POTENTIAL FOR GEOTHERMAL DESALINATION IN THE SOUTHWEST UNITED STATES

by

Chandler A. Swanberg and Sandra M. Rybarczyk

New Mexico State University
Department of Physics
Department of Earth Sciences

Arizona Geological Survey
Open-File Report 80-1b

March, 1980

Arizona Geological Survey
416 W. Congress, Suite #100, Tucson, Arizona 85701

Funded by the U.S. Department of Energy
Contract Number EG-77-S-02-4362
Division of Geothermal Energy and the
U.S. Department of the Interior, Bureau of Reclamation

This report is preliminary and has not been edited
or reviewed for conformity with Arizona Geological Survey standards

ABSTRACT

Combining the results of standard chemical geothermometry techniques, chemical analysis of ground water and geologic mapping of large sedimentary basins, we have delineated areas in the southwestern United States where geothermal desalination may help to augment deficient water supplies. Ten areas favorable for geothermal desalting have been located within Arizona, New Mexico, and southwest Texas.

Introduction

The southwestern United States is an area characterized by accelerating population and economic growth and water deficiency. Availability of water represents a limiting factor in the continued development of the area. Low annual precipitation, high mean annual temperatures, and low humidity with resultant loss of large amounts of water to evaporation assures a small net water yield available as runoff in streams and recharge of underground aquifers from within the area's boundaries. Much of the water presently used is obtained from ground water supplies.

Chemical quality of ground water is variable but significant amounts of previously unusable saline water (more than 1,000 parts per million total dissolved solids) may be made available for urban, industrial, and agricultural utilization in areas where geothermal resources occur in conjunction with large volumes of saline water in permeable aquifers.

This report outlines major sedimentary basins with saline water and geothermal potential in order to outline areas which may benefit from geothermal desalination. It follows from Imperial Valley studies for other major southwestern basins. A description of the techniques of geothermal desalting and its impact on fresh water resources is reported by Fernelius (1975).

Geology

The main area of interest is the Basin and Range province of California, New Mexico, Arizona, and Texas, including the Southern

Rockies province and the Rio Grande Rift. Basin and Range structure is dominated by generally north-northwest trending fault block mountains or ridges separated by sediment-filled basins.

The structural basins between the mountain ranges are filled to depths of thousands of feet with unconsolidated or weakly consolidated deposits of gravel, sand, silt, and clay (alluvium) and are the primary aquifers in most of the area. The large major basins with their great water storage capacity and high permeability are therefore prime sites for large volumes of easily accessible ground water. In the Colorado Plateau and Great Plains provinces the primary aquifers are comprised of consolidated sandstone and limestone, respectively.

Techniques

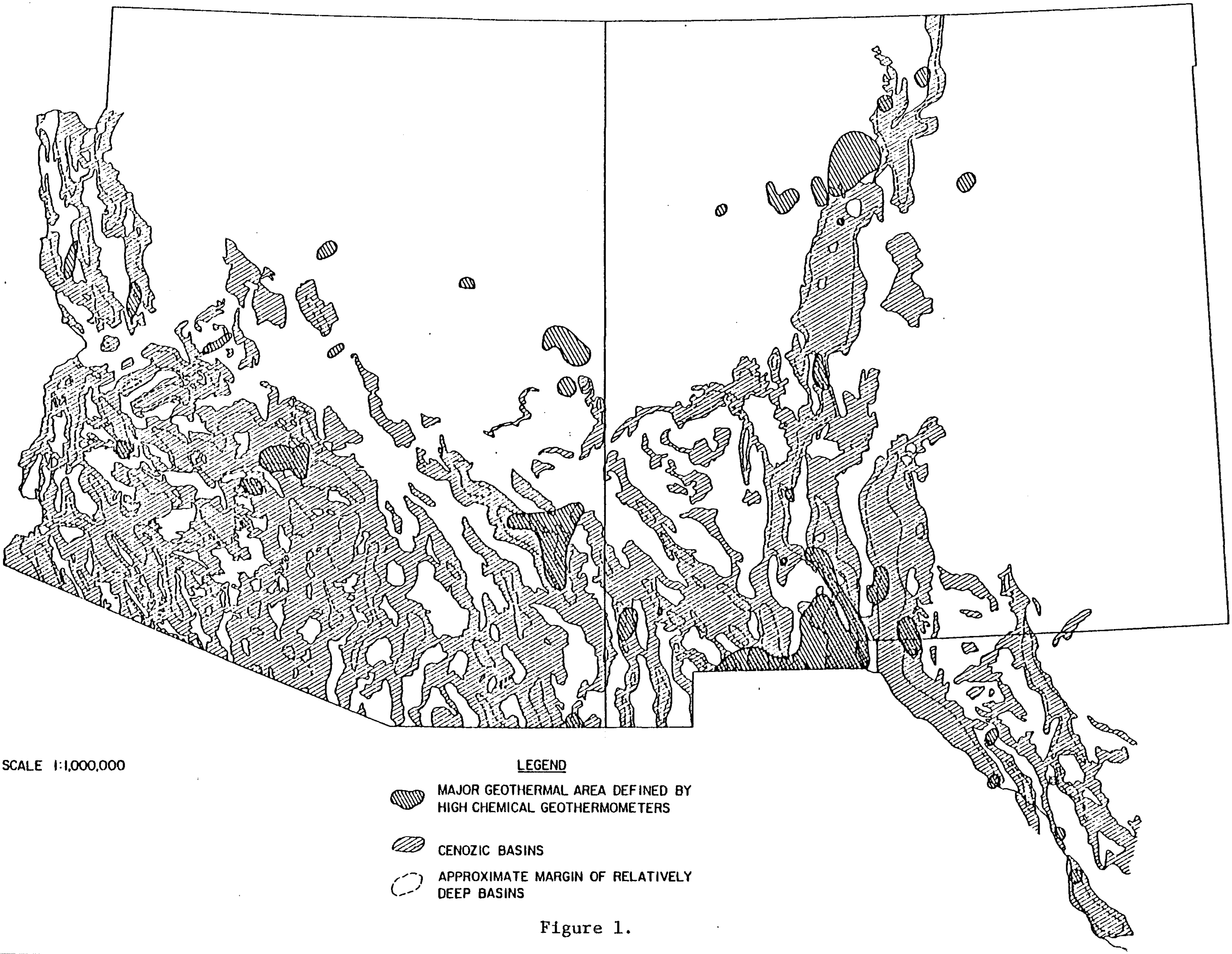
Locations of deep sedimentary basins were obtained from the work of Gerlach et al. (1975) and Swanberg (1979). Data from Hahman et al. (1978) and Swanberg (1979) were used to determine the distribution and extent of major geothermal areas (Figure 1). Figure 2 represents additional and extended potential geothermal regions (Swanberg, unpublished data). This information was not available at the time figure 1 was prepared, but is included since the results were used in forming the conclusions drawn in this report.

Over 20,000 groundwater chemical analyses from the U.S. Geological Survey's WATSTORE "water quality file", plus those of approximately 300 water samples collected in the study area were used to locate major areas of saline water occurrence. Areas of overlap between abundant saline water, geothermal potential and major sedimentary basins are shown in Figure 3. Availability of significant volumes of water for desalination in the Colorado Plateau Province was inferred from the approximate areal extent of consolidated sedimentary aquifers shown on the Productive Aquifers and Withdrawal from Wells map of the National Atlas of the United States.

Results

Geothermal resources may originate in deep sedimentary basins where the water is heated by the geothermal gradient and rises to the surface along active faults. Figure 3 shows 10 areas of overlap of high salinity groundwater, geothermal potential and major sedimentary basins. These are the areas that we suggest be targeted for detailed evaluation for desalting of geothermal brine.

The majority of the areas favorable for geothermal desalination occur in the Basin and Range. Waters of the province are generally of low salinity, however, areas where geothermal prospects occur may have saline water at depth. Also shown are three areas in the Great Plains region where abundant saline water occurs in areas of no known geothermal potential and potential for desalination is low.



SCALE 1:1,000,000

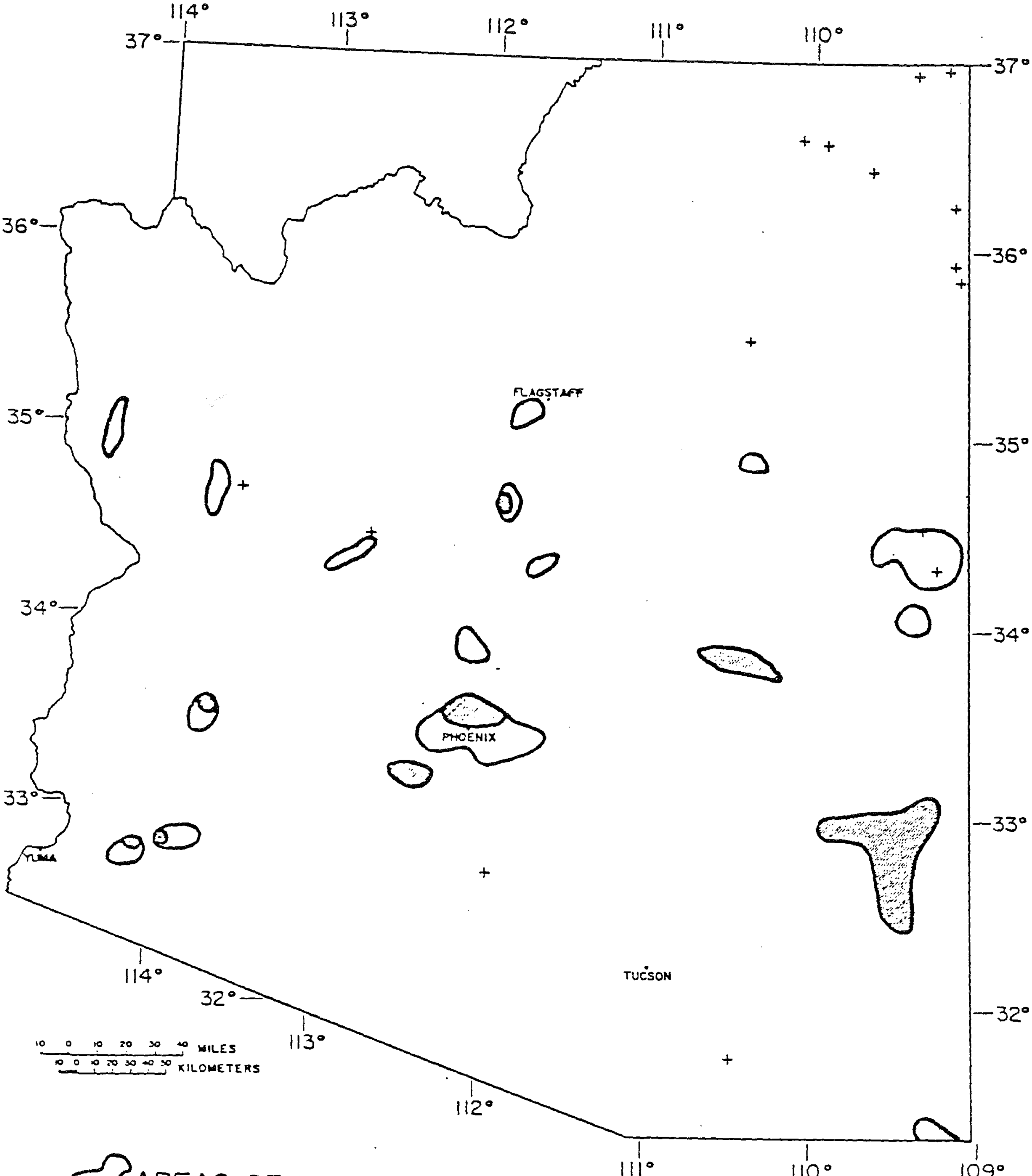
LEGEND

MAJOR GEOTHERMAL AREA DEFINED BY HIGH CHEMICAL GEOTHERMOMETERS

CENOZIC BASINS

APPROXIMATE MARGIN OF RELATIVELY DEEP BASINS

Figure 1.

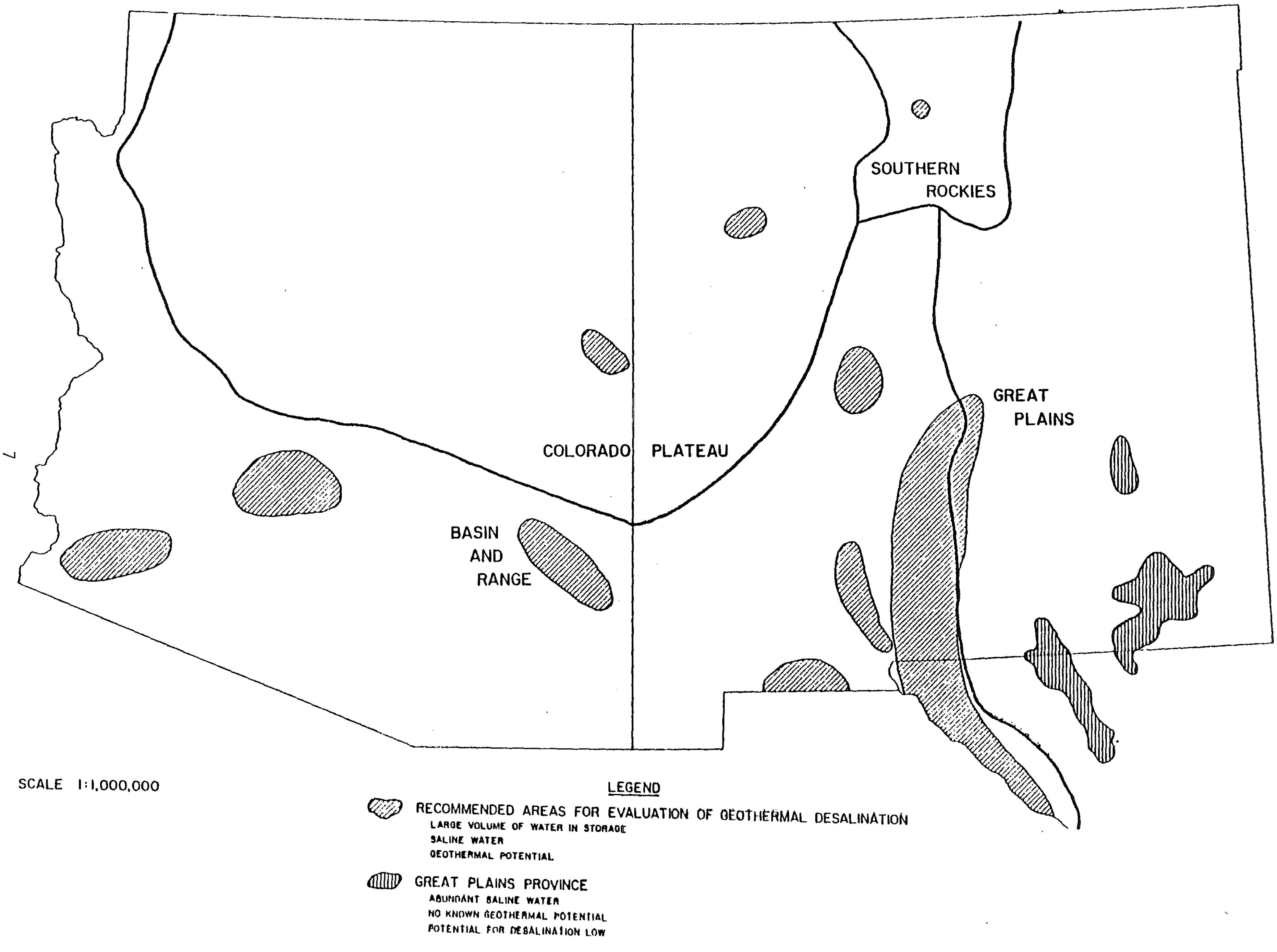


AREAS OF HIGH GEOCHEMICAL TEMPERATURES

AREAS OF HIGH GEOCHEMICAL TEMPERATURES INCLUDING Na-K-Ca-Mg

+ SINGLE HIGH Na-K-Ca-Mg GEOTHERMOMETERS

Figure 2.



SOUTHERN
ROCKIES
GREAT
PLAINS
COLORADO PLATEAU
BASIN
AND
RANGE
SCALE 1:1,000,000
LEGEND
RECOMMENDED AREAS FOR EVALUATION OF GEOTHERMAL DESALINATION
LARGE VOLUME OF WATER IN STORAGE
SALINE WATER
GEOTHERMAL POTENTIAL
GREAT PLAINS PROVINCE
ABUNDANT SALINE WATER
NO KNOWN GEOTHERMAL POTENTIAL
POTENTIAL FOR DESALINATION LOW

Figure 3.

Acknowledgement

We would like to thank A. Viescas for help with the computer programming and J. Gilkey for assistance in map preparation. Chemical analyses were performed by Andrew Bristol and his staff at the New Mexico State University's Soil and Water Testing Laboratory in the Department of Agronomy. The study was funded in part by U.S. Department of Energy, Division of Geothermal Energy, contract no. EG-77-S-02-4362.

References

Fernelius, W.A., 1975, Production of fresh water by desalting geothermal brines--a pilot desalting program at the East Mesa Geothermal field, Imperial Valley, California: Proceedings Second United Nations Symposium on the Development and Use of Geothermal Resources, U.S. Govt. Printing Office, Washington, D.C., p. 2201-2208.

Gerlach, T., Norton, D., DeCook, K.J., and Summer, J.S., 1975, Geothermal water resources in Arizona: Feasibility Study: Project Completion Report, U.S. Dept. Int., Office Water Res. Research Project A-054-Ariz., Washington, D.C., 36 p.

Hahman, W.R., Stone, C., Witcher, J.C., 1978, Preliminary Map: Geothermal Energy Resources of Arizona, Bureau of Geology and Mineral Technology Geological Survey Branch, Univ. of Arizona, Tucson, Arizona.

Ligner, J.J., White, N.D., Kister, L.R., and Moss, M.E., 1969, Water Resources: Mineral and Water Resources of Arizona, Ariz. Bur. Mines, Bull. 180, p. 471-569.

The National Atlas of the United States of America, 1970, Water Resources Section, U.S. Dept. of the Interior, Geological Survey, Washington, D.C.

Swanberg, C.A., Morgan, P. Stoyer, C.H., and Witcher, J.C., 1977, An appraisal study of the geothermal resources of Arizona and adjacent areas in New Mexico and Utah and their value for desalination and other uses.

Swanberg, C.A., 1979, Chemistry of thermal and nonthermal groundwaters in the Rio Grande rift and adjacent tectonic provinces: in R.E. Riecher (editor), Rio Grande Rift: Tectonics and Magmatism, American Geophysical Union, Washington, D.C.

Woodward, L.A., Callender, J.F., Seager, W.R., Chapin, C.E., Gries, J.C., Shaffer, W.L., and Zilinski, R.E., 1978, Tectonic map of Rio Grande rift region in New Mexico, Chihuahua, and Texas, New Mexico Bur. Mines and Mineral Res., circ. 163.