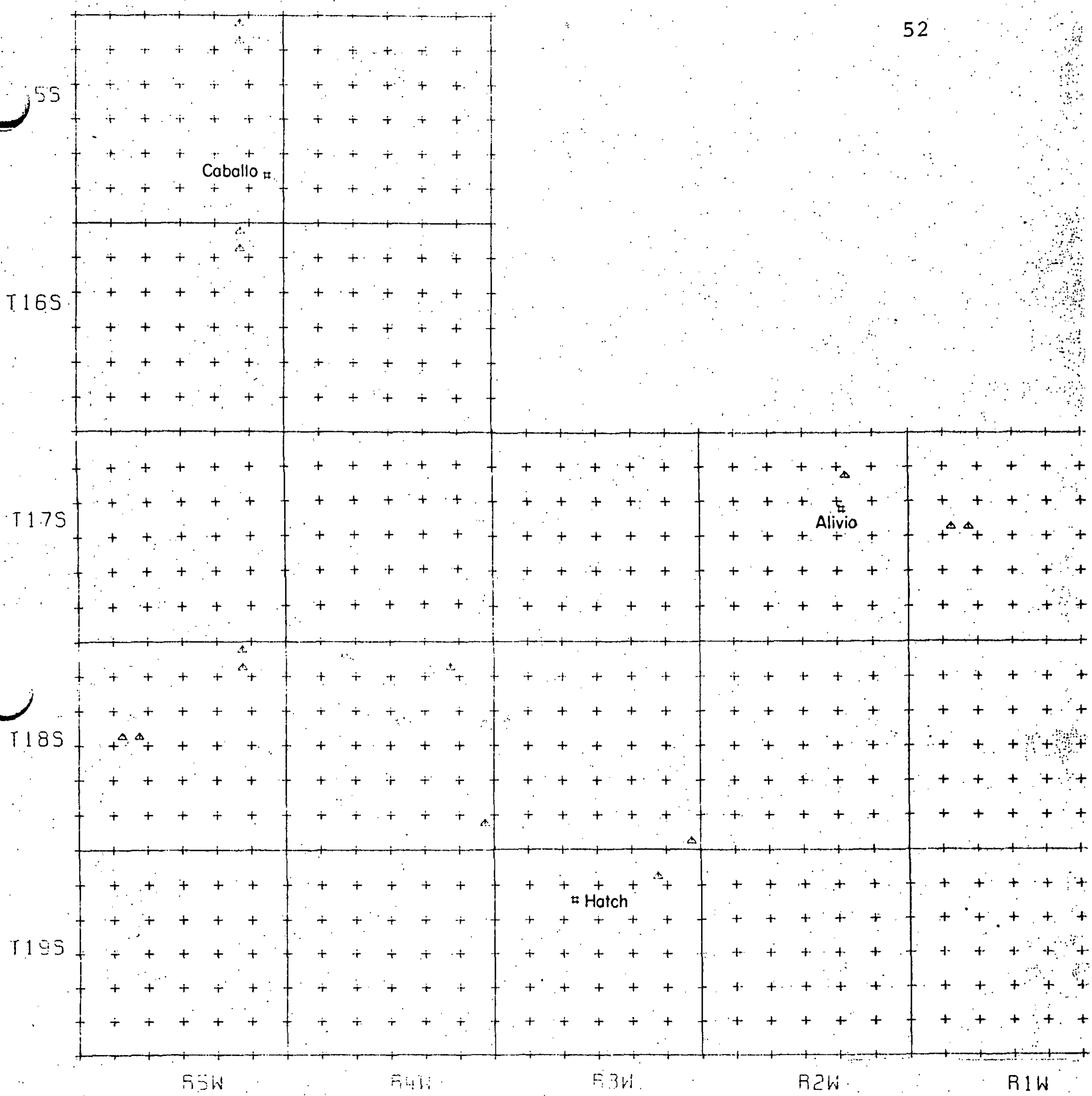

FIGURE 15--State geothermal resource lands leased in southern part of Truth or Consequences - Rincon target area (triangles give location to ¼ section).

SOUTHERN JORNADA DEL MUERTO - MESILLA BASIN

Introduction

This target area lies within the Basin and Range Province and coincides with the southernmost extension of the Rio Grande Rift in New Mexico (Figs. 1, 3, and 5). It also lies within Doña Ana County (Plate I).

Thermal waters originally flowed at Radium Springs (21S.1W.10.213) but are now obtained from a well. Other wells in the area yielding thermal waters according to Summers (1976) include: Berino Well (25S.3E.11.111), Federal "H" No. 1 (28S.2W.24.213), Grimm Well (25S.1E.32.114), Kilbourne Hole (275.1W.8.000), Las Alturas Estates Well (23S.2E.34.000), Victoria Land and Cattle Co. No. 1 (10S.1W.25.100), Weaver-Federal No. 1 (26S.1E.35.333), and unnamed wells at 23S.2W.35.411 and 265.8E.33.200. Geologic evidence of geothermal activity in this area includes the associated Tertiary volcanic rock and the volcanic features in the vicinity of Kilbourne Hole.

Data Available

Geologic information is available in reports by Reiche (1940), DeHon (1965), Reeves and DeHon (1965), Ruhe (1967), Hawley and Kottlowski (1969), Hawley and others (1969), James (1971), Hoffer (1971 and 1976), Seager and others (1971, 1975, and 1976), Chapin (1971), Hoffer and Hoffer (1973), Seager (1973 and 1975), Seager and Clemons (1974), Belcher (1975), Hawley (1975), King and Hawley (1975), Chapin and Seager (1975).

Gravity studies of the area include those by: Smithson and Decker (1973), Ramberg and others (1974), and Decker and others (1975). The only heat flow measurement made by Reiter and others (1975) in the southern part of the rift falls outside this target area. Seismic data were given by Sanford and others (1972), Johnson and Combs (1976), and Quillin and Combs (1976). Geophysical studies of the Kilbourne Hole KGRA include: total magnetic intensity by Cordell (1975), geomagnetic variations by Towle and Fitterman (1975), a direct current survey by Jackson and Bisdorf (1975), a Telluric survey by O'Donnell and others (1975), and an audio-magnetotelluric reconnaissance by Hoover and Tippens (1975). Jiracek and Smith (1976) and Jiracek and others (1976) gave results of deep electrical resistivity soundings in this target area.

Hydrogeologic and hydrochemical data on this target area have been presented by Conover (1954), Conover and others (1955), Dinwiddie (1967), King and others (1971), and King and Hawley (1975), Stone and Brown (1975), Swanberg (1975), Seager and others (1975), and Summers (1976).

Leasing and Drilling

Both Federal and State geothermal resource lands have been leased in the northern part of this target area near the Radium Springs KGRA (Fig. 16; Tables 3 and 4).

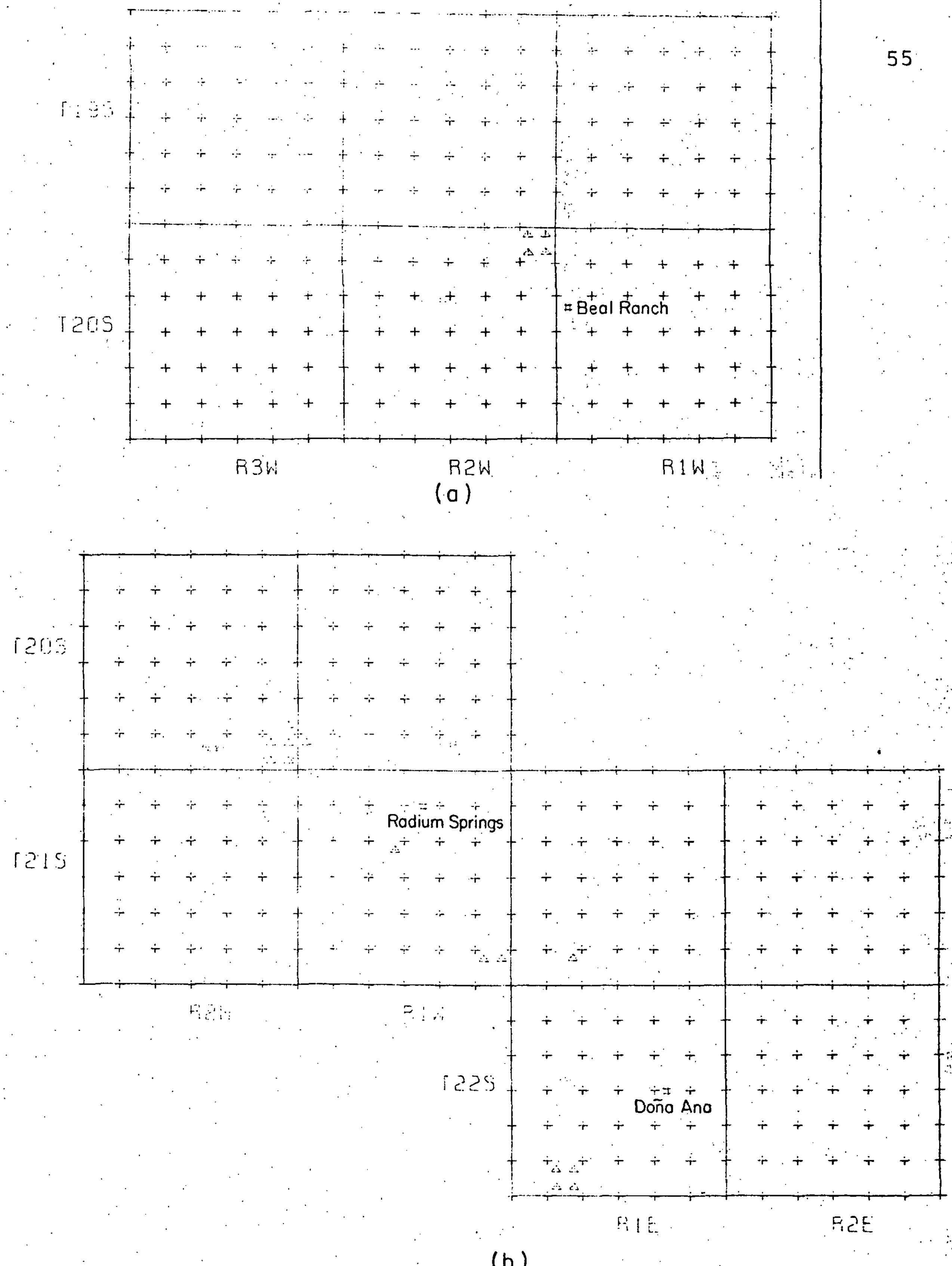

FIGURE 16--Geothermal resource lands leased in the northern part of the Southern Jornada del Muerto - Mesilla Basin target area: a) federal lands, b) state lands (triangles give location to ¼ section).

In the southern part of the area, however, in the vicinity of the Kilbourne Hole KGRA, only Federal lands have been leased to date (Fig. 17; Table 4). No drilling is known in this target area.

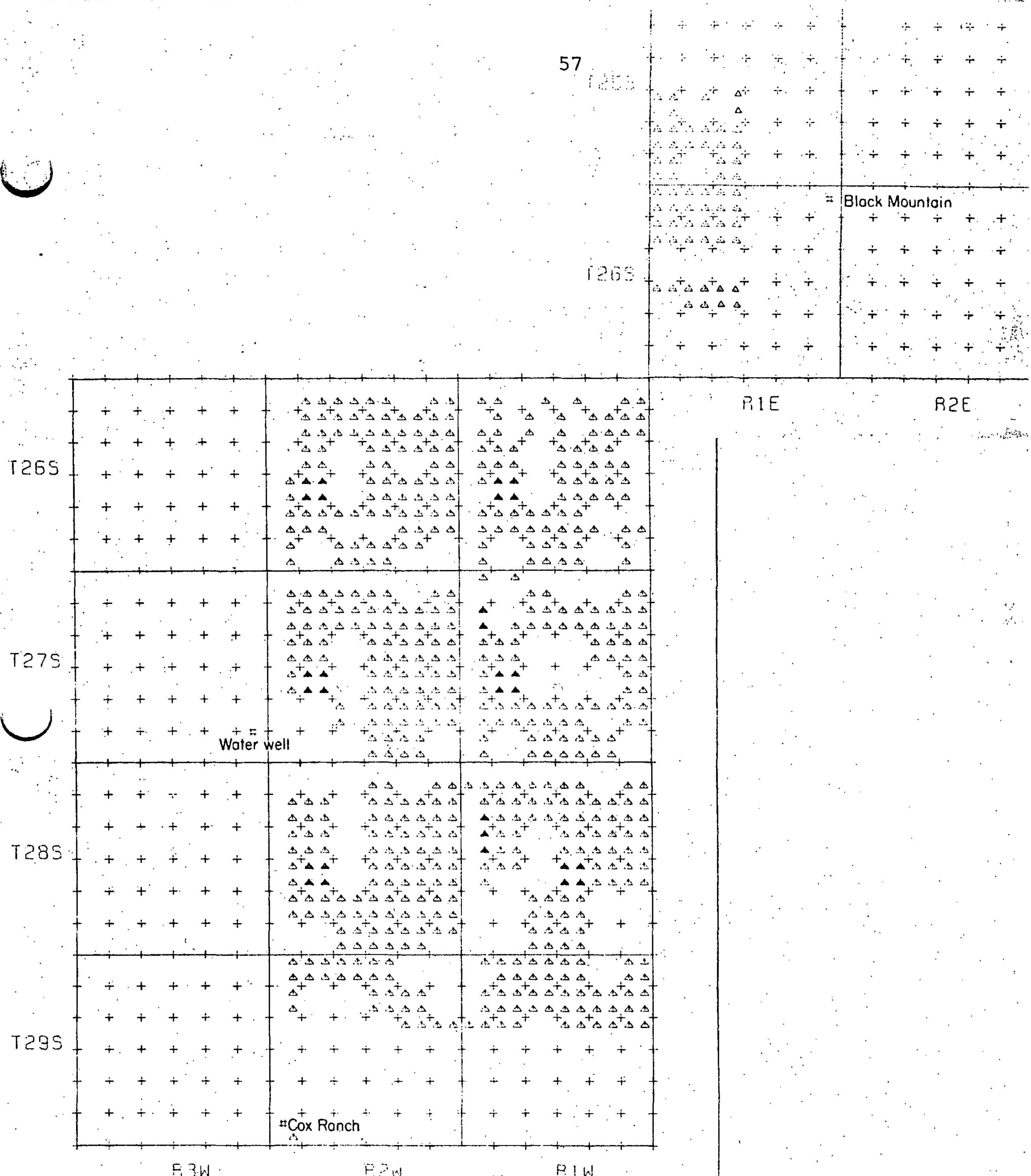

FIGURE 17--Federal geothermal resource lands leased in southern part of Southern Jornada del Muerto - Mesilla Basin target area (triangles give location to ¼ section; solid triangles indicate multiple leasing in the ¼ section).

TULAROSA BASIN

Introduction

The Tularosa Basin lies within the Basin and Range Province and covers parts of Doña Ana, Otero, and Sierra Counties (Figs. 1 and 3). The only occurrence of thermal water in this target area (Fig. 29) is at Garton Well (18S.8E.5.144). In addition to this, the young (about 10,000 yrs old) and extensive lava flow on the basin floor near Carrizozo (the Malpais) together with its volcanic source to the northeast attest to considerable geothermal activity here in very recent geologic time.

Data Available

Geologic information has been included in various hydrogeologic reports on this target area: Meinzer and Hare (1915), Meeks (1950), Conover and others (1955), Herrick and Davis (1965), and McLean (1970). Decker and others (1975) presented results of a gravity survey in this region. Summers (1976) reported results of a chemical analysis of thermal waters from the Garton Well.

Leasing and Drilling

No geothermal resource leasing or drilling is known for this target area.

GALLINAS CREEK

Introduction

The Gallinas Creek target area lies on the boundary between the Great Plains and the Rocky Mountains Provinces in western San Miguel County (Figs. 1 and 3). The major indication of geothermal activity in this area is Montezuma Hot Springs (17N.15E.36.400), about 10 miles west of the town of Las Vegas (Plate I). Summers (1976) referred to this area as the Pecos River Basin; the springs occur along Gallinas Creek, the headwaters of Gallinas River, a tributary of the Pecos River. Because the thermal springs are restricted to such a small part of the Pecos River Basin, the local name was deemed to be more appropriate.

Data Available

Geologic information on this area has been given by Griggs and Hendrickson (1951), and Baltz (1972). No geophysical data have been published for this area. The hydrogeology of San Miguel County was given by Griggs and Hendrickson (1951). Chemical data for the Montezuma Hot Springs have been compiled by Summers (1976).

Leasing and Drilling

No geothermal resource leasing or drilling is known for this area.

ON-GOING RESEARCH

The New Mexico Energy Research Resource Registry, under the direction of the New Mexico Energy Resources Board, has compiled comprehensive lists of "Researchers, Facilities, and Projects" involved with all fields of energy research including geothermal resources (Kroger, 1975 and 1976a, b). These listings are voluminous and no attempt will be made to reproduce them here. As an additional source of information concerning on-going research, 33 one-page questionnaires were distributed (Appendix). The responses to this questionnaire are summarized in Table 6. As seen in this table, scientists of various affiliations are quite active in the area of geothermal resources and are presently studying many aspects of numerous geographic areas in the state.

Most of the on-going as well as previous work has been devoted to exploration for, or further understanding of, areas of geothermal potential. A uniquely different type of research has been under way at LASL, namely that associated with their Dry-Hot-Rock project. Much has been published on this work but space permits mention of only a few summary papers: Aamodt (1973), Brown (1973), West (1974), Smith and others (1975), Blair and others (1976), Eichelberger (1976), and Pettitt (1976). Basically this project has involved the attempt to capture heat from the earth by circulating water through a dry, artificially fractured, hot rock zone in the Jemez Mountains. Other potential dry-hot-rock targets have also been investigated (Laughlin and West, 1976). Another unique approach to geothermal energy recovery has involved scientists at Sandia Laboratories who have been investigating the feasibility of tapping underground molten material directly (Young, 1973).

SUMMARY AND CONCLUSIONS

1. Based on heat-flow data, the occurrence of thermal waters, and other geophysical and geologic evidence, the highest potential for developing geothermal energy in New Mexico is associated with the Rio Grande Rift and the Basin and Range geologic province in the central and southwestern parts of the state (Figs. 3, 4, 5 and Plate 1).

2. For ease in evaluating the state's geothermal resource potential, some 14 target areas have been recognized: the San Juan Basin, San Francisco River Basin, Gila River Basin, Mimbres River Basin, Animas Valley, Playas Basin, San Luis Basin, Jemez Mountains, Albuquerque Basin, Socorro-La Jencia Basin, Truth or Consequences-Rincon Basin, Southern Jornada del Muerto-Mesilla Basin, Tularosa Basin, and Gallinas Creek (Fig. 1).

3. The U.S. Geological Survey has designated 8 KGRA's in New Mexico covering some 327,849 acres: the Baca Location No. 1, Radium Springs, Kilbourne Hole, Lightning Dock, Gila Hot Springs, Lower Frisco Hot Springs, Socorro Peak, and San Ysidro (Fig. 6). Except for the Lower Frisco Hot Springs KGRA and the Gila Hot Springs KGRA, leasing and drilling activity has fairly well coincided with designated KGRA's (Figs. 1, 7 through 17).

4. More than 1 million acres of state and federal geothermal resource lands have been leased in New Mexico and at least 38 geothermal wells are known to have been drilled in the state.

5. The most significant development to date has centered on the Jemez Mountains target area (Baca Location No. 1 KGRA). This has included drilling of steam wells by Union Oil and work associated with the Dry-Hot-Rock project conducted by LASL.

6. The next most developed area is the Animas Valley (Lightning Dock KGRA) where both state and federal geothermal resource lands have been leased and considerable drilling has been done (Figs. 1, 6, 9).

7. The Socorro-La Jencia Basin target area (Socorro Peak KGRA) is second in potential for development only to the Baca Location. Considerable geological and geophysical work has been done in the Socorro area and both shallow and deep magma bodies have been located. However, no development work has been done (Figs. 1, 6, 13).

8. Significant work has been done on the geothermal setting of New Mexico (see References Cited). Especially conspicuous are the efforts of the following investigators: Chapin (Socorro area, Rio Grande Rift), Clemons and Seager (regional geology of Rio Grande

Rift), Cordell (geophysics of Rio Grande Rift), Elston (volcanology of southwestern New Mexico), Jiracek (resistivity of Rio Grande Rift), Kelley (tectonics of Rio Grande Rift), Reiter (terrestrial heat flow of region), Sanford (seismicity of Rio Grande Rift), Summers (hydrochemistry of thermal waters), and Trainer (hydrogeology of Jemez Mountains area).

9. Exploration for geothermal resources is far from complete in the state. As shown in Table 7, some target areas have not yet been studied in terms of one or more of the basic exploration data categories (geology, geophysics, hydrogeology, and hydrochemistry).

10. No attempt has yet been made to outline in detail the extent of <u>geothermal resources</u> (recoverable earth heat) in New Mexico. This together with detailed on-site testing are necessary to define the state's <u>geothermal reserves</u> (geothermal resources competitive with existing energy sources).

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TABLES

TABLE 1 - Geographical list of thermal springs, wells, and discharge sites in New Mexico grouped by target area (compiled from Summers, 1972 and 1976). Less common names are given in parentheses; numbers indicate location as shown in Fig. 2.

San Juan Basin

Ft. Wingate Well 15N.16W.30.3443
Navajo No. 1 19N.17W.29.000
No Name Spring 16N.18W.35.000
No Name Spring 24N.18W.30.000
No Name Spring 25N.18W.34.000
No Name Spring 25N.18W.00.000
No Name Spring 28N.18W.10.000
Pure Oil No. 3 19N.17W.22.000
Togay Spring 19N.15W.33.000

San Francisco River Basin

Freiborn Canyon Spring 7S.21W.8.422
Lower Frisco Hot Springs 12S.20W.23.120
Upper Frisco Hot Springs 5S.19W.35.100
Zuni Salt Lake 3S.18W.18.000

Gila River Basin

Cliff-Gila-Riverside Area 15,16S.17W.
Gila Hot Springs 13S.13W.5.241
Lyons Hunting Lodge Hot Springs 13S.13W.10.121
The Meadows (Warm Spring) 11S.14W.30.200
No Name Seep, Middle Fork Gila River 11S.14W.35.400
No Name Spring, East Fork Gila River 13S.13W.10.200
No Name Spring, East Fork Gila River 13S.13W.20.430
No Name Spring, Middle Fork Gila River 12S.13W.7.340
No Name Spring, Middle Fork Gila River 12S.13W.31.100
Test Well 12S.13W.30.231

Mimbres River Basin

Apache Tejo Warm Spring 19S.12W.19.300
Carne Well 24S.7W.5.100
Faywood Hot Springs 20S.11W.20.243
Kennecott Warm Springs 20S.11W.18.310
Mimbres Hot Springs 18S.10W.13.110
Well 19S.12W.12.000

Animas Valley

Animas Valley Hot Wells 25S.19W.7.000
Animas Valley Well 30S.19W.7.000
Steins Peak Well 23S.21W.3.312

Table 1 (cont'd.)

Playas Basin

Humble No. 1 State AB 32S.16W.25.210

San Luis Basin

Mamby's (American) Hot Springs 26N.11E.1.120
No Name Spring, south of John Dunn's bridge
27N.12E.36.411
Ojo Caliente (Joseph's Hot Spring) 24N.8E.24.110
- Arsenic Spring
- Iron Spring
- Lithia Spring
- Soda Spring
- Sodium Sulfate Spring

Ponce de Leon Hot Spring 24N.13E.7.000

Jemez Mountains

Fenton Hill (LASL "Granite" or "Hot-Dry Rock") Wells
19N.2E.1.400;13.200
Indian Springs 16N.2E.29.142
Jemez Hot Springs 18N.2E.23.000
McCauley Spring 19N.3E.32.000
Phillips Spring 16N.1E.00.000
Salado-Jemez River Area
- Kaseman No. 1 16N.1E.7.100
- Kaseman No. 2 (Warm Springs) 16N.1W.1.410
- San Ysidro Springs 15N.2E.6.000

San Antonio (Murray) Hot Spring 20N.3E.29.120
San Antonio Warm Spring 20N.4E.7.000
Soda Dam Springs 18N.2E.14.000
Spence Spring 19N.3E.28.310
Sulphur Springs (The Sulphurs) 19N.3E.4.000:
- Alum Spring
- Electric Spring
- Footbath Spring (Mudbath Spring, Mud Geyser)
- Laxative Spring
- Lemonade Spring
- Seltzer (Stomach, Kidney) Spring

Albuquerque Basin

Isleta Well 9N.4E.24.100
Mesita Well 9N.5W.1.000
Tomé Well 6N.3E.5.234
West Mesa Well 10N.2W.21.343

Socorro - La Jencia Basin

Blue Canyon Well 3S.1W.16.323
Cook Gallery (Spring) 3S.1W.15.313

Table 1 (cont'd.)

Socorro - La Jencia Basin (cont'd.)

Evergreen (Sedillo) Gallery 3S.1W.22.131
Socorro Gallery (Spring) 3S.1W.22.113

Truth or Consequences - Rincon Basin

Derry Warm Springs 17S.4W.29.340
Federal "M" No. 1 15S.2W.23.000
Barney Iorio No. 1 Fee 14S.5W.25.410
Rincon Well 19S.2W.9.120
Truth or Consequences Area 13S.4W.33.400;14S.4W.4.100
- Caballo Hot Springs
- Geronimo Hot Springs
- Hot Springs
- Palomas Hot Springs
- Yucca Lodge

Victoria Land and Cattle Co. No. 1 10S.1W.25.100
Victoria Land and Cattle Co. No. 2 10S.1W.26.000

Southern Jornada del Muerto - Mesilla Basin

Berino Well 26S.3E.11.111
Federal "H" No. 1 28S.2W.24.213
Grimm Well 25S.1E.32.114
Kilbourne Hole 27S.1W.8.000
Las Alturas Estates Wells 23S.2E.34.000
Radium (Selden) Springs 21S.1W.10.213
- Bailey's Bathhouse
- Radium Springs Hotel Well

Weaver - Federal No. 1 26S.1E.35.333
Well 23S.2W.35.411
Well 26S.8E.33.200

Tularosa Basin

Garton Well 18S.8E.5.144

Gallinas Creek

Montezuma (Las Vegas) Hot Springs 17N.15E.36.440

TABLE 2 - Alphabetical list of thermal springs, wells, and discharge sites (compiled from Summers 1972 and 1976). Less common names are given in parentheses; numbers indicate location as shown in Fig. 2. Letters in parentheses give location as to target area; see explanation at end of table and Fig. 1.

(Alum Spring) see Sulphur Springs (JM)
(American) Mamby's Hot Springs 26N.11E.1.120 (SL)
Animas Valley Hot Wells 25S.19W.7.000 (AN)
Animas Valley Well 30S.19W.7.000 (AN)
Apache Tejo Warm Spring 19S.12W.19.300 (M)
(Arsenic Spring) see Ojo Caliente (SL)
Bailey's Bathhouse see Radium (Selden) Springs (SJM)
Berino Well 25S.3E.11.111 (SJM)
Blue Canyon Well 3S.1W.16.323 (SLJ)
Caballo Hot Springs see Truth or Consequences area (TCR)
Carne Well 24S.7W.5.100 (M)
Cliff-Gila-Riverside Area 15,16S.17W. (GR)
Cook Gallery 3S.1W.15.313 (SLJ)
Derry Warm Springs 17S.4W.29.340 (TCR)
(Electric Spring) see Sulphur Springs (JM)
Evergreen (Sedillo) Gallery 3S.1W.22.131 (SLJ)
Faywood Hot Springs 20S.11W.20.243 (M)
Federal "H" No. 1 28S.2W.24.213 (SJM)
Federal "M" No. 1 15S.2W.23.000 (TCR)
Fenton Hill (LASL "Granite" or "Dry-Hot Rock") Wells 19N.2E.1.400;13.200 (JM)
(Footbath Spring) see Sulphur Springs (JM)
Ft. Wingate Well 15N.16W.30.3443 (SJ)
Freiborn Canyon Spring 7S.21W.8.422 (SF)
Garton Well 18S.8E.5.144 (T)
Geronimo Hot Spring see Truth or Consequences Area (TCR)
Gila Hot Springs 13S.13W.5.241 (GR)
Grimm Well 25S.1E.32.114 (SJM)
Hot Springs see Truth or Consequences Area (TCR)
Humble No. 1 State AB 32S.16W.25.210 (P)
Indian Springs 16N.2E.29.142 (JM)
(Iron Spring) see Ojo Caliente (SL)
Isleta Well 9N.4E.24.100 (AB)
Barney Iorio No. 1 Fee 14S.5W.25.410 (TCR)
Jemez Hot Springs 18N.2E.23.000 (JM)
(Joseph's Hot Spring) Ojo Caliente 24N.8E.24.110 (SL)
Kaseman No. 1 16N.1E.7.100 (JM)
Kaseman No. 2 (Warm Springs) 16N.1W.1.410 (JM)
Kennecott Warm Springs 20S.11W.18.310 (M)
(Kidney Spring) see Sulphur Springs (JM)
Kilbourne Hole 27S.1W.8.000 (SJM)
Las Alturas Estates 23S.2E.34.000 (SJM)
(Las Vegas) Montezuma Hot Springs 17N.15E.36.440 (GC)
(Laxative Spring) see Sulphur Springs (JM)

Table 2 (cont'd.)

(Lemonade Spring) see Sulphur Springs (JM)
(Lithia Spring) see Ojo Caliente (SL)
(Los Alamos "Dry-Hot-Rock") Granite Test Wells 19N.2E.1.400; 13.200 (JM)
Lower Frisco Hot Springs 12S.20W.23.120 (SF)
Lyons Hunting Lodge Hot Springs 13S.13W.10.121 (GR)
Mamby's (American) Hot Spring 26N.11E.1.120 (SL)
McCauley Spring 19N.3E.32.000 (JM)
The Meadows (Warm Spring) 11S.14W.30.200 (GR)
Mesita Well 9N.5W.1.000 (AL)
Mimbres Hot Spring 18S.10W.13.110 (M)
Montezuma (Las Vegas) Hot Springs 17N.15E.36.440
(Mudbath Spring) see Sulphur Springs (JM)
(Mud Geyser) see Sulphur Springs (JM)
(Murray) San Antonio Hot Spring 20N.3E.29.120 (JM)
Navajo No. 1 19N.17W.29.000 (SJ)
No Name Seep, middle Fork, Gila River 11S.14W.35.400 (GR)
No Name Spring, south of John Dunn's bridge 27N.12E.36.411 (SL)
No Name Spring, east Fork, Gila River 13S.13W.10.200 (GR)
No Name Spring, east Fork, Gila River 13S.13W.20.430 (GR)
No Name Spring, middle Fork, Gila River 12S.13W.7.340 (GR)
No Name Spring, middle Fork, Gila River 12S.13W.31.100 (GR)
Ojo Caliente (Joseph's Hot Spring) 24N.8E.24.110 (SL)
- Arsenic Spring
- Iron Spring
- Lithia Spring
- Soda Spring
- Sodium Sulfate Spring

Palomas Hot Springs see Truth or Consequences Area (TCR)
Phillip's Spring 16N.1E.00.000 (JM)
Ponce de Leon Hot Spring 24N.13E.7.000 (SL)
Pure Oil No. 3 19N.17W.22.000 (SJ)
Radium (Selden) Springs 21S.1W.10.213 (SJM)
- Bailey's Bathhouse
- Radium Springs Hotel Well

Radium Springs Hotel see Radium (Selden) Springs (SJM)
Rincon Well 19S.2W.9.120 (TCR)
San Antonio (Murray) Hot Spring 20N.3E.29.120 (JM)
San Antonio Warm Spring 20N.4E.7.000 (JM)
San Ysidro Springs 15N.2E.6.000 (JM)
(Sedillo) Evergreen Gallery 3S.1W.22.131 (SLJ)
(Selden) Radium Springs 21S.1W.10.213 (TCR)
(Seltzer Spring) see Sulphur Springs (JM)
Socorro Gallery 3S.1W.22.113 (SLJ)
Soda Dam Springs 18N.2E.14.000 (JM)
(Soda Spring) see Ojo Caliente (SL)
(Sodium Sulfate Spring) see Ojo Caliente (SL)
Spence Spring 19N.3E.28.310 (J)
Steins Peak Well 23S.19W.7.000 (AN)

Table 2 (cont'd.)

Sulphur Springs (The Sulphurs) 19N.3E.4.000 (JM):
Alum Spring
Electric Spring
Footbath Spring (Mudbath Spring, Mud Geyser)
Laxative Spring
Lemonade Spring
Seltzer (Stomach, Kidney) Spring
Test Well 12S.13W.30.231 (GR)
Tomé Well 6N.3E.5.234 (AB)
Truth or Consequences Area 13S.4W.33.400; 14S.4W.4.100 (TCR)
Caballo Hot Springs
Hot Springs
Palomas Hot Springs
Yucca Lodge
Upper Frisco Hot Springs 5S.19W.35.100 (SF)
Victoria Land and Cattle Co. No. 1 10S.1W.25.100 (TCR)
Victoria Land and Cattle Co. No. 2 10S.1W.26.000 (TCR)
(Warm Spring) The Meadows 11S.14W.30.200 (GR)
(Warm Springs) Kaseman No. 2 16S.1W.1.410 (JM)
Weaver-Federal No. 1 26S.1E.35.333 (SJM)
Well 6N.3E.5.234 (SLJ)
Well 19S.12W.12.000 (M)
Well 23S.1W.31.432 (SJM)
Well 23S.2W.35.411 (SJM)
Well 26S.8E.33.200 (SJM)
West Mesa Well 10N.2W.21.343 (AB)
Yucca Lodge Well see Truth or Consequences Area (TCR)
Zuni Salt Lake 3S.18W.18.000 (SF)

(SJ), San Juan Basin; (SF), San Francisco River Basin; (GR), Gila River Basin; (M), Mimbres River Basin; (AN), Animas Valley; (P), Playas Basin; (SL), San Luis Basin; (JM), Jemez Mountains; (AL), Albuquerque Basin; (SLJ), Socorro - La Jencia Basin; (TCR), Truth or Consequences - Rincon Basin; (SJM), Southern Jornada del Muerto - Mesilla Basin; (T), Tularosa Basin; and (GC) Gallinas Creek.

TABLE 3 - State geothermal resource lands leased in New Mexico as of January 31, 1977. Schematic computer plots of these lands are given in Figs. 7, 8, 9, 10, 11b, 13, 14, 15, 16b.

Leasee	Lease No.	Location T	R	S	¼ Sec.*	Date Issued
GILA RIVER BASIN TARGET AREA						
Hodges, L.A. Trustee	GTR164	14S	17W	29	1	3-12-75
Southern Union Production	GTR165	15S	17W	2	1	3-12-75
	GTR166	15S	17W	8	1	3-12-75
	GTR167	15S	17W	17	3	3-12-75
	GTR168	15S	17W	18	1,3	3-12-75
	GTR169	15s	17W	25	4	3-12-75
	GTR170	15S	17W	32	2	3-12-75
	GTR171	15S	18W	2	4	3-12-75
	GTR172	15S	18W	10	3	3-12-75
	GTR173	15S	18W	10	4	3-12-75
	GTR174	15S	18W	11	3	3-12-75
	GTR175	15S	18W	13	1	3-12-75
	GTR176	15S	18W	13	3	3-12-75
	GTR177	15S	18W	14	2	3-12-75
	GTR178	15S	18W	24	2	3-12-75
Hodges, L.A. Trustee	GTR179	16S	17W	7	4	3-12-75
	GTR180	16S	17W	17	3	3-12-75
	GTR181	16S	18W	24	1	3-12-75
MIMBRES RIVER BASIN TARGET AREA						
Southern Union Production	GTR182	18S	9W	31	1	3-12-75
Burmah Oil & Gas	GTR183	18S	10W	28	2	3-12-75
	GTR184	18S	10W	29	2,3	3-12-75
	GTR185	18S	10W	30	4	3-12-75
	GTR186	18S	10W	31	1	3-12-75
	GTR187	18S	10W	32	1,2,3,4	3-12-75
	GTR188	18S	10W	33	3	3-12-75
Southern Union Production	GTR189	18S	10W	36	1,2,3,4	3-12-75
	GTR190	19S	9W	6	1	3-12-75
	GTR191	19S	9W	7	1	3-12-75
Burmah Oil & Gas	GTR192	19S	10W	4	3	3-12-75
	GTR193	19S	10W	5	3	3-12-75
	GTR194	19S	10W	5	3	3-12-75
	GTR195	19S	10W	5	3	3-12-75

(cont'd.)

*Quarter sections designated as shown in Fig. 2: 1 northwest; 2 northeast; 3 southwest; and 4 southeast.

Table 3 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	GTR084	20S	11W	1	4	8-14-74
	GTR085	20S	11W	12	3	8-14-74
	GTR086	20S	11W	22	1	8-14-74
	GTR087	20S	11W	23	4	8-14-74
	GTR088	20S	11W	24	3	8-14-74
	GTR089	20S	11W	25	1,2	8-14-74
	GTR090	20S	11W	26	3	8-14-74
	GTR091	20S	11W	36	1,2,3,4	8-14-74
Gulf Oil	GTR196	20S	12W	15	2	3-12-75
	GTR197	20S	12W	17	2	3-12-75
	GTR198	20S	12W	18	1	3-12-75
	GTR199	20S	12W	20	1	3-12-75
	GTR200	20S	12W	21	2	3-12-75
	GTR201	20S	12W	22	2	3-12-75
	GTR202	20S	12W	23	1	3-12-75
	GTR203	20S	12W	26	1	3-12-75
	GTR204	20S	12W	27	3	3-12-75
	GTR205	20S	12W	28	2	3-12-75
	GTR206	20S	12W	33	1	3-12-75
	GTR207	20S	12W	36	1,2,3,4	3-12-75
	ANIMAS VALLEY TARGET AREA					
Wolter, Emmet E.	GTR092	23S	19W	32	1,2,3,4	8-14-74
Burmah Oil & Gas	GTR208	23S	19W	36	1	3-12-75
	GTR209	23S	20W	36	1,2,3,4	3-12-75
Calvert Geothermal Resources	GTR040	24S	20W	36	1,2,3,4	9-18-73
Burmah Oil & Gas	GTR215	24S	20W	2	1	3-12-75
	GTR216	24S	20W	7	1	3-12-75
	GTR217	24S	20W	8	1	3-12-75
	GTR218	24S	20W	8	1	3-12-75
	GTR219	24S	20W	9	1,2,3,4	3-12-75
	GTR220	24S	20W	10	2	3-12-75
	GTR221	24S	20W	12	4	3-12-75
	GTR222	24S	20W	16	1,2,3,4	3-12-75
	GTR223	24S	20W	17	1,2,3,4	3-12-75
	GTR224	24S	20W	20	1,2,3,4	3-12-75
	GTR225	24S	20W	28	1,2,3,4	3-12-75
	GTR226	24S	20W	32	1,2,3,4	3-12-75
	GTR227	24S	20W	33	1,2,3,4	3-12-75
Amax Exploration	GTR006	24S	19W	31	4	12-29-75
Wolter, Emmet E.	GTR093	24S	19W	6	1	8-14-74
	GTR094	24S	19W	7	1	8-14-74
Burmah Oil & Gas	GTR095	24S	19W	15	1,2,3,4	8-14-74
	GTR096	24S	19W	16	1,2,3,4	8-14-74

(cont'd.)

Table 3 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	GTR097	24S	19W	21	1,4	8-14-74
	GTR098	24S	19W	22	1,2,3,4	8-14-74
	GTR099	24S	19W	23	3	8-14-74
	GTR100	24S	19W	25	1,2,3,4	8-14-74
	GTR101	24S	19W	26	1,2	8-14-74
	GTR102	24S	19W	27	1,2,3,4	8-14-74
	GTR103	24S	19W	36	1,2,3,4	8-14-74
	GTR210	24S	19W	1	1	3-12-75
	GTR211	24S	19W	2	1	3-12-75
	GTR212	24S	19W	11	1	3-12-75
	GTR213	24S	19W	12	1	3-12-75
	GTR214	24S	19W	14	1	3-12-75
	GTR139	27S	19W	2	1,2,3,4	8-14-74
	GTR140	27S	19W	3	2	8-14-74
	GTR141	27S	19W	4	1,2	8-14-74
	GTR142	27S	19W	5	1,2,3,4	8-14-74
Chevron Oil	GTR143	27S	19W	6	2	8-14-74
	GTR144	27S	19W	7	2	8-14-74
Burmah Oil & Gas	GTR229	27S	19W	8	2	3-12-75
	GTR230	27S	19W	9	1,2,3,4	3-12-75
	GTR231	27S	19W	16	1,2,3,4	3-12-75
Amax Exploration	GTR232	27S	19W	29	3,4	3-12-75
	GTR233	27S	19W	33	1	3-12-75
	GTR234	27S	19W	33	2	3-12-75
	GTR235	27S	19W	36	1	3-12-75
Chevron Oil	GTR145	27S	20W	1	1,2,3,4	8-14-74
	GTR146	27S	20W	2	1,2,3,4	8-14-74
	GTR147	27S	20W	3	1	8-14-74
	GTR148	27S	20W	11	4	8-14-74
	GTR149	27S	20W	13	2	8-14-74
	GTR150	27S	20W	14	3	8-14-74
	GTR151	27S	20W	16	1,2,3,4	8-14-74
	GTR152	27S	20W	23	2	8-14-74
Amax Exploration	GTR236	27S	20W	32	2	3-12-75
	GTR237	27S	20W	36	1	3-12-75
	GTR238	27S	20W	36	1,2,3,4	3-12-75
Calvert Geothermal Resources	GTR010	25S	19W	15	1	11-15-72
	GTR012	25S	19W	19	1	11-15-72
	GTR013	25S	19W	36	1	11-15-72
Burmah Oil & Gas	GTR104	25S	19W	2	4	8-14-74
Amax Exploration	GTR105	25S	19W	10	1,4	8-14-74
	GTR106	25S	19W	13	4	8-14-74
	GTR107	25S	19W	14	1	8-14-74
	GTR108	25S	19W	15	1,4	8-14-74
Wolter, Emmet E.	GTR109	25S	19W	24	1,4	8-14-74

Table 3 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
Amax Exploration	GTR110	25S	19W	32	1,2,3,4	8-14-74
	GTR111	25S	19W	35	3	8-14-74
	GTR112	25S	19W	36	1,2,3,4	8-14-74
Calvert Geothermal Resources	GTR041	25S	20W	2	4	9-18-73
Amax Exploration	GTR113	25S	20W	4	4	8-14-74
	GTR114	25S	20W	5	4	8-14-74
	GTR115	25S	20W	9	1,2,3,4	8-14-74
	GTR116	25S	20W	16	1	8-14-74
	GTR228	25S	20W	32	1,2,3,4	3-12-75
Calvert Geothermal Resources	GTR014	26S	19W	18	1	11-15-72
	GTR016	26S	19W	6	1	11-15-72
Amax Exploration	GTR117	26S	19W	1	4	8-14-74
	GTR118	26S	19W	2	2	8-14-74
	GTR119	26S	19W	10	1,4	8-14-74
	GTR120	26S	19W	12	2	8-14-74
	GTR121	26S	19W	13	1	8-14-74
	GTR122	26S	19W	15	4	8-14-74
	GTR123	26S	19W	16	1,2,3,4	8-14-74
	GTR124	26S	19W	21	2	8-14-74
	GTR125	26S	19W	22	4	8-14-74
Burmah Oil & Gas	GTR126	26S	19W	23	4	8-14-74
	GTR127	26S	19W	24	1	8-14-74
Amax Exploration	GTR128	26S	19W	27	1	8-14-74
Burmah Oil & Gas	GTR129	26S	19W	29	3	8-14-74
	GTR130	26S	19W	30	1	8-14-74
	GTR131	26S	19W	31	1	8-14-74
	GTR132	26S	19W	31	4	8-14-74
	GTR133	26S	19W	32	1,2,3,4	8-14-74
	GTR134	26S	19W	33	1,4	8-14-74
	GTR135	26S	19W	36	1,2,3,4	8-14-74
Calvert Geothermal Resources	GTR015	26S	19W	36	4	11-15-72
Chevron Oil	GTR136	26S	20W	16	1,2,3,4	8-14-74
	GTR137	26S	20W	32	2	8-14-74
	GTR138	26S	20W	36	1,2,3,4	8-14-74
SAN LUIS BASIN TARGET AREA						
Antweil, A.J.	GTR153	24N	8E	2	3	8-14-74
JEMEZ MOUNTAINS TARGET AREA						
Fogelson, E.E.	GTR246	15N	4W	16	1,2,3,4	3-12-75
	GTR247	15N	4W	32	1,2,3,4	3-12-75
Amax Exploration	GTR005	15N	1W	2	1	12-29-75
Cherokee & Pittsburg Coal & Mining	GTR241	13N	1W	2	1	3-12-75

(cont'd.)

Table 3 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	GTR242	13N	1W	16	1,2,3,4	3-12-75
	GTR243	13N	1W	32	1	3-12-75
	GTR244	14N	1W	16	1,2,3,4	3-12-75
	GTR245	14N	1W	32	1,2,3,4	3-12-75
SOCORRO - LA JENCIA BASIN TARGET AREA						
Kelly, John M	GTR248	2S	1W	16	1,2,3,4	3-12-75
	GTR249	2S	1W	32	1,2,3,4	3-12-75
	GTR250	2S	1W	34	1	3-12-75
Covello, J.W.	GTR251	2S	2W	16	1	3-12-75
Gulf Oil	GTR252	2S	2W	32	1	3-12-75
Kelly, John M.	GTR253	2S	2W	36	1,2,3,4	3-12-75
Gulf Oil	GTR254	2S	3W	36	1,2,3,4	3-12-75
	GTR255	3S	2W	2	3,4	3-12-75
	GTR256	3S	2W	16	1,2,3,4	3-12-75
Kelly, John M.	GTR257	3S	2W	36	1,2,3,4	3-12-75
Deuterium Geothermal	GTR258	1S	1E	19	4	3-12-75
	GTR259	1S	1E	30	1	3-12-75
	GTR260	3S	1E	32	1	3-12-75
TRUTH OR CONSEQUENCES - RINCON BASIN TARGET AREA						
Fogelson, E.E.	GTR162	8S	3W	16	1,2,3,4	8-14-74
	GTR163	9S	3W	32	1,2,3,4	8-14-74
	GTR154	12S	1W	12	1,2,3,4	8-14-74
Deuterium Geothermal	GTR155	13S	4W	16	1,2,3,4	8-14-74
	GTR072	18S	3W	36	4	8-14-74
Fogelson, E.E.	GTR158	17S	1W	17	3,4	8-14-74
	GTR159	17S	2W	11	2	8-14-74
Deuterium Geothermal	GTR156	15S	5W	2	1,4	8-14-74
	GTR157	16S	5W	2	1,4	8-14-74
	GTR073	18S	4W	2	4	8-14-74
	GTR074	18S	4W	36	1	8-14-74
	GTR160	18S	5W	2	1,4	8-14-74
Fogelson, E.E.	GTR161	18S	5W	17	3,4	8-14-74
Deuterium Geothermal	GTR075	19S	3W	2	4	8-14-74
SOUTHERN JORNADA DEL MUERTO - MESILLA BASIN TARGET AREA						
Deuterium Geothermal	GTR076	20S	1W	31	2	8-14-74
	GTR077	20S	2W	25	4	8-14-74
	GTR078	20S	2W	36	1,2,3,4	8-14-74
Chevron Oil	GTR079	21S	1W	16	1	8-14-74
Deuterium Geothermal	GTR080	21S	1W	36	1	8-14-74
	GTR081	21S	1W	36	2	8-14-74
Fogelson, E.E.	GTR082	21S	1E	32	1	8-14-74
Deuterium Geothermal	GTR083	22S	1E	32	1,2,3,4	8-14-74

TABLE 4 - Federal geothermal resource lands leased in New Mexico as of January 31, 1977. Schematic computer plots of these lands are given in Figs. 9a, 16a, and 17.

Leasee	Lease No.	Location T	R	S	¼ Sec.*	Date Issued
			ANIMAS VALLEY TARGET AREA			
Aminoil USA	26316	23S	19W	36	1	11-30-76
Antweil, Mary F.	20700	23S	19W	31	1,2,3,4	12-28-76
	20700	24S	19W	5	1,2,3,4	12-28-76
	20700	24S	19W	8	1,2,3,4	12-28-76
Aminoil USA	26316	24S	19W	1	3	11-30-76
	26316	24S	19W	2	2	11-30-76
	26316	24S	19W	11	2	11-30-76
	26316	24S	19W	13	1	11-30-76
	26317	24S	19W	3	1	11-30-76
	26317	24S	19W	4	1	11-30-76
	26317	24S	19W	10	1,2,3,4	11-30-76
	26317	24S	19W	11	1	11-30-76
Earth Power	28213	24S	19W	8	1,2,3,4	10-01-76
	28213	24S	19W	19	3	10-01-76
	28213	24S	19W	20	1	10-01-76
	28213	24S	19W	29	2	10-01-76
	28213	24S	19W	30	1	10-01-76
Aminoil USA	29085	25S	19W	3	3,4	1-01-77
	29085	25S	19W	10	2,3	1-01-77
	29085	25S	19W	15	2	1-01-77
	29086	25S	19W	4	3,4	1-01-77
	29086	25S	19W	9	1,2,3,4	1-01-77
Thermal Resources	21388	25S	19W	24	3,4	11-30-76
	20727	25S	19W	13	1	12-28-76
	20727	25S	19W	14	3,4	12-28-76
	20727	25S	19W	22	3	12-28-76
	20727	25S	19W	23	1,2,3,4	12-28-76
	20727	25S	19W	24	2	12-28-76
Earth Power	20735	25S	19W	30	1,4	12-28-76
	20735	25S	19W	31	1,4	12-28-76
Phillips Petroleum	28215	25S	19W	27	1,2,3,4	10-01-76
	28215	25S	19W	28	1,2,3,4	10-01-76
	28215	25S	19W	33	1,2,3,4	10-01-76
	28215	25S	19W	34	1,2,3,4	10-01-76
	28216	25S	19W	29	1,2,3,4	10-01-76
	28216	25S	19W	30	1,4	10-01-76
	28216	25S	19W	31	1,4	10-01-76
Amax Exploration (cont'd.)	28214	25S	19W	17	3,4	9-01-76

*Quarter sections designated as shown in Fig. 2: 1 northwest; 2 northeast; 3 southwest; and 4 southeast.

Table 4 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	28214	25S	19W	20	1,2,3,4	9-01-76
	28214	25S	19W	21	1,2,3,4	9-01-76
	28214	25S	19W	18	1,4	9-01-76
	28214	25S	19W	19	1,4	9-01-76
Earth Power	21963	25S	20W	8	1,2,3,4	10-01-76
	21963	25S	20W	17	1,2	10-01-76
	21963	25S	20W	20	2,3	10-01-76
	21963	25S	20W	29	1,2	10-01-76
	21963	25S	20W	33	1	10-01-76
	21963	25S	20W	34	1,2	10-01-76
Amax Exploration	23197	26S	19W	33	2,3	12-28-76
Earth Power	20735	26S	19W	5	3	12-28-76
	20735	26S	19W	6	3	12-28-76
Thermal Resources	20723	26S	19W	9	1,2,3,4	12-28-76
	20723	26S	19W	17	1,2,3,4	12-28-76
	20723	26S	19W	18	1	12-28-76
	21388	26S	19W	12	3	11-30-76
	21388	26S	19W	13	1,4	11-30-76
	21388	26S	19W	14	1,2,3,4	11-30-76
	21388	26S	19W	15	2	11-30-76
	21389	26S	19W	20	1,2,3,4	11-30-76
	21339	26S	19W	21	1,2	11-30-76
	21389	26S	19W	22	2	11-30-76
	21389	26S	19W	23	1,2	11-30-76
	21389	26S	19W	24	1,2	11-30-76
	21389	26S	19W	29	1,2	11-30-76
Earth Power	20733	26S	19W	3	3	10-01-76
	20733	26S	19W	4	3	10-01-76
	20733	26S	19W	10	2,3	10-01-76
	20733	26S	19W	11	1,2,3,4	10-01-76
Phillips Petroleum	28216	26S	19W	6	3,4	10-01-76
Thermal Resources	21966	26S	20W	8	1,2,3,4	11-30-76
	21966	26S	20W	17	1,2	11-30-76
	21966	26S	20W	33	1,2,3,4	11-30-76
	21966	26S	20W	34	1,2,3,4	11-30-76
Amax Exploration	24890	28S	19W	11	1,2,3,4	12-01-76
	24890	28S	19W	13	1,2,3,4	12-01-76
	24890	28S	19W	23	1,4	12-01-76
	24890	28S	19W	24	1,2,3,4	12-01-76
	24882	28S	19W	17	2,3	12-01-76
	24882	28S	19W	29	1	12-01-76
	24882	28S	19W	19	1	12-01-76
	24882	28S	19W	31	1	12-01-76
	24882	28S	19W	21	3	12-01-76
	24883	28S	19W	8	2	12-01-76
	24883	28S	19W	28	2,3	12-01-76

(cont'd.)

Table 4 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	24883	28S	19W	18	1,4	12-01-76
	24883	28S	19W	33	2,3	12-01-76
	24883	28S	19W	20	1,2,3,4	12-01-76
	24881	28S	19W	3	3,4	11-01-76
	24881	28S	19W	4	4	11-01-76
	24881	28S	19W	9	1	11-01-76
	24880	28S	19W	14	1,2,3,4	11-01-76
	24888	28S	20W	5	1	12-01-76
	24888	28S	20W	24	1,2,3,4	12-01-76
	24889	28S	20W	8		12-01-76
	24889	28S	20W	21	1,2	12-01-76
	24889	28S	20W	22	2,3	12-01-76
	24889	28S	20W	26	3	12-01-76
	24884	27S	19W	15	1,2,3,4	12-01-76
	24884	27S	19W	22	1,2,3,4	12-01-76
	24884	27S	19W	34	1,2	12-01-76
	24884	27S	19W	35	1,3	12-01-76
Chevron Oil	23192	27S	19W	18	1	11-01-76
Amax Exploration	24880	27S	19W	26	1,2,3,4	11-01-76
	24880	27S	19W	27	1,4	11-01-76
Chevron Oil	23195	27S	20W	8	1,2,3,4	12-28-76
	23195	27S	20W	10	1,2,3,4	12-28-76
	23195	27S	20W	9	1	12-28-76
	23195	27S	20W	17	1,2,3,4	12-28-76
Amax Exploration	24886	27S	20W	26	1	12-01-76
	24886	27S	20W	32	1,2	12-01-76
	24886	27S	20W	34	2	12-01-76
Chevron Oil	23192	27S	20W	13	1,4	11-01-76
	23192	27S	20W	14	1	11-01-76
	23192	27S	20W	15	1,2	11-01-76
	23193	27S	20W	3	1	11-01-76
SOUTHERN JORNADA DEL MUERTO - MESILLA BASIN TARGET AREA						
Hunt, Norma K.	20692	20S	2W	1	1,2,3,4	6-01-75
Grimm, Jack F.	20566	25S	1E	19	1,2	7-01-75
	20566	25S	1E	21	1,4	7-01-75
	20566	25S	1E	29	1,2,3,4	7-01-75
	24879	25S	1E	20	1	7-01-75
	24879	25S	1E	30	1,2,3,4	7-01-75
	20565	25S	1E	28	1,2,3,4	7-01-75
	20565	25S	1E	33	1,2,3,4	7-01-75
	20564	25S	1E	31	1,2,3,4	7-01-75
	20565	26S	1E	4	1,2,3,4	7-01-75
	20565	26S	1E	5	1,2,3,4	7-01-75
	20564	26S	1E	6	1,2,3,4	7-01-75
	20564	26S	1E	7	1,2,3,4	7-01-75

(cont'd.)

Table 4 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	20564	26S	1E	19	1,2	7-01-75
	20563	26S	1E	8	1,2,3,4	7-01-75
	20563	26S	1E	9	1,2,3,4	7-01-75
	20563	26S	1E	20	1,2,3,4	7-01-75
	20563	26S	1E	21	1,2,3,4	7-01-75
Hunt, W.H.	20756	26S	1W	17	1,2,3,4	6-01-75
	20756	26S	1W	18	1,4	6-01-75
	20756	26S	1W	20	1,2,3,4	6-01-75
	20756	26S	1W	21	1,2,3,4	6-01-75
	20757	26S	1W	19	1	6-01-75
	20757	26S	1W	29	1,2,3,4	6-01-75
	20757	26S	1W	30	1,4	6-01-75
	20757	26S	1W	31	1,4	6-01-75
	20758	26S	1W	1	3,4	6-01-75
	20758	26S	1W	10	2,3	6-01-75
	20758	26S	1W	11	1,2,3,4	6-01-75
	20758	26S	1W	12	1,2,3,4	6-01-75
	20758	26S	1W	13	3	6-01-75
Hunt, Nelson B.	20662	26S	1W	3	4	6-01-75
	20662	26S	1W	4	4	6-01-75
	20662	26S	1W	5	3	6-01-75
	20662	26S	1W	8	2,3	6-01-75
	20662	26S	1W	9	2,3	6-01-75
Hunt, W.H.	20761	26S	1W	24	2,3	6-01-75
	20761	26S	1W	25	3,4	6-01-75
	20761	26S	1W	26	3	6-01-75
	20761	26S	1W	36	2,3	6-01-75
	20762	26S	1W	27	1,2,3,4	6-01-75
	20762	26S	1W	28	1,2,3,4	6-01-75
	20762	26S	1W	33	1,2,3,4	6-01-75
	20762	26S	1W	34	1,2,3,4	6-01-75
	20763	26S	1W	14	1,2,3,4	6-01-75
	20763	26S	1W	15	1,2,3,4	6-01-75
	20763	26S	1W	22	1,2,3,4	6-01-75
	20763	26S	1W	23	1,2,3,4	6-01-75
Hunt, Nelson B.	20832	26S	1W	6	4	6-01-75
	20832	26S	1W	7	4	6-01-75
	20772	26S	2W	25	1,2,3,4	6-01-75
	20772	26S	2W	26	1,2,3,4	6-01-75
	20772	26S	2W	34	1,2,3,4	6-01-75
	20772	26S	2W	35	1,2	6-01-75
Hunt, W.H.	20760	26S	2W	3	3,4	6-01-75
	20760	26S	2W	10	1,2,3,4	6-01-75
	20760	26S	2W	11	1,2,3,4	6-01-75
	20760	26S	2W	15	1,2,3,4	6-01-75
Hunt, Nelson B. (cont'd.)	20832	26S	2W	1	3,4	6-01-75

Table 4 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	20832	26S	2W	12	1,2,3,4	6-01-75
	20827	26S	2W	4	3,4	6-01-75
	20827	26S	2W	5	3,4	6-01-75
	20827	26S	2W	8	1,2,3,4	6-01-75
	20827	26S	2W	9	1,2,3,4	6-01-75
	20828	26S	2W	17	1,2,3,4	6-01-75
	20828	26S	2W	19	1,4	6-01-75
	20828	26S	2W	20	1,2,3,4	6-01-75
	20828	26S	2W	21	1,2,3,4	6-01-75
	20829	26S	2W	29	1,2,3,4	6-01-75
	20829	26S	2W	30	1,4	6-01-75
	20829	26S	2W	31	1,4	6-01-75
	20829	26S	2W	33	1,2,3,4	6-01-75
	20830	26S	2W	22	1,2,3,4	6-01-75
	20830	26S	2W	23	1,2,3,4	6-01-75
	20830	26S	2W	27	1,2	6-01-75
	20830	26S	2W	28	1,2	6-01-75
	20831	26S	2W	13	1,2,3,4	6-01-75
	20831	26S	2W	14	1,2	6-01-75
	20831	26S	2W	24	1,2,3,4	6-01-75
Schoellkopf, H.W.	20801	27S	2W	34	1,2,3,4	4-01-76
	20801	27S	2W	35	1,2,3,4	4-01-76
	20795	27S	2W	11	1,2,3,4	4-01-76
	20795	27S	2W	13	1,2,3,4	4-01-76
	20795	27S	2W	14	1,2,3,4	4-01-76
	20795	27S	2W	15	1,2,3,4	4-01-76
	20796	27S	2W	3	3,4	4-01-76
	20796	27S	2W	4	3,4	4-01-76
	20796	27S	2W	9	1,2,3,4	4-01-76
	20796	27S	2W	10	1,2,3,4	4-01-76
	20797	27S	2W	5	3,4	4-01-76
	20797	27S	2W	6	4	4-01-76
	20797	27S	2W	7	1,4	4-01-76
	20797	27S	2W	8	1,2,3,4	4-01-76
	20798	27S	2W	21	1,2,3,4	4-01-76
	20798	27S	2W	22	1,2,3,4	4-01-76
	20798	27S	2W	27	1,2,3,4	4-01-76
	20798	27S	2W	28	2,3	4-01-76
	20799	27S	2W	17	1,2,3,4	4-01-76
	20799	27S	2W	18	1,4	4-01-76
	20799	27S	2W	19	1,4	4-01-76
	20799	27S	2W	20	1,2,3,4	4-01-76
Hunt, Caroline	20663	27S	2W	1	3,4	6-01-75
	20663	27S	2W	12	1,2,3,4	6-01-75
	20664	27S	2W	23	1,2,3,4	6-01-75
	20664	27S	2W	24	1,2,3,4	6-01-75

(cont'd.)

Table 4 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	20664	27S	2W	25	1,2,3,4	6-01-75
	20664	27S	2W	26	1,2,3,4	6-01-75
Phillips Petroleum	29082	27S	1W	35	1,2,3,4	1-01-77
Anadarko Production	25718	27S	1W	4	3,4	7-01-75
	25718	27S	1W	9	1,2,3,4	7-01-75
	25718	27S	1W	10	1,2,3,4	7-01-75
	25719	27S	1W	5	1	7-01-75
	25719	27S	1W	6	1	7-01-75
	25719	27S	1W	7	1,4	7-01-75
	25719	27S	1W	8	4	7-01-75
	25720	27S	1W	17	1,2,3,4	7-01-75
	25720	27S	1W	18	1,4	7-01-75
	25720	27S	1W	19	1,4	7-01-75
	25721	27S	1W	20	1,2,3,4	7-01-75
	25721	27S	1W	21	1,2,3,4	7-01-75
	25722	27S	1W	27	1,2,3,4	7-01-75
	25722	27S	1W	28	1,2,3,4	7-01-75
	25722	27S	1W	33	1,2,3,4	7-01-75
	25722	27S	1W	34	1,2,3,4	7-01-75
	25723	27S	1W	29	1,2,3,4	7-01-75
	25723	27S	1W	30	1,4	7-01-75
	25723	27S	1W	31	1,4	7-01-75
Hunt, Caroline	20775	27S	1W	24	1,2,3,4	6-01-75
	20775	27S	1W	25	1,2,3,4	6-01-75
	20775	27S	1W	26	1,2	6-01-75
Hunt, W.H.	20761	27S	1W	1	3,4	6-01-75
	20759	27S	1W	11	1,2,3,4	6-01-75
	20759	27S	1W	12	1,2,3,4	6-01-75
	20759	27S	1W	13	1,2,3,4	6-01-75
	20759	27S	1W	14	1,2,3,4	6-01-75
Hunt, Caroline	20663	27S	1W	7	1,4	6-01-75
Schoellkopf, H.W.	20801	28S	2W	1	3,4	4-01-76
	20801	28S	2W	3	3,4	4-01-76
Hunt, Lamar	20744	28S	2W	28	1,2,3,4	6-01-75
	20744	28S	2W	29	1,2,3,4	6-01-75
	20744	28S	2W	33	1,2,3,4	6-01-75
	20655	28S	2W	10	1,2,3,4	6-01-75
	20655	28S	2W	11	1,2,3,4	6-01-75
	20655	28S	2W	14	1,2,3,4	6-01-75
	20655	28S	2W	15	1,2,3,4	6-01-75
	20656	28S	2W	22	1,2,3,4	6-01-75
	20656	28S	2W	23	1,2,3,4	6-01-75
	20656	28S	2W	24	1,2,3,4	6-01-75
	20656	28S	2W	25	1,2,3,4	6-01-75
	20657	28S	2W	19	1,4	6-01-75
	20657	28S	2W	20	1,2,3,4	6-01-75

(cont'd.)

Table 4 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	20657	28S	2W	21	1,2,3,4	6-01-75
	20657	28S	2W	30	1,4	6-01-75
	20658	28S	2W	7	1,4	6-01-75
	20658	28S	2W	8	1,2,3,4	6-01-75
	20658	28S	2W	17	1,2,3,4	6-01-75
	20658	28S	2W	18	1,4	6-01-75
	20659	28S	2W	26	1,2,3,4	6-01-75
	20659	28S	2W	27	1,2,3,4	6-01-75
	20659	28S	2W	34	1,2,3,4	6-01-75
	20659	28S	2W	35	1,2,3,4	6-01-75
Hunt, Nancy B.	20819	28S	2W	12	1,2,3,4	6-01-75
	20819	28S	2W	13	1,2,3,4	6-01-75
	24053	28S	2W	36	1,2	7-01-75
Phillips Petroleum	29083	28S	1W	1	3,4	1-01-77
	29083	28S	1W	12	1,2,3,4	1-01-77
	29084	28S	1W	11	1,2,3,4	1-01-77
Anadarko Production	25724	28S	1W	3	3,4	7-01-75
	25724	28S	1W	4	3,4	7-01-75
	25724	28S	1W	9	1,2,3,4	7-01-75
	25725	28S	1W	5	3,4	7-01-75
	25725	28S	1W	6	3,4	7-01-75
	25725	28S	1W	7	1,4	7-01-75
	25725	28S	1W	8	1,2,3,4	7-01-75
	25726	28S	1W	17	1,2,3,4	7-01-75
	25726	28S	1W	18	1,4	7-01-75
	25726	28S	1W	19	1,4	7-01-75
	25726	28S	1W	20	1,2	7-01-75
Hunt, Nancy B.	20820	28S	1W	27	1,2,3,4	6-01-75
	20820	28S	1W	28	1,2,3,4	6-01-75
	20820	28S	1W	33	1,2,3,4	6-01-75
	20820	28S	1W	34	1,2,3,4	6-01-75
	20822	28S	1W	13	1,2,3,4	6-01-75
	20822	28S	1W	14	1,2,3,4	6-01-75
	20822	28S	1W	23	1,2,3,4	6-01-75
	20822	28S	1W	24	1,2,3,4	6-01-75
	20824	28S	1W	10	1,2,3,4	6-01-75
	20824	28S	1W	15	1,2,3,4	6-01-75
	20824	28S	1W	21	1,2,3,4	6-01-75
	20824	28S	1W	22	1,2,3,4	6-01-75
	20819	28S	2W	7	4	6-01-75
	20819	28S	2W	18	4	6-01-75
Hunt, Norma K.	20690	29S	2W	3	1,2,3,4	6-01-75
	20690	29S	2W	10	1,2,3,4	6-01-75
	20690	29S	2W	11	1,2,3,4	6-01-75
	20690	29S	2W	14	1,2	6-01-75
	20695	29S	2W	5	1,2,3,4	6-01-75

(cont'd.)

Table 4 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	20695	29S	2W	6	1,4	6-01-75
	20695	29S	2W	7	1,4	6-01-75
	20695	29S	2W	31	4	6-01-75
Hunt, Lamar	20744	29S	2W	4	1,2,3,4	6-01-75
Hunt, Norma K.	20691	29S	2W	13	1,2	5-29-75
	20692	29S	1W	5	1,2,3,4	6-01-75
	20692	29S	1W	6	1	6-01-75
	20688	29S	1W	4	1,2,3,4	6-01-75
	20688	29S	1W	9	1,2,3,4	6-01-75
	20688	29S	1W	15	1,2	6-01-75
	20688	29S	1W	17	1,2	6-01-75
	20688	29S	1W	18	1,2	6-01-75
	20693	29S	1W	1	1,2,3,4	6-01-75
	20693	29S	1W	3	1,2,3,4	6-01-75
	20693	29S	1W	10	1,2,3,4	6-01-75
	20694	29S	1W	11	1,2,3,4	6-01-75
	20694	29S	1W	12	1,2,3,4	6-01-75
	20694	29S	1W	14	1,2	6-01-75
	20691	29S	1W	7	1,4	5-29-75
	20691	29S	1W	8	1,2,3,4	5-29-75

TABLE 5 - Drilling for geothermal resources in New Mexico as of January 31, 1977. Schematic computer plots of these locations are given in Figs. 9c, 11a, and 12.

Leasee	Lease No.	Location T	R	S	¼ Sec.*	Date Issued
ANIMAS VALLEY TARGET AREA						
Amax Exploration	1	24S	19W	31	2	9-20-76
	2	24S	19W	32	4	9-20-76
	3	25S	19W	6	3	9-20-76
	4	25S	19W	8	2	9-20-76
	5	25S	19W	8	1	9-20-76
	6	25S	19W	18	4	9-20-76
	12	25S	19W	19	3	9-20-76
	13	25S	19W	19	4	9-20-76
	14	25S	19W	20	1	9-20-76
	16	25S	19W	29	2	9-20-76
	19	25S	19W	29	1	9-20-76
Chevron Oil	L-3	27S	20W	1	1	5-1-76
	L-5	27S	20W	1	3	5-1-76
	L-4	27S	20W	9	1	5-1-76
	L-2	27S	20W	11	2	5-1-76
	L-1	27S	20W	16	2	5-1-76
	L-6	27S	20W	21	2	5-1-76
Amax Exploration	11	27S	20W	23	1	9-20-76
	17	27S	20W	36	1	9-20-76
	22	28S	20W	14	2	10-18-76
JEMEZ MOUNTAINS TARGET AREA						
Sunoco Energy Development	9-76-1A	18N	2W	12	3	1-24-77
Union Oil of California	Baca-16	19N	3W	1	3	7-17-75
	Baca-6	19N	3W	11	3	5-29-75
	Baca-15	19N	3W	11	3	12-27-74
	Baca-15	19N	3W	12	2	3-24-75
	Baca-15	19N	3W	12	4	5-9-75
	Baca-13	19N	3W	12	2	6-13-74
	Baca-14	19N	3W	14	2	10-15-74
	Baca-14	19N	3W	14	4	5-29-75
ALBUQUERQUE BASIN TARGET AREA						
Sunoco Energy Development	10-76-6	11N	1E	13	3	7-1-76

(cont'd.)

*Quarter sections designated as shown in Fig. 2: 1 northwest; 2 northeast; 3 southwest; and 4 southeast.

Table 5 (cont'd.)

Leasee	Lease No.	Location T	R	S	¼ Sec.	Date Issued
	10-76-7	11N	1E	36	4	7-1-76
	10-76-8	10N	1W	10	2	7-1-76
	10-76-8	10N	1W	13	1	7-1-76
	10-76-2	10N	1W	15	4	7-1-76
	10-76-9	10N	1W	27	1	7-1-76
	10-76-5	11N	1W	9	1	7-1-76
	10-76-3	11N	1W	26	2	7-1-76
	10-76-4	11N	2W	9	3	7-1-76

TABLE 6 - Results of survey of on-going research on geothermal resources of New Mexico.

Principal Investigator	Address	Specialty	Co-Investigators	On-Going Research
Cordell, Lindreth	U.S. Geol. Survey Federal Center P.O. Box 25046 Denver, CO 80225	Geophysics (magnetism, gravity)	-	Regional geophysics and tectonics of the Rio Grande graben
Fitterman, D.V.	Same as above	-	-	No response
Hoover, D.B.	Same as above	Geophysics (electrical)	C.L. Long R.M. Senterfit	Electrical techniques for shallow to medium depth exploration for geothermal systems
Jackson, D.B. and Bisdorf, R.J.	Same as above	Geophysics (electrical)	(both were sent questionnaires; the 1 response received did not identify the sender.)	None in New Mexico at present
Lipman, P.W.	U.S. Geol. Survey Hawaiian Volcano Observatory Hawaii Natl. Park P.O., Hawaii 96718	Volcanology	-	Cenozoic volcanism around margins of the Colorado Plateau: relation to geothermal anomalies
Martinez, R.	U.S. Geol. Survey Federal Center P.O. Box 25046 Denver, CO 80225	-	-	No response

Table 6 (cont'd.)

Principal Investigator	Address	Specialty	Co-Investigators	On-Going Research
O'Donnell, J.E.	U.S. Geol. Survey Federal Center P.O. Box 25046 Denver, CO 80225	-	-	No response
Tippins, C.L.	Same as above	-	-	No response
Towle, J.N.	Same as above	-	-	No response
Trainer, Frank	Same as above	-	-	No response
Williams, J.	Same as above	-	-	No response
Blair, A.B.	Los Alamos Sci. Lab. P.O. Box 1663 Los Alamos, NM 87545	Geothermal energy	J.W. Tester B.R. Dennis J. Landt A.W. Laughlin	Hot-Dry-Rock geothermal project
Bridwell, Joe	Same as above	Geology and geophysics	-	1) Thermal modeling of the magmatic setting of the Rio Grande Rift 2) Radiometric dating, intrarift volcanics
Brown, D.W.	Same as above	-	-	No response
Laughlin, A.W.	Same as above	Geochemistry	A.C. Eddy F.G. West	Petrology and geochemistry of Precambrian rocks from the LASL F[illegible]ton Hill drill site

Table 6 (cont'd.)

Principal Investigator	Address	Specialty	Co-Investigators	On-Going Research
Pettitt, R.A.	Los Alamos Sci. Lab. P.O. Box 1663 Los Alamos, NM 87545	-	-	No response
Potter, R.M.	Same as above	-	-	No response
Smith, Morton	Same as above	-	-	No response
West, F.	Same as above	Geoscience, hydrology	-	Various geothermal resources research projects
Chapin, C.E.	New Mexico Bureau Mines Mineral Resources Socorro, NM 87801	Volcanology	R.M. Chamberlain D. White	1) Geology and mineral resources of the Socorro-Magdalena area 2) Origin and evolution of the Rio Grande Rift
Reiter, M.A.	Same as above	Geophysics (terrestrial heat flow)	A. Mansure	Deep terrestrial heat flow studies in New Mexico and neighboring areas
Sanford, A.R.	N. Mexico Inst. of Technology Socorro, NM 87801	Geophysics (seismicity)	-	Seismic exploration for magma bodies in the crust beneath the Rio Grande Rift in the vicinity of Socorro, NM

Table 6 (cont'd.)

Principal Investigator	Address	Specialty	Co-Investigators	On-Going Research
Clemons, R.E.	Dept. Earth Sci. N.M.S.U. Las Cruces, NM 88003	Volcanology, petrography, economic geology	-	Geologic and mineral-resource study of the Goodsight Mtns., NM
Seager, W.R.	Same as above	Tectonics	Clemons, R.E. J.W. Hawley F.E. Kottlowski	1) Geology of Organ Mtns., NM 2) Geology of Las Cruces, NM 2 degree sheet 3) Geology of Robledo Mtns., NM
Elston, W.E.	Dept. Geology Univ. New Mexico Albuquerque, NM 87131	Volcanology	D.G. Brookins J.F. Callender G.R. Jiracek A.M. Kudo G.P. Landis C.A. Swanberg L.A. Woodward	Evaluation of geothermal potential of the Basin and Range Province of NM
Jiracek, G.R.	Same as above	Geophysics (resistivity)	D.G. Brookins J.F. Callender W.E. Elston A.M. Kudo G.P. Landis C.A. Swanberg L.A. Woodward	1) Deep electrical resistivity investigations coupled with dry geothermal reservoir experiments in NM 2) Evaluation of geothermal potential of the Basin and Range Province of NM

Table 6 (cont'd.)

Principal Investigator	Address	Specialty	Co-Investigators	On-Going Research
Decker, Edward R., Smithson, S.B.	Dept. Geology University Wyoming Laramie, WY 82071	Geophysics	-	Geophysical studies in the southern Rio Grande Rift
Ramberg, I.R.	Same as above	-	-	No response
Combs, Jim	Center for Energy Studies Univ. of Texas Dallas, TX 75080	-	-	No response
Johnson, D.M.	Same as above	-	-	No response
Quillian, Robert	Same as above	-	-	No response

TABLE 7 - Summary of work to date on geothermal resources in New Mexico by target area and topic. Numbers refer to references cited at end of report. (*HF, heat flow; M, magnetism; S, seismicity; E/R, electrical/resistivity; G, gravity)

Target Area/ Category	Geology	Geophysics* HF	M	S	E/R	G	Hydrogeology	Hydrochem.	Other
San Juan Basin	3,11,14,31 85,116,160						30,31,161,170 172	8	
San Francisco River Basin	37,194,195						190		
Gila River Basin	48,49,56 67,128,202						191,192		
Mimbres River Basin	47,82,150		82				19,192		
Animas Valley	50,51,52 55,129,151	94 95					129,151		
Playas Basin	44,207,208 209,210,211 212,213,214						44		
San Luis Basin	5,9,84,104 111,112		32						
Jemez Mountains	4,29,58,101 117,120,124 136,167,168 183,185,187 196,203,205	76 119 135	76	76	76 77	33 76	29,38,58,61,91 121,122,188,197	61,91,123 189	1,12,15 46,102 118,166 198

Table 7 (cont'd.)

Target Area/ Category	Geology	Geophysics HF	M	S	E/R	G	Hydrogeology	Hydrochem.	Other
Albuquerque Basin	2,80,87,88 89		35				10,87	68,130	
Socorro - La Jencia Basin	16,24,40 163,165,193		126	17,27 109,138 144,146 147,162 164		140	20,180	25,60,72	
Truth or Consequences - Rincon Area	63,64,65,90 152,153,154 155,156,157						27,28,36,108 110	108,182	
Southern Jornada del Muerto - Mesilla Basin	42,63,64,65 69,70,71,75 92,93,131 132,137,152 153,154,155 156,157,158 159	34	34 78 186	34 81 125	31 74 78 114	34 41	92,93,181	181	
Tularosa Basin	105,107						66,105,107 171	113	
Gallinas Creek	6,59						59		

Table 7 (cont'd.)

Target Area/ Category	Geology	Geophysics					Hydrogeology	Hydrochem.	Other
		HF	M	S	E/R	G			
Rio Grande Rift	7,13,23,24 43,83,103	23 133 169 216	169 215	141,142 169	79 169	127 169 217	23,43,199		45,86
General	18,39,54 148,149 173			139,143 145,184			106	26,175,176 179	22,53,57 62,97,98 99,100 115,134 174,177 178,200 201,206

APPENDIX — Geothermal-Resource Research Survey Questionnaire

GEOTHERMAL-RESOURCE RESEARCH SURVEY

ON-GOING RESEARCH

Project Title ______________________________

____

Source, Amount, Duration of Funding ______________________________

Principal Investigator/Specialty ______________________________

Address of Principal Investigator ______________________________

____

General Research Interests of Principal Investigator ______________________________

____

____

Co-investigators/Specialties ______________________________

____

Address of Co-investigators ______________________________

(if different than that of P.I.) ______________________________

PREVIOUS RESEARCH (only if published)

Research Field*	Complete Bibliographic Information (Co-authors, Year, Title, Where Published)

(continue on back if necessary)

Return to:
Dr. William J. Stone
New Mexico Bureau of Mines & Mineral Resources
Socorro, New Mexico 87801

* Geology, Geophysics, Hydrogeology, Hydrochemistry, Physics, Other (specify)