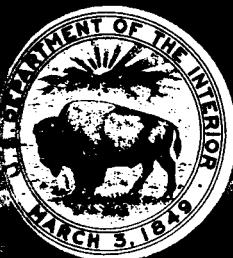


U.S.G.S.-CIRC-647

MAP

MASTER

Classification of Public Lands  
Valuable for Geothermal Steam and  
Associated Geothermal Resources



GEOLOGICAL SURVEY CIRCULAR 647

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United States Department of the Interior  
ROGERS C. B. MORTON, Secretary



Geological Survey  
V. E. McKelvey, Director

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# Classification of Public Lands Valuable for Geothermal Steam and Associated Geothermal Resources

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By L. H. Godwin, L. B. Haigler, R. L. Rioux, D. E. White, L. J. P. Muffler, and R. G. Wayland

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## ABSTRACT

The Organic Act of 1879 (43 U.S.C. 31) that established the U.S. Geological Survey provided, among other things, for the classification of the public lands and for the examination of the geological structure, mineral resources, and products of the national domain. In order to provide uniform executive action in classifying public lands, standards for determining which lands are valuable for mineral resources, for example, leasable mineral lands, or for other products are prepared by the U.S. Geological Survey. This report presents the classification standards for determining which Federal lands are classifiable as geothermal steam and associated geothermal resources lands under the Geothermal Steam Act of 1970 (84 Stat. 1566).

The concept of a geothermal resources province is established for classification of lands for the purpose of retention in Federal ownership of rights to geothermal resources upon disposal of Federal lands. A geothermal resources province is defined as an area in which higher than normal temperatures are likely to occur with depth and in which there is a reasonable possibility of finding reservoir rocks that will yield steam or heated fluids to wells.

The determination of a "known geothermal resources area" is made after careful evaluation of the available geologic, geochemical, and geophysical data and any evidence derived from nearby discoveries, competitive interests, and other indicia. The initial classification required by the Geothermal Steam Act of 1970 is presented.

## INTRODUCTION

The Organic Act of 1879 (43 U.S.C. 31) that established the U.S. Geological Survey provided, among other things, for the classification of the public lands and for the examination of the geological structure, mineral resources, and other products of the national domain. With the enactment of the Geothermal Steam Act of 1970, that authority and responsibility now includes, without limitation,

to the same extent as in classifying lands under the mineral leasing laws, the authority and responsibility to classify lands as valuable for geothermal steam and associated geothermal resources. Land is so classified in order to reserve or retain those substances in Federal ownership and to determine for the Department of the Interior which lands are included within "known geothermal resources areas" and thus subject to the competitive leasing provisions of the Geothermal Steam Act of 1970 (84 Stat. 1566).

The Geothermal Steam Act of 1970 (see "Appendix"), effective December 24, 1970, includes the following provisions:

SEC. 2(e). "known geothermal resources area" means an area in which the geology, nearby discoveries, competitive interests, or other indicia would, in the opinion of the Secretary, engender a belief in men who are experienced in the subject matter that the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose.

SEC. 4. If lands to be leased under this Act are within any known geothermal resources area, they shall be leased to the highest responsible qualified bidder by competitive bidding under regulations formulated by the Secretary. If the lands to be leased are not within any known geothermal resources area, the qualified person first making application for the lease shall be entitled to a lease of such lands without competitive bidding. \* \* \*

SEC. 21(a). Within one hundred and twenty days after the effective date of this Act, the Secretary shall cause to be published in the Federal Register a determination of all lands which were included within any known geothermal resources area on the effective date of the Act. He shall likewise publish in the Federal Register from time to time his determination of other known geothermal resources areas specifying in each case the date the lands were included in such area;

SEC. 25. As to any land subject to geothermal leasing under section 3 of this Act, all laws which either (a) provide for the disposal of land by patent or other form of conveyance or by grant or by operation of law subject to a reservation of any mineral or (b) prevent or restrict the disposal of such land because of the mineral character of the land, shall hereafter be deemed to embrace geothermal steam and associated geothermal resources as a substance which either *must be reserved or must prevent or restrict the disposal of such land*, as the case may be. [Italics added.] This section shall not be construed to affect grants, patents, or other forms of conveyances made prior to the date of enactment of this Act.

In order to assure uniform executive action in the classification of leasable mineral lands in the public domain, standards for determining which lands are mineral lands have been prepared from time to time by the U.S. Geological Survey. It is the duty of the Geological Survey to use geologic expertise to identify those Federal lands that are underlain by or have a reasonable expectation of containing mineral deposits or other products that meet

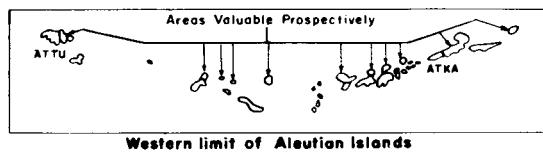
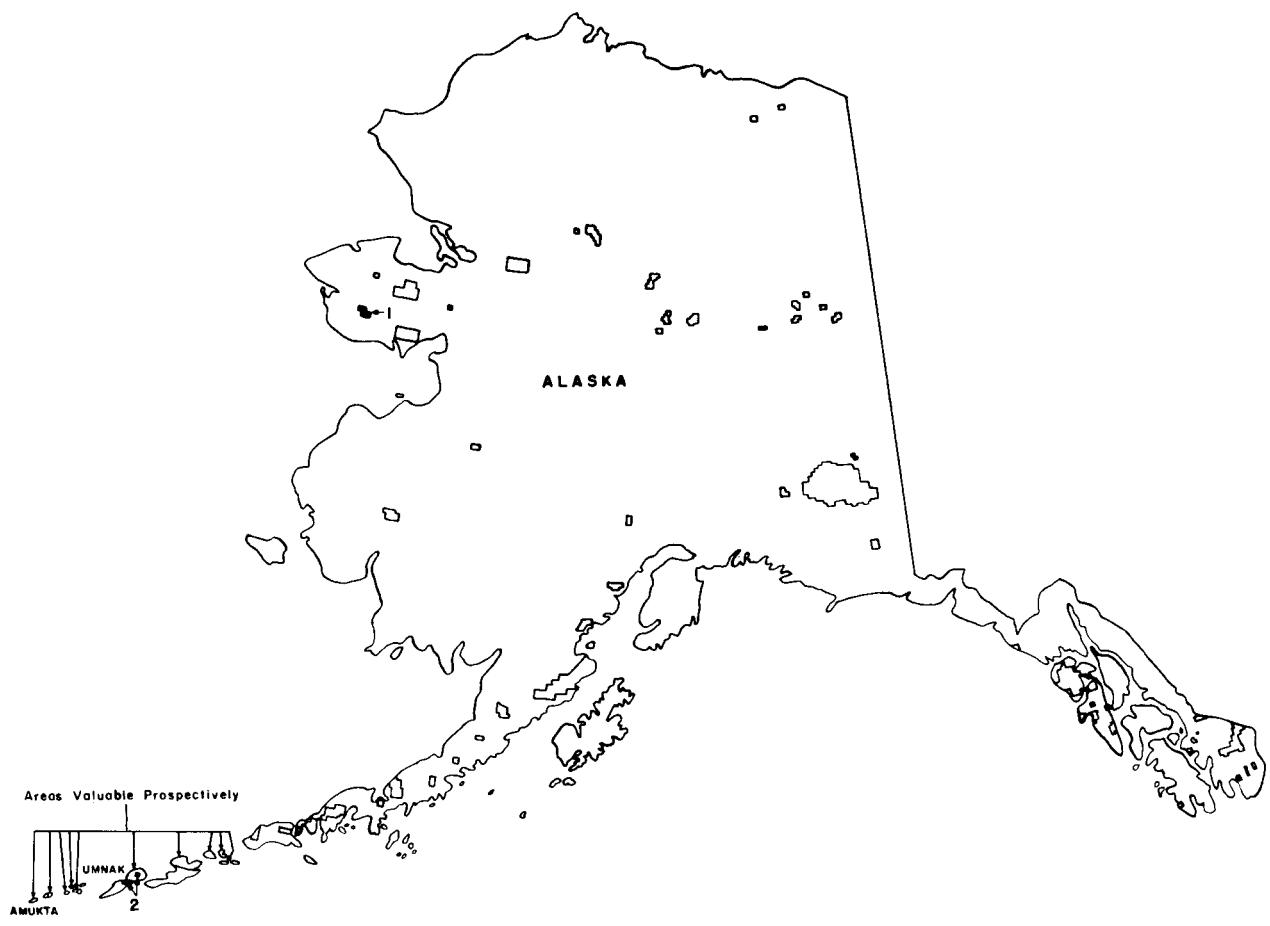
or exceed the minimum limits set by the classification standards. Field examination and a study of subsurface, geophysical, and geochemical data may precede classification. Similarly, all known pertinent geologic facts are considered in determining which legal subdivisions of lands are classified as geothermal steam and associated resources lands.

The purpose of this report is to present the classification standards that have been established to implement the Geothermal Steam Act of 1970. Figures 1 and 2 show those areas which include, in part, Federal lands classified as known geothermal resources areas that may be leased only competitively to the highest qualified bidder and those lands classified as valuable prospectively for the purpose of retention of geothermal rights in Federal ownership upon disposal of the lands. Table 1 lists the known geothermal resources areas effective December 24, 1970.

TABLE 1.—*Known geothermal resources areas*

[Number corresponds to location shown in fig. 1 or 2. Detailed land descriptions of these areas have been published in the "Federal Register," v. 36, p. 5626, March 25, 1971; v. 36, p. 6118, April 2, 1971; v. 36, p. 6441, April 3, 1971; v. 36, p. 7819, April 17, 1971; and v. 36, p. 7759, April 24, 1971]

Locality	Name	Locality	Name
<i>Alaska</i>			
1.....	Pilgrim Springs	4.....	Steamboat Springs
2.....	Geyser Spring Basin and Okmok Caldera	5.....	Brady Hot Springs
<i>California</i>			
1.....	The Geysers	6.....	Stillwater-Soda Lake
2.....	Salton Sea	7.....	Darrough Hot Springs
3.....	Mono-Long Valley	8.....	Gerlach
4.....	Calistoga	9.....	Moana Springs
5.....	Lake City	10.....	Double Hot Springs
6.....	Wendel-Amedee	11.....	Wabuska
7.....	Coso Hot Springs	12.....	Monte Neva
8.....	Lassen	13.....	Elko Hot Springs
9.....	Glass Mountain	<i>New Mexico</i>	
10.....	Sespe Hot Springs	1.....	Baca Location No. 1
11.....	Heber	<i>Oregon</i>	
12.....	Brawley	1.....	Breitenbush Hot Springs
13.....	Dunes	2.....	Crump Geyser
14.....	Glamis	3.....	Vale Hot Springs
<i>Idaho</i>			
1.....	Yellowstone	4.....	Mount Hood
2.....	Frazier	5.....	Lakeview
<i>Montana</i>			
1.....	Yellowstone	6.....	Carey Hot Springs
<i>Nevada</i>			
1.....	Beowawe	7.....	Klamath Falls
2.....	Fly Ranch	<i>Utah</i>	
3.....	Leach Hot Springs	1.....	Crater Springs
		2.....	Roosevelt
<i>Washington</i>			
		1.....	Mount St. Helens



#### EXPLANATION



Known Geothermal Resources Areas



Areas Valuable Prospectively

FIGURE 1.—Map of Alaska showing lands classified for geothermal resources effective December 24, 1970. Numbers correspond to areas listed in table 1.

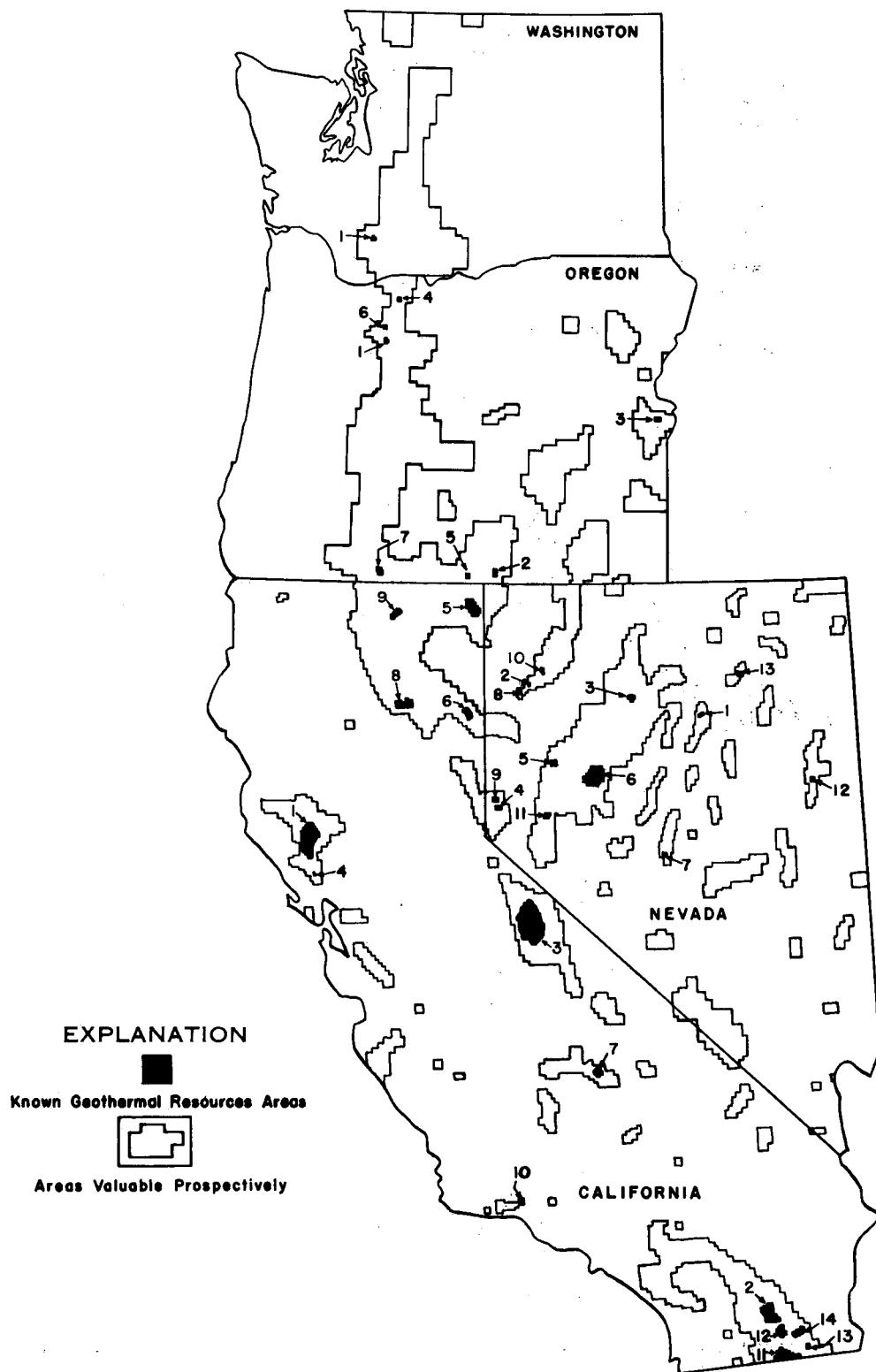
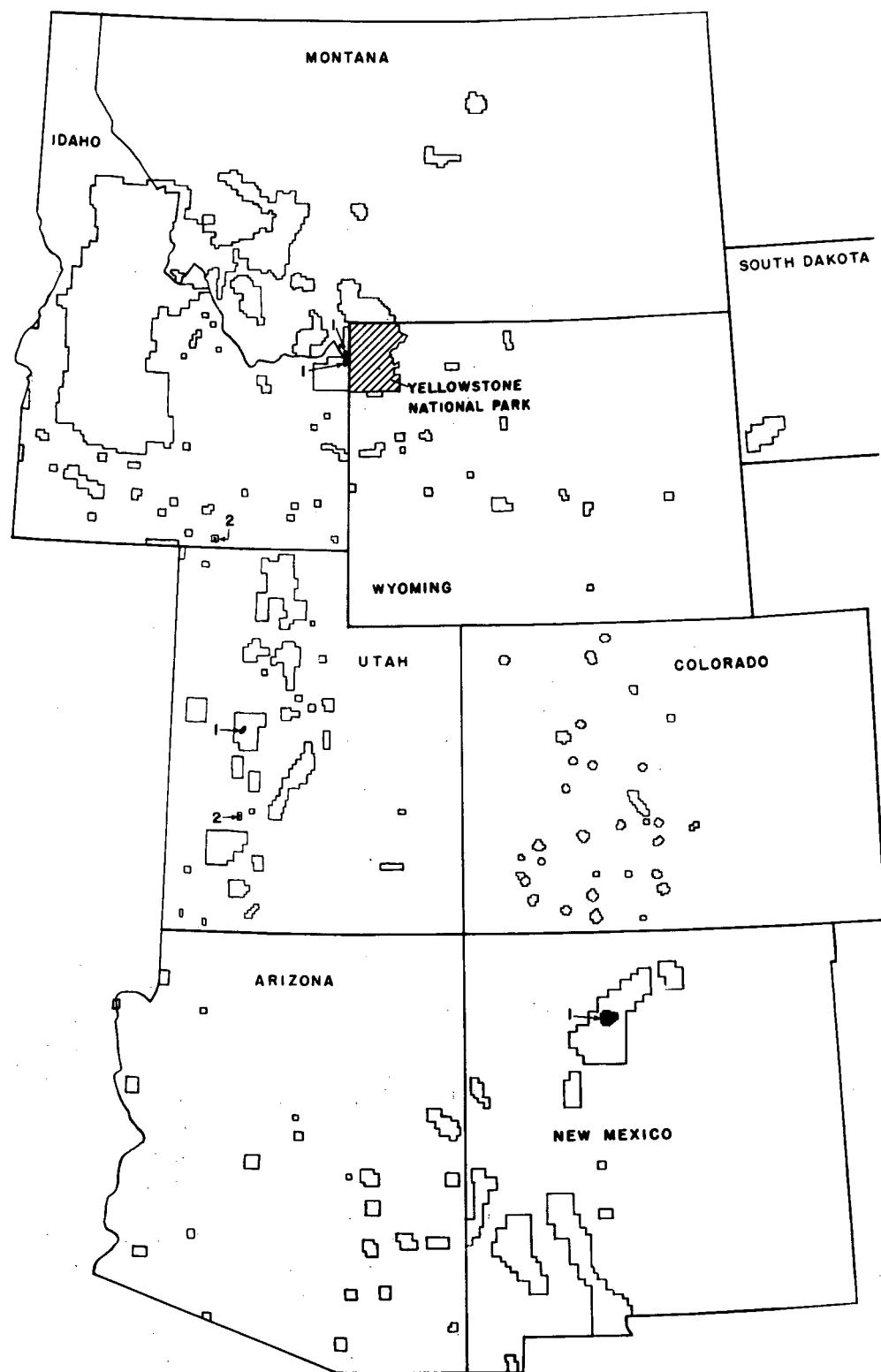


FIGURE 2.—Map of the Western United States showing lands classified for geothermal



resources effective December 24, 1970. Numbers correspond to areas listed in table 1.

Several Geological Survey personnel contributed helpful suggestions in critical reviews during the preparation of this report, and their assistance is gratefully acknowledged. The review and suggestions made by John F. Hughes, Office of the Solicitor, concerning the classification standards were especially useful.

#### NATURE OF GEOTHERMAL RESOURCES

The earth is an immense reservoir of energy, but most of this energy is contained in the earth's core and mantle at depths unlikely ever to be tapped by any foreseeable drilling technology. Within the earth at depths potentially accessible to drilling (about 6 miles) are stored approximately  $10^{24}$  British thermal units of heat (White, 1965, p. 2), but most of this heat is far too diffuse to be considered as a potential resource. However, economically significant concentrations of geothermal energy do occur in local "hot spots" where high temperatures (150° to 650°F) are found in porous rocks containing liquid water and (or) steam; such concentrations of extractable heat are known as "geothermal reservoirs." The reservoirs are found in regions of recent volcanism and mountain-building and in the deep parts of many sedimentary basins.

The energy in a geothermal reservoir consists of heat, largely stored in rocks and to a lesser extent in liquid water and (or) steam filling pores and fractures. The water and steam provide the means by which heat from deep sources is transferred by convection to depths shallow enough to be tapped by drilling. Water and steam also serve as the agents by which geothermal heat escapes at the surface in hot springs and fumaroles and through which geothermal heat can be tapped commercially by wells.

The fluid in most geothermal reservoirs is liquid water (White and others, 1971) that is held at temperatures above surface boiling by the confining pressure. Decrease in pressure upon withdrawal of the liquid water causes steam to form by boiling, and a mixture of steam and water is produced at the surface. A few reservoirs contain primarily steam, and the wells produce dry or superheated steam with no water. These dry steam reservoirs are

positively known only in the Larderello-Mt. Amiata region of Italy and at The Geysers, Calif.

For a geothermal reservoir to have appreciable potential for exploitation, it must meet the following requirements: (1) relatively high temperature (greater than 150° to 400°F, depending on processing technology), (2) a depth shallow enough to permit drilling (currently 10,000 ft or less), (3) sufficient rock permeability to allow the heat transfer agent (water and (or) steam) to flow continuously at a high rate, and (4) sufficient water recharge to maintain production over many years.

Limited exploitation of geothermal resources has occurred since the turn of the century, primarily to generate electric power. Geothermal resources also have been used for space heating, product processing, and agricultural heating, and in addition some geothermal fluids contain chemicals and metals that are potentially valuable byproducts. Furthermore, geothermal energy appears to have an important potential use in desalination, either of the geothermal fluid itself or of other saline waters that may occur near a source of geothermal energy.

#### PRESENT STATE OF GEOTHERMAL KNOWLEDGE

Geothermal areas exist throughout the world, primarily along the belts of young volcanism that ring the Pacific Ocean and that follow the midoceanic ridges. Geothermal areas of the United States are found primarily in the Western States, along the circum-Pacific belt of young volcanism and mountain-building and where the Pacific ridge system (a locus of high heat flow) intersects the North American continent along the Gulf of California and the Imperial-Coachella Valley of California. In the Eastern United States, potentially economic reservoirs of geothermal heat have been identified in the deep parts of the Gulf of Mexico sedimentary basin.

The distribution, extent, and magnitude of the geothermal resources of the United States are, at present, poorly known. The general extent of the resource in the Western States can be inferred from the distribution of hot springs and in a more general way from the distribu-

tion of young volcanic rocks. In the past, geothermal exploration was primarily on sites identified by hot springs (an exploration method analogous to the primitive oil exploration methods of the turn of the century when oil fields could be located only by finding surface oil seeps). Available geologic and geochemical techniques have not been used adequately in discovering and evaluating new fields, and geophysical principles and techniques are only now beginning to be adapted to geothermal exploration.

Knowledge of the characteristics and parameters of individual geothermal systems in the United States has come from exploratory drilling in about 40 hot-spring areas (J. B. Koenig, "Geothermal Exploration in the Western United States": Paper II/19, United Nations Symposium on the Development and Utilization of Geothermal Resources, Pisa, Italy, September 1970), from developmental drilling (mainly at The Geysers of northern California and the Salton Sea in southern California), and from scientific studies of a few major thermal-spring areas, supplemented by shallow research drilling. Extrapolation of knowledge from other countries, mainly New Zealand, Italy, and Iceland, has proven useful, but techniques for estimating the size and power potential of geothermal sites prior to drilling are only beginning to be developed. Techniques for efficiently utilizing all the energy produced from geothermal wells (that is, by desalination or by two-phase generation) are only beginning to be investigated and developed.

#### CLASSIFICATION FACTORS FOR RETENTION

The petroleum province is an established concept in classification of oil and gas lands for purposes of retention of Federal mineral rights upon disposal of public lands. A geothermal resources province (GRP) similar in concept to a petroleum province is necessary to define those areas valuable prospectively for geothermal steam and associated geothermal resources.

A geothermal resources province is an area in which higher than normal temperatures are likely to occur with depth and there is a reasonable possibility of finding reservoir rocks that will yield steam or heated fluids to wells.

In most prospective areas, data on geothermal gradients and conductive heat flow are scarce. Adequate temperature-depth data exist only in sedimentary basins that have been extensively explored for oil and gas. Most of these basins are characterized by nearly "normal" geothermal gradients rather than the abnormally high rates needed for development of geothermal energy.

The present-day use of geothermal energy includes generation of electricity, manufacturing, agriculture, and space heating. The minimum present-day use for geothermal resources is the exploitation of stored heat energy for space heating. Geothermal fluids used for space heating are generally delivered at above 100°F and are available at the surface or at shallow depths below the surface. S. S. Einarsson ("Utilization of Low Enthalpy Water for Space Heating, Industrial, Agricultural and Other Uses": Rapporteur rept., Sec. X, United Nations Symposium on the Development and Utilization of Geothermal Resources, Pisa, Italy, September 1970) reported use of 118°F water in space heating in Olafsfjordhur, Iceland, and 104°F water in Japan. S. H. Ross ("Geothermal Potential of Idaho": Paper II/1, United Nations Symposium on the Development and Utilization of Geothermal Resources, Pisa, Italy, September 1970) reported use of 104°F water for agricultural purposes in Idaho. Because a heat exchanger can extract the heat from the geothermal fluid, the chemical composition or the corrosiveness of the fluid is not necessarily a controlling factor in classification.

The classification of geothermal resources provinces is based on geologic inference similar to that used by the Geological Survey in classifying lands for retention of oil and gas mineral rights and should provide adequate protection against alienation of leasable geothermal resources. One or more of the following indicia are necessary for the retention classification of lands in geothermal resources provinces:

1. Volcanism of late Tertiary or Quaternary age—especially caldera structures, cones, and volcanic vents.
2. Geysers, fumaroles, mud volcanoes, or thermal springs at least 40°F higher than

average ambient temperature.

3. Subsurface geothermal gradients generally in excess of two times normal, as reflected in deep water wells, oil well tests, and other test holes.

#### CLASSIFICATION FACTORS FOR A KNOWN GEOTHERMAL RESOURCES AREA

Lands shall be classified as a "known geothermal resources area" (KGRA) when "the prospects for extraction of geothermal steam or associated geothermal resources from an area are good enough to warrant expenditures of money for that purpose." The accumulation of geothermal resources is in some ways similar to the accumulation of oil and gas resources, and only a test hole can establish with certainty the existence of adequate temperatures, pressures, and production capacity of an area. However, the definition of a "known geothermal resources area" departs from the concept of a "known geologic structure of a producing oil or gas field" (Finley, 1959) in that it does *not* require a producible well. Thus, any relevant data and information pertaining to the criteria enumerated in sec. 2(e) of the Geothermal Steam Act can be considered in determining whether lands are included within any KGRA.

The extent of a KGRA is influenced by such geologic factors as the pattern of temperature gradient, structure, stratigraphy, porosity, conductivity, permeability, heat source, and rate of recharge of fluids. The determination of a KGRA is made after evaluating the net effect of all geologic, geochemical, and geophysical data and any evidence derived from nearby discoveries, competitive interests, and other indicia.

#### GEOLOGY (INCLUDING GEOPHYSICAL AND GEOCHEMICAL DATA)

The following kinds of data, considered together, indicate that the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose:

1. Siliceous sinter and natural geysers both imply high subsurface temperatures, generally 350°F or greater (D. E. White, "Geochemistry Applied to the Discovery,

Evaluation and Exploitation of Geothermal Energy Resources"; Rapporteur rept., Sec. V, United Nations Symposium on the Development and Utilization of Geothermal Resources, Pisa, Italy, September 1970) in hot-water systems, because of relationships generally existing between temperature and SiO<sub>2</sub> content of liquid water.

2. The temperatures of fumaroles, thermal springs, and mud volcanoes provide minimum subsurface temperatures.
3. The SiO<sub>2</sub> content of spring water is a very useful chemical geothermometer for indicating the reservoir temperatures of many hot-water systems (R. O. Fournier and A. H. Truesdell, "Chemical Indicators of Subsurface Temperature Applied to Hot Spring Waters of Yellowstone National Park, Wyoming, U.S.A."; Paper V/2, United Nations Symposium on the Development and Utilization of Geothermal Resources, Pisa, Italy, September 1970; D. E. White, see above).
4. The Na/K ratio in spring waters of many hot-water systems is also a useful chemical geothermometer when there is adequate knowledge of competing influences (D. E. White, see above).
5. Most known potential geothermal systems occur in or near volcanoes and calderas of late Tertiary or Quaternary age.
6. Abnormally high conductive heat flow and the geothermal gradient are the best indicators of deep, concealed geothermal reservoirs. Although specific limits have not yet been established, two to 10 times the world-wide average (heat flow of 1.5 microcalories per cm<sup>2</sup> per second; temperature gradient of 1°F per 100 ft) extended consistently over hundreds of feet of depth appears favorable.
7. The porosity and the permeability of a potential reservoir are important parameters but can be established only by drilling and testing. Where stratigraphic control of the reservoir fluid or steam by a caprock is expected, near-surface characteristics of the rocks may provide preliminary evaluations.
8. Electrical resistivity surveys are probably

- the best geophysical means to geothermal evaluation available at this time, especially for the hot-water systems.
9. Magnetic, gravity, and airborne infrared geophysical surveys may provide useful supplemental data.
  10. Other geophysical methods such as micro-seismic, seismic ground noise, electromagnetic, and telluric surveys may have significant future use in evaluation.

#### NEARBY DISCOVERIES

In classifying land as a KGRA, the discovery of a deposit of geothermal steam or associated geothermal resources in the vicinity of such lands is evaluated together with the available data concerning the other criteria enumerated in sec. 2(e) of the Act which are to be considered in classification action.

#### COMPETITIVE INTERESTS

Competitive interest is considered together with the available data concerning the other criteria enumerated in sec. 2(e) of the Act in classifying lands as being within a KGRA.

Available information which could be considered in determining the existence of competitive interest in connection with an application for a geothermal lease would include information concerning the existence of bona fide, allowable applications for geothermal leases which have been filed for all or any part of the lands sought under the application being considered, or for lands in the vicinity of the lands being sought. The circumstance that two or more companies are exploring, applying for, or actually leasing available State or fee lands for geothermal resources in the same general area might constitute competitive interest that

would affect Federal lands considered valuable prospectively for geothermal resources and could warrant its classification as a KGRA. The absence of indicated competitive interest, however, is, in and of itself, no bar to classification of lands for inclusion in a KGRA and would not be sufficient to warrant revocation of a KGRA.

#### OTHER INDICIA

Any pertinent engineering and (or) economic data may be considered together with other available data relating to the criteria enumerated in sec. 2(e) of the Geothermal Steam Act in classifying land for inclusion in a KGRA.

In defining the lands valuable for geothermal resource development under the proposed withdrawal published in the "Federal Register," v. 32, p. 4506, March 24, 1967, the Director of the Geological Survey used primarily a combination of the then known geologic and geophysical data as well as temperature and chemical data, in part supplied by industry, from areas that had been drilled in exploration for geothermal steam. Future developments will provide substantially more geologic and geophysical information as well as engineering and economic data. These factors will be considered in future determinations of KGRA's.

#### REFERENCES CITED

- Finley, E. A., 1959, The definition of known geologic structures of producing oil and gas fields: U.S. Geol. Survey Circ. 419, 6 p.
- White, D. E., 1965, Geothermal energy: U.S. Geol. Survey Circ. 519, 17 p.
- White, D. E., Muffler, L. J. P., and Truesdell, A. H., 1971, Vapor-dominated hydrothermal systems, compared with hot-water systems: Econ. Geology, v. 66, no. 1, p. 75-97.



Public Law 91-581  
91st Congress, S. 368  
December 24, 1970

## An Act

84 STAT. 1566

To authorize the Secretary of the Interior to make disposition of geothermal steam and associated geothermal resources, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Geothermal Steam Act of 1970".*

SEC. 2. As used in this Act, the term—

- (a) "Secretary" means the Secretary of the Interior;
- (b) "geothermal lease" means a lease issued under authority of this Act;
- (c) "geothermal steam and associated geothermal resources" means (i) all products of geothermal processes, embracing indigenous steam, hot water and hot brines; (ii) steam and other gases, hot water and hot brines resulting from water, gas, or other fluids artificially introduced into geothermal formations; (iii) heat or other associated energy found in geothermal formations; and (iv) any byproduct derived from them;
- (d) "byproduct" means any mineral or minerals (exclusive of oil, hydrocarbon gas, and helium) which are found in solution or in association with geothermal steam and which have a value of less than 75 per centum of the value of the geothermal steam or are not, because of quantity, quality, or technical difficulties in extraction and production, of sufficient value to warrant extraction and production by themselves;

(e) "known geothermal resources area" means an area in which the geology, nearby discoveries, competitive interests, or other indicia would, in the opinion of the Secretary, engender a belief in men who are experienced in the subject matter that the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose.

SEC. 3. Subject to the provisions of section 15 of this Act, the Secretary of the Interior may issue leases for the development and utilization of geothermal steam and associated geothermal resources (1) in lands administered by him, including public, withdrawn, and acquired lands, (2) in any national forest or other lands administered by the Department of Agriculture through the Forest Service, including public, withdrawn, and acquired lands, and (3) in lands which have been conveyed by the United States subject to a reservation to the United States of the geothermal steam and associated geothermal resources therein.

Leases.

SEC. 4. If lands to be leased under this Act are within any known geothermal resources area, they shall be leased to the highest responsible qualified bidder by competitive bidding under regulations formulated by the Secretary. If the lands to be leased are not within any known geothermal resources area, the qualified person first making application for the lease shall be entitled to a lease of such lands without competitive bidding. Notwithstanding the foregoing, at any time within one hundred and eighty days following the effective date of this Act:

- (a) with respect to all lands which were on September 7, 1965, subject to valid leases or permits issued under the Mineral Leasing Act of February 25, 1920, as amended (30 U.S.C. 181 et seq.), or under the Mineral Leasing Act of Acquired Lands, as amended (30 U.S.C. 351, 358), or to existing mining claims located on or prior to September 7, 1965, the lessees or permittees or claimants or their successors in interest who are qualified to hold geothermal

Bids.

41 Stat. 437.

61 Stat. 913.

Geothermal Steam  
Act of 1970.  
Definitions.

December 24, 1970

leases shall have the right to convert such leases or permits or claims to geothermal leases covering the same lands;

(b) where there are conflicting claims, leases, or permits therefor embracing the same land, the person who first was issued a lease or permit, or who first recorded the mining claim shall be entitled to first consideration;

(c) with respect to all lands which were on September 7, 1965, the subject of applications for leases or permits under the above Acts, the applicants may convert their applications to applications for geothermal leases having priorities dating from the time of filing of such applications under such Acts;

(d) no person shall be permitted to convert mineral leases, permits, applications therefor, or mining claims for more than 10,240 acres; and

(e) the conversion of leases, permits, and mining claims and applications for leases and permits shall be accomplished in accordance with regulations prescribed by the Secretary. No right to conversion to a geothermal lease shall accrue to any person under this section unless such person shows to the reasonable satisfaction of the Secretary that substantial expenditures for the exploration, development, or production of geothermal steam have been made by the applicant who is seeking conversion, on the lands for which a lease is sought or on adjoining, adjacent, or nearby Federal or non-Federal lands.

(f) with respect to lands within any known geothermal resources area and which are subject to a right to conversion to a geothermal lease, such lands shall be leased by competitive bidding: *Provided*, That, the competitive geothermal lease shall be issued to the person owning the right to conversion to a geothermal lease if he makes payment of an amount equal to the highest bona fide bid for the competitive geothermal lease, plus the rental for the first year, within thirty days after he receives written notice from the Secretary of the amount of the highest bid.

Lease provisions.  
Royalties.

SEC. 5. Geothermal leases shall provide for—

(a) a royalty of not less than 10 per centum or more than 15 per centum of the amount or value of steam, or any other form of heat or energy derived from production under the lease and sold or utilized by the lessee or reasonably susceptible to sale or utilization by the lessee;

(b) a royalty of not more than 5 per centum of the value of any byproduct derived from production under the lease and sold or utilized or reasonably susceptible of sale or utilization by the lessee, except that as to any byproduct which is a mineral named in section 1 of the Mineral Leasing Act of February 25, 1920, as amended (30 U.S.C. 181), the rate of royalty for such mineral shall be the same as that provided in that Act and the maximum rate of royalty for such mineral shall not exceed the maximum royalty applicable under that Act;

(c) payment in advance of an annual rental of not less than \$1 per acre or fraction thereof for each year of the lease. If there is no well on the leased lands capable of producing geothermal resources in commercial quantities, the failure to pay rental on or before the anniversary date shall terminate the lease by operation of law: *Provided, however*, That whenever the Secretary discovers that the rental payment due under a lease is paid timely but the amount of the payment is deficient because of an error or other reason and the deficiency is nominal, as determined by the Secretary pursuant to regulations prescribed by him, he shall notify the lessee of the deficiency and such lease shall not automatically terminate unless

41 Stat. 437.

Rent.

the lessee fails to pay the deficiency within the period prescribed in the notice: *Provided further*, That, where any lease has been terminated automatically by operation of law under this section for failure to pay rental timely and it is shown to the satisfaction of the Secretary of the Interior that the failure to pay timely the lease rental was justifiable or not due to a lack of reasonable diligence, he in his judgment may reinstate the lease if—

(1) a petition for reinstatement, together with the required rental, is filed with the Secretary of the Interior; and

(2) no valid lease has been issued affecting any of the lands in the terminated lease prior to the filing of the petition for reinstatement; and

(d) a minimum royalty of \$2 per acre or fraction thereof in lieu of rental payable at the expiration of each lease year for each producing lease, commencing with the lease year beginning on or after the commencement of production in commercial quantities. For the purpose of determining royalties hereunder the value of any geothermal steam and byproduct used by the lessee and not sold and reasonably susceptible of sale shall be determined by the Secretary, who shall take into consideration the cost of exploration and production and the economic value of the resource in terms of its ultimate utilization.

SEC. 6. (a) Geothermal leases shall be for a primary term of ten years. If geothermal steam is produced or utilized in commercial quantities within this term, such lease shall continue for so long thereafter as geothermal steam is produced or utilized in commercial quantities, but such continuation shall not exceed an additional forty years.

Term.

(b) If, at the end of such forty years, steam is produced or utilized in commercial quantities and the lands are not needed for other purposes, the lessee shall have a preferential right to a renewal of such lease for a second forty-year term in accordance with such terms and conditions as the Secretary deems appropriate.

Limitation.  
Renewal.

(c) Any lease for land on which, or for which under an approved cooperative or unit plan of development or operation, actual drilling operations were commenced prior to the end of its primary term and are being diligently prosecuted at that time shall be extended for five years and so long thereafter, but not more than thirty-five years, as geothermal steam is produced or utilized in commercial quantities. If, at the end of such extended term, steam is being produced or utilized in commercial quantities and the lands are not needed for other purposes, the lessee shall have a preferential right to a renewal of such lease for a second term in accordance with such terms and conditions as the Secretary deems appropriate.

Extension.

(d) For purposes of subsection (a) of this section, production or utilization of geothermal steam in commercial quantities shall be deemed to include the completion of one or more wells producing or capable of producing geothermal steam in commercial quantities and a bona fide sale of such geothermal steam for delivery to or utilization by a facility or facilities not yet installed but scheduled for installation not later than fifteen years from the date of commencement of the primary term of the lease.

(e) Leases which have extended by reasons of production, or which have produced geothermal steam, and have been determined by the Secretary to be incapable of further commercial production and utilization of geothermal steam may be further extended for a period of not more than five years from the date of such determination but only for so long as one or more valuable byproducts are produced in commercial quantities. If such byproducts are leasable under the Mineral Leasing Act of February 25, 1920, as amended (30 U.S.C. 181, et seq.), or under the Mineral Leasing Act for Acquired Lands (30 U.S.C.

41 Stat. 437.

61 Stat. 913. 351-358), and the leasehold is primarily valuable for the production thereof, the lessee shall be entitled to convert his geothermal lease to a mineral lease under, and subject to all the terms and conditions of, such appropriate Act upon application at any time before expiration of the lease extension by reason of byproduct production. The lessee shall be entitled to locate under the mining laws all minerals which are not leasable and which would constitute a byproduct if commercial production or utilization of geothermal steam continued. The lessee in order to acquire the rights herein granted him shall complete the location of mineral claims within ninety days after the termination of the lease for geothermal steam. Any such converted lease or the surface of any mining claim located for geothermal byproducts mineral affecting lands withdrawn or acquired in aid of a function of a Federal department or agency, including the Department of the Interior, shall be subject to such additional terms and conditions as may be prescribed by such department or agency with respect to the additional operations or effects resulting from such conversion upon adequate utilization of the lands for the purpose for which they are administered.

(f) Minerals locatable under the mining laws of the United States in lands subject to a geothermal lease issued under the provisions of this Act which are not associated with the geothermal steam and associated geothermal resources of such lands as defined in section 2(c) herein shall be locatable under said mining laws in accordance with the principles of the Multiple Mineral Development Act (68 Stat. 708; found in 30 U.S.C. 521 et seq.).

Leases,  
acreage.

SEC. 7. A geothermal lease shall embrace a reasonably compact area of not more than two thousand five hundred and sixty acres, except where a departure therefrom is occasioned by an irregular subdivision or subdivisions. No person, association, or corporation, except as otherwise provided in this Act, shall take, hold, own, or control at one time, whether acquired directly from the Secretary under this Act or otherwise, any direct or indirect interest in Federal geothermal leases in any one State exceeding twenty thousand four hundred and eighty acres, including leases acquired under the provisions of section 4 of this Act.

Increase.

At any time after fifteen years from the effective date of this Act the Secretary, after public hearings, may increase this maximum holding in any one State by regulation, not to exceed fifty-one thousand two hundred acres.

Readjustment.

SEC. 8. (a) The Secretary may readjust the terms and conditions, except as otherwise provided herein, of any geothermal lease issued under this Act at not less than ten-year intervals beginning ten years after the date the geothermal steam is produced, as determined by the Secretary. Each geothermal lease issued under this Act shall provide for such readjustment. The Secretary shall give notice of any proposed readjustment of terms and conditions, and, unless the lessee files with the Secretary objection to the proposed terms or relinquishes the lease within thirty days after receipt of such notice, the lessee shall conclusively be deemed to have agreed with such terms and conditions. If the lessee files objections, and no agreement can be reached between the Secretary and the lessee within a period of not less than sixty days, the lease may be terminated by either party.

Notice.

(b) The Secretary may readjust the rentals and royalties of any geothermal lease issued under this Act at not less than twenty-year intervals beginning thirty-five years after the date geothermal steam is produced, as determined by the Secretary. In the event of any such readjustment neither the rental nor royalty may be increased by more than 50 per centum over the rental or royalty paid during the preceding period, and in no event shall the royalty payable exceed 22½ per centum. Each geothermal lease issued under this Act shall provide

for such readjustment. The Secretary shall give notice of any proposed readjustment of rentals and royalties, and, unless the lessee files with the Secretary objection to the proposed rentals and royalties or relinquishes the lease within thirty days after receipt of such notice, the lessee shall conclusively be deemed to have agreed with such terms and conditions. If the lessee files objections, and no agreement can be reached between the Secretary and the lessee within a period of not less than sixty days, the lease may be terminated by either party.

Notice.

(c) Any readjustment of the terms and conditions as to use, protection, or restoration of the surface of any lease of lands withdrawn or acquired in aid of a function of a Federal department or agency other than the Department of the Interior may be made only upon notice to, and with the approval of, such department or agency.

SEC. 9. If the production, use, or conversion of geothermal steam is susceptible of producing a valuable byproduct or byproducts, including commercially demineralized water for beneficial uses in accordance with applicable State water laws, the Secretary shall require substantial beneficial production or use thereof unless, in individual circumstances he modifies or waives this requirement in the interest of conservation of natural resources or for other reasons satisfactory to him. However, the production or use of such byproducts shall be subject to the rights of the holders of preexisting leases, claims, or permits covering the same land or the same minerals, if any.

Byproducts.

SEC. 10. The holder of any geothermal lease at any time may make and file in the appropriate land office a written relinquishment of all rights under such lease or of any legal subdivision of the area covered by such lease. Such relinquishment shall be effective as of the date of its filing. Thereupon the lessee shall be released of all obligations thereafter accruing under said lease with respect to the lands relinquished, but no such relinquishment shall release such lessee, or his surety or bond, from any liability for breach of any obligation of the lease, other than an obligation to drill, accrued at the date of the relinquishment, or from the continued obligation, in accordance with the applicable lease terms and regulations, (1) to make payment of all accrued rentals and royalties, (2) to place all wells on the relinquished lands in condition for suspension or abandonment, and (3) to protect or restore substantially the surface and surface resources.

Relinquishment.

SEC. 11. The Secretary, upon application by the lessee, may authorize the lessee to suspend operations and production on a producing lease and he may, on his own motion, in the interest of conservation suspend operations on any lease but in either case he may extend the lease term for the period of any suspension, and he may waive, suspend, or reduce the rental or royalty required in such lease.

Suspension.

SEC. 12. Leases may be terminated by the Secretary for any violation of the regulations or lease terms after thirty days notice provided that such violation is not corrected within the notice period, or in the event the violation is such that it cannot be corrected within the notice period then provided that lessee has not commenced in good faith within said notice period to correct such violation and thereafter to proceed diligently to correct such violation. Lessee shall be entitled to a hearing on the matter of such claimed violation or proposed termination of lease if request for a hearing is made to the Secretary within the thirty-day period after notice. The period for correction of violation or commencement to correct such violation of regulations or of lease terms, as aforesaid, shall be extended to thirty days after the Secretary's decision after such hearing if the Secretary shall find that a violation exists.

Leases,  
termination.  
Notice.

SEC. 13. The Secretary may waive, suspend, or reduce the rental or royalty for any lease or portion thereof in the interests of conservation and to encourage the greatest ultimate recovery of geothermal

Surface  
land, use.

41 Stat. 1075;  
62 Stat. 275.

16 USC 1.

Lessees,  
citizenship  
requirement.

Cooperative  
or unit  
plan.

resources, if he determines that this is necessary to promote development or that the lease cannot be successfully operated under the lease terms.

SEC. 14. Subject to the other provisions of this Act, a lessee shall be entitled to use so much of the surface of the land covered by his geothermal lease as may be found by the Secretary to be necessary for the production, utilization, and conservation of geothermal resources.

SEC. 15. (a) Geothermal leases for lands withdrawn or acquired in aid of functions of the Department of the Interior may be issued only under such terms and conditions as the Secretary may prescribe to insure adequate utilization of the lands for the purposes for which they were withdrawn or acquired.

(b) Geothermal leases for lands withdrawn or acquired in aid of functions of the Department of Agriculture may be issued only with the consent of, and subject to such terms and conditions as may be prescribed by, the head of that Department to insure adequate utilization of the lands for the purposes for which they were withdrawn or acquired. Geothermal leases for lands to which section 24 of the Federal Power Act, as amended (16 U.S.C. 818), is applicable, may be issued only with the consent of, and subject to, such terms and conditions as the Federal Power Commission may prescribe to insure adequate utilization of such lands for power and related purposes.

(c) Geothermal leases under this Act shall not be issued for lands administered in accordance with (1) the Act of August 25, 1916 (39 Stat. 535), as amended or supplemented, (2) for lands within a national recreation area, (3) for lands in a fish hatchery administered by the Secretary, wildlife refuge, wildlife range, game range, wildlife management area, waterfowl production area, or for lands acquired or reserved for the protection and conservation of fish and wildlife that are threatened with extinction, (4) for tribally or individually owned Indian trust or restricted lands, within or without the boundaries of Indian reservations.

SEC. 16. Leases under this Act may be issued only to citizens of the United States, associations of such citizens, corporations organized under the laws of the United States or of any State or the District of Columbia, or governmental units, including, without limitation, municipalities.

SEC. 17. Administration of this Act shall be under the principles of multiple use of lands and resources, and geothermal leases shall, insofar as feasible, allow for coexistence of other leases of the same lands for deposits of minerals under the laws applicable to them, for the location and production of claims under the mining laws, and for other uses of the areas covered by them. Operations under such other leases or for such other uses, however, shall not unreasonably interfere with or endanger operations under any lease issued pursuant to this Act, nor shall operations under leases so issued unreasonably interfere with or endanger operations under any lease, license, claim, or permit issued pursuant to the provisions of any other Act.

SEC. 18. For the purpose of properly conserving the natural resources of any geothermal pool, field, or like area, or any part thereof, lessees thereof and their representatives may unite with each other, or jointly or separately with others, in collectively adopting and operating under a cooperative or unit plan of development or operation of such pool, field, or like area, or any part thereof, whenever this is determined and certified by the Secretary to be necessary or advisable in the public interest. The Secretary may in his discretion and with the consent of the holders of leases involved, establish, alter, change, revoke, and make such regulations with reference to such leases in connection with the institution and operation of any such cooperative or unit plan as he may deem necessary or proper to secure reasonable protection of the

public interest. He may include in geothermal leases a provision requiring the lessee to operate under such a reasonable cooperative or unit plan, and he may prescribe such a plan under which such lessee shall operate, which shall adequately protect the rights of all parties in interest, including the United States. Any such plan may, in the discretion of the Secretary, provide for vesting in the Secretary or any other person, committee, or Federal or State agency designated therein, authority to alter or modify from time to time the rate of prospecting and development and the quantity and rate of production under such plan. All leases operated under any such plan approved or prescribed by the Secretary shall be excepted in determining holdings or control for the purposes of section 7 of this Act.

When separate tracts cannot be independently developed and operated in conformity with an established well-spacing or development program, any lease, or a portion thereof, may be pooled with other lands, whether or not owned by the United States, under a communization or drilling agreement providing for an apportionment of production or royalties among the separate tracts of land comprising the drilling or spacing unit when determined by the Secretary to be in the public interest, and operations or production pursuant to such an agreement shall be deemed to be operations or production as to each lease committed thereto.

The Secretary is hereby authorized, on such conditions as he may prescribe, to approve operating, drilling, or development contracts made by one or more lessees of geothermal leases, with one or more persons, associations, or corporations whenever, in his discretion, the conservation of natural products or the public convenience or necessity may require or the interests of the United States may be best served thereby. All leases operated under such approved operating, drilling, or development contracts, and interests thereunder, shall be excepted in determining holdings or control under section 7 of this Act.

SEC. 19. Upon request of the Secretary, other Federal departments and agencies shall furnish him with any relevant data then in their possession or knowledge concerning or having bearing upon fair and adequate charges to be made for geothermal steam produced or to be produced for conversion to electric power or other purposes. Data given to any department or agency as confidential under law shall not be furnished in any fashion which identifies or tends to identify the business entity whose activities are the subject of such data or the person or persons who furnished such information.

SEC. 20. All moneys received under this Act from public lands under the jurisdiction of the Secretary shall be disposed of in the same manner as moneys received from the sale of public lands. Moneys received under this Act from other lands shall be disposed of in the same manner as other receipts from such lands. *Moneys.*

SEC. 21. (a) Within one hundred and twenty days after the effective date of this Act, the Secretary shall cause to be published in the Federal Register a determination of all lands which were included within any known geothermal resources area on the effective date of the Act. He shall likewise publish in the Federal Register from time to time his determination of other known geothermal resources areas specifying in each case the date the lands were included in such area; and

Publication in  
Federal Register.

(b) Geothermal resources in lands the surface of which has passed from Federal ownership but in which the minerals have been reserved to the United States shall not be developed or produced except under geothermal leases made pursuant to this Act. If the Secretary of the Interior finds that such development is imminent, or that production from a well heretofore drilled on such lands is imminent, he shall so report to the Attorney General, and the Attorney General is authorized

and directed to institute an appropriate proceeding in the United States district court of the district in which such lands are located, to quiet the title of the United States in such resources, and if the court determines that the reservation of minerals to the United States in the lands involved included the geothermal resources, to enjoin their production otherwise than under the terms of this Act: *Provided*, That upon an authoritative judicial determination that Federal mineral reservation does not include geothermal steam and associated geothermal resources the duties of the Secretary of the Interior to report and of the Attorney General to institute proceedings, as hereinbefore set forth, shall cease.

SEC. 22. Nothing in this Act shall constitute an express or implied claim or denial on the part of the Federal Government as to its exemption from State water laws.

Waste,  
prevention.

SEC. 23. (a) All leases under this Act shall be subject to the condition that the lessee will, in conducting his exploration, development, and producing operations, use all reasonable precautions to prevent waste of geothermal steam and associated geothermal resources developed in the lands leased.

(b) Rights to develop and utilize geothermal steam and associated geothermal resources underlying lands owned by the United States may be acquired solely in accordance with the provisions of this Act.

Rules and  
regulations.

SEC. 24. The Secretary shall prescribe such rules and regulations as he may deem appropriate to carry out the provisions of this Act. Such regulations may include, without limitation, provisions for (a) the prevention of waste, (b) development and conservation of geothermal and other natural resources, (c) the protection of the public interest, (d) assignment, segregation, extension of terms, relinquishment of leases, development contracts, unitization, pooling, and drilling agreements, (e) compensatory royalty agreements, suspension of operations or production, and suspension or reduction of rentals or royalties, (f) the filing of surety bonds to assure compliance with the terms of the lease and to protect surface use and resources, (g) use of the surface by a lessee of the lands embraced in his lease, (h) the maintenance by the lessee of an active development program, and (i) protection of water quality and other environmental qualities.

SEC. 25. As to any land subject to geothermal leasing under section 3 of this Act, all laws which either (a) provide for the disposal of land by patent or other form of conveyance or by grant or by operation of law subject to a reservation of any mineral or (b) prevent or restrict the disposal of such land because of the mineral character of the land, shall hereafter be deemed to embrace geothermal steam and associated geothermal resources as a substance which either must be reserved or must prevent or restrict the disposal of such land, as the case may be. This section shall not be construed to affect grants, patents, or other forms of conveyances made prior to the date of enactment of this Act.

30 USC 530.

Sec. 26. The first two clauses in section 11 of the Act of August 13, 1954 (68 Stat. 708, 716), are amended to read as follows:

30 USC 181.  
30 USC 281.

"As used in this Act, 'mineral leasing laws' shall mean the Act of February 25, 1920 (41 Stat. 437); the Act of April 17, 1926 (44 Stat. 301); the Act of February 7, 1927 (44 Stat. 1057); Geothermal Steam Act of 1970, and all Acts heretofore or hereafter enacted which are amendatory of or supplementary to any of the foregoing Acts; 'Leasing Act minerals' shall mean all minerals which, upon the effective date of this Act, are provided in the mineral leasing laws to be disposed of thereunder and all geothermal steam and associated geothermal resources which, upon the effective date of the Geothermal Steam Act of 1970, are provided in that Act to be disposed of thereunder;".

December 24, 1970

Pub. Law 91-681

84 STAT. 1574

Sec. 27. The United States reserves the ownership of and the right to extract under such rules and regulations as the Secretary may prescribe oil, hydrocarbon gas, and helium from all geothermal steam and associated geothermal resources produced from lands leased under this Act in accordance with presently applicable laws: *Provided*, That whenever the right to extract oil, hydrocarbon gas, and helium from geothermal steam and associated geothermal resources produced from such lands is exercised pursuant to this section, it shall be exercised so as to cause no substantial interference with the production of geothermal steam and associated geothermal resources from such lands.

Certain mineral rights, retention by U. S.

Approved December 24, 1970.

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LEGISLATIVE HISTORY:

HOUSE REPORT No. 91-1544 (Comm. on Interior and Insular Affairs).  
SENATE REPORT No. 91-1160 (Comm. on Interior and Insular Affairs).  
CONGRESSIONAL RECORD, Vol. 116 (1970):

Sept. 16, Oct. 14, Dec. 4, 10, considered and passed Senate.  
Oct. 5, Dec. 9, considered and passed House.

