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# THE UTILIZATION OF GEOTHERMAL RESOURCES AT UNITED STATES AIR FORCE BASES

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## ABSTRACT

The use of geothermal energy is one of the few energy sources which may be an answer to our present and future energy crisis.

The Air Force installations on the continental United States as well as Alask and Hawaii, were evaluated as to the possibility of utilizaing geothermal energy to develop electricity, produce process steam, or heat and/or cool buildings. Twenty-five bases have suspected geothermal resources available. Because of either need and available technology seven installations were rated priority I, six were rated priority II and priority III and IV totaled ten.

Geological and geophysical data indicated further investigation of the priority I installations, Saylor Creek Range, Idaho, Ellsworth AFB, South Dakota, Charleston AFB, South Carolina, Kirtland AFB, New Mexico, Vandenberg AFB, California, Luke AFB, Arizona, and Williams AFB, Arizona, should be accomplished as soon as possible.

The use of geothermal energy will decrease the need for fossil fuels by the USAF and during times of short supply allow such fuels to be used for the Air Force's primary mission, military defense.

## INTRODUCTION

The United States Air Force (USAF) has become increasingly interested in developing alternative energy resources and lessening their dependence on unstable and decreasing energy sources. Since the mid-70's and the 1973 embargo of fossil fuels by OPEC.

Previous studies (1,2) have investigated possible geothermal areas in or near the following United States Air Force Bases: Dover AFB, Dover, Delaware; Mountain Home AFB, Mountain Home, Idaho; Kingsley AFB, Klamath Falls, Oregon; Bellows AFB, Waimanalo, Oahu, Hawaii, and Williams AFB, Chandler, Arizona.

## LOCATION AND EVALUATION OF POSSIBLE GEOTHERMAL AREAS ON AIRFORCE PROPERTY

Using previous knowledge of potential areas, the Known Geothermal Resource Area's (KGRA) of the United States Geological Survey (USGS) and material at the USGS geologic research libraries at Denver, Colorado and Reston, Virginia, a list of air bases that needed to be geologically evaluated was developed. Further geological and geophysical investigation of the geothermal potential determined whether they were of primary or secondary importance and separated the locations into their potential as to electricity, cooling, and/or heating and each of these categories were classified as to being an area of high, moderate, or low possibility. (Table 1)

The final analysis of the geothermal potential of USAF bases included an energy consumption and utilization review as well as a general economic evaluation. From this final analysis the air bases were again classified as to being a primary or a secondary prospect. Using this methodology, seven installations were considered to have a high possibility for utilizing geothermal resources in one or more ways: Ellsworth AFB, South Dakota; Saylor Creek Range, Idaho; Williams AFB, Arizona; Kirtland AFB, Albuquerque, New Mexico; Vandenberg AFB, Lompoc, California; Charleston AFB, Charleston, South Carolina; and Luke AFB, Phoenix, Arizona.

Further geologic investigation, remote sensing as well as initial geophysical and geochemical studies of seven of the eight high possibility bases, excluding Williams AFB, will be attempted during the 1980-81 period, as funding for such research is obtained. If enough funding is obtained, six other bases will also be investigated further: Mountain Home AFB, McClelland/Mather AFB's, Sacramento, California; Davis-Monthan AFB, Tucson, Arizona; Edwards AFB, Rosamond, California; Holloman AFB, Almogordo, New Mexico; and Bellows AFB and Wheeler AFB, Hawaii.

Specific data obtained, economic feasibility, and the type of geothermal resourc(s) available are listed in Table 2. During the time this report was written, no magma or vapor-dominated geothermal systems have been positively identified; Keesler AFB, Mississippi and Ellington AFB,

TABLE 1. A TIME REVIEW OF THE DETERMINATION OF THE POSSIBLE UTILIZATION OF GEOTHERMAL RESOURCES AT UNITED STATES AIR FORCE BASES

| Air Base Possibility List | Intensive Geologic Research | Further Earth Science Review, Phone Calls&Visits | After Base Energy Consumption & Utilization Review |
|---|---|---|---|
| Dover | S[1] | L[4] | No |
| Ellsworth | S | G (heating) | P[1] |
| Mtn Home | S | M (heating) | P |
| Saylor Creek | P | M (electricity) | P[6] |
| Williams | P[2] | G (electric/cooling) | P[6] |
| Keesler | S | L | S[3] |
| Davis-Monthan | P | M (cooling) | P |
| Edwards | P | H (heating)<br>M (cooling) | P |
| George | P | M (cooling) | S |
| Hickam | P | L | No |
| Holloman | P | M (cooling) | P |
| Kingsley | P | H (heating) | S |
| Kirtland | P | G (cooling) | P |
| March | S | M (cooing) | S |
| McClellan/ Mather | P[3] | | |
| Norton | S | M (cooling) | |
| Vandenberg | P | M (cooling) | P |
| Wheeler | S | M (cooling) | S |
| Langley | P | M (heating) | S |
| Charleston | P | H (cooling) | P |
| Ellington | | H (electric)[4] | |
| Luke | | H (cooling) | P |
| Bellows | | M (electric) | P |
| Offutt | | M (heating) | S |

Genoa, Texas, are located above geopressed systems. McClellan and Mather AFBs, Sacramento, California may be located on a geopressed system. The seven possible hot dry rock sytems are indicated in Table 2. To develop the hot dry type of geothermal resource, assistance from the Department of Energy's Hot Dry Rock section at Los Alamos Scientific Laboratories will be necessary. The primary geothermal system found at USAF bases is the water-dominated system with fourteen of the twenty-five bases having a strong possibility of such a system being utilized.

Electrical production may be possible at five bases: Saylor Creek, Davis-Monthan, Bellows, Luke, and Williams AFBs. With further technological advances the possibility of electrical productions at six other bases could become reality: Charleston, Kirtland, Edwards, Vandenberg, Kessler, and Ellington AFB's.

The final rating of priority for further investigation of Air Force installations is illustrated in Table 3. The priority listing is based on geothermal resource data and the need for geothermal utilization.

TABLE 2. FACTORS CONSIDERED IN DETERMINING THE POSSIBILITY OF GEOTHERMAL UTILIZATION AT US AIR FORCE BASES

| Air Base | Location | Command | Type of Geothermal Resource[1,2,] | | | | Economics | | | Type of Fuel and amount of energy used[5,6] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vapor-dominated | Water-dominated | Hot dry rock | Geopressed | Economic | Marginal | Submarginal | Electricity | Fuel oil | Natural gas | Propane | Coal |
| 1. Mtn Home/ | Mtn Home, | TAC | Possible | 100°C at 4Km | | | Heating | | | 572,704 | 155,016 | 57,844 | | 336,236 |
| 2. Saylor Creek[7] | ID | | | 100°C to 200°C at 4Km | | | Electric | Electric | | 583,004 | 121,573 | 5,930 | | 324,564 |
| 3. Dover | Dover, DE | MAC | | 48°C at 1Km | X | | | | | 699,352<br>801,479 | 698,256<br>754,629 | | | |
| 4. Ellsworth | Rapid City SD | SAC | | 40°C at 1Km | | | Heating | | | 846,928<br>865,476 | 18,059<br>77,846 | 893,473<br>889,941 | 398<br>0 | |
| 5. Kingsley | Klamath Falls, OR | ADC | | 30°C at 1Km | | | | Heating | | 200,635<br>190,565 | 12,334<br>9,148 | | | 105,139<br>52,511 |
| 6. Davis-Monthan | Tucson, AZ | TAC | | 126+°C at 1Km | | | Cooling | Electric | | 877,575<br>963,508 | 4,479<br>7,992 | 348,754<br>301,611 | | |
| 7. Hickam[8] | Honolulu, Oahu, HI | PACAF | | | | | | | | 1,690,526<br>1,611,658 | 64,471<br>26,108 | | 27,067<br>21,317 | |
| 8. Wheeler[8] | Wahiawa, Oahu, HI | PACAF | | | | | | | Cooling | | | | | |
| 9. Bellows[8] | Waimanalo, Oahu, HI | PACAF | | | | | | Electric | | | | | | |
| 10. Langley | Hampton, VA | TAC | | 41°C/700m | | | | | Heating | 1,019,488<br>1,227,036 | 652,423<br>653,140 | 97,266<br>102,421 | 1,185<br>1,289 | |
| 11. Charleston | Charleston, SC | MAC | | 60°C at 1Km | X | | Heating | Cooling | | 593,421<br>685,444 | 499,034<br>279,870 | 103,205<br>117,100 | 17<br>14 | |
| 12. Holloman | Alamogordo, NM | TAC | | | X | | | Heating | Cooling | 697,857<br>750,137 | 624<br>334 | 596,459<br>605,148 | 4,426<br>2,062 | |
| 13. Kirtland | Albuquerque, NM | MAC | | 32°C at 500m | | | Heating | Cooling | | 1,184,940<br>1,007,680 | 24,390<br>16,712 | 920,259<br>775,271 | 9,384<br>6,034 | |
| 14. Edwards | Rosamond CA | AFSC | | 85°C-90°C at 2Km | Possible | | Heating | Cooling | | 1,270,327<br>1,321,668 | 72,779<br>23,157 | 722,012<br>592,484 | 12,259<br>6,200 | |
| 15. George | Victorville CA | TAC | | 30°C | Possible | | | Heating | Cooling | 482,189<br>503,347 | 4,937<br>22,095 | 483,108<br>381,915 | 1,336<br>1,310 | |
| 16. McClellan/ Mather | Sacramento CA | AFLC/ ATC | | | | X | | Heating | Cooling | 2,057,934<br>2,090,274 | 11,653<br>83,388 | 1,393,666<br>1,121,575 | 2,243<br>3,031 | |
| 17. March | Riverside CA | SAC | | | Possible | | | | Heating | 533,924<br>521,722 | 20,214<br>16,379 | 296,528<br>244,887 | 351<br>0 | |
| 18. Norton | San Bernardino, CA | MAC | | 35°C | | | | | Heating | 801,352<br>813,902 | 32,747<br>44,988 | 475,881<br>408,392 | | |
| 19. Vandenberg | Lompoc, CA | SAC | | 25-35°C | | | | Cooling | | 1,589,720<br>1,456,786 | 207,104<br>267,509 | 800,338<br>645,080 | 12,515<br>13,141 | |
| 20. Keesler | Biloxi, MS | ATC | | | | 100°C at 4Km | | Cooling | | 1,727,089<br>1,697,253 | 844<br>204 | 967,798<br>955,730 | | |
| 21. Ellington | Genoa, TX | | | | | 200°C at 4Km | Cooling | | | 294,675<br>144,107 | | 96,482<br>59,727 | | |
| 22. Luke | Phoenix, AZ | TAC | Possible | 150°-200°C at 3Km | | | Cooling | Electric | | 701,522<br>827,451 | 30,116<br>38,479 | 390,799<br>364,043 | 2,738<br>2,838 | |
| 23. Offutt | Omaha, NE | SAC | | | X | | | Heating | Cooling | 1,558,054<br>1,730,058 | 46,518<br>187,535 | 1,151,829<br>1,076,369 | | |
| 24. Williams | Chandler, AZ | ATC | | 200°C at 3Km | | | Cooling | Electric | | 524,320<br>573,191 | 691<br>504 | 197,059<br>158,768 | 408<br>408 | |

1 Temperature/depth is given if known or can be estimated.
2 Magma is not listed as it is not known on any bases.
3 Use is listed.
4 If resource is available.
5 Figures are in MBTU's.
6 Upper figure is for 1975; lower is for 1978.
7 Mountain Home & Saylor Creek fuel amounts are totaled together.
8 Fuel amounts for all three bases in Hawaii are totaled and presented as Hickam AFB energy use.

TABLE 3.

RELATIVE PRIORITIES FOR EXPLORATION AND UTILIZATION OF AIR FORCE LANDS

| Air Base | Resource Temp °C | Thermal Grad °C/Km | Depth to Prod Km | Need | Assessed Priority[1] |
|---|---|---|---|---|---|
| Mtn Home | 100 | 4-60 | 4 | Low | II |
| Saylor Creek Range | 100-200 | 50-90 | 3 | Low | I |
| Dover | 48 | 38 | 1 | Moderate | IV |
| Ellsworth | 50 | 31-45 | 1.35 | High | I |
| Kingsley | 30 | UK | 1 | Very Low | IV |
| Davis-Monthan | 130 | 50 | 1 | Moderate | II |
| Hawaiian bases | UK[2] | UK | UK | High | II/III |
| Langley | 41 | 41 | .07 | High | III |
| Charleston | 60 | 60 | 1 | Moderate | I |
| Holloman | 40 | 32 | 3 | High | II |
| Kirtland | 60 | 80 | 1 | Very High | I |
| Edwards | 85-90 | 45 | 2 | Very High | II |
| George | 30 | UK | UK | Moderate | III |
| McClellan/ Mather | UK | UK | UK | Very High | II |
| March | UK | UK | UK | Moderate | IV |
| Norton | 35 | UK | UK | High | III |
| Vandenberg | 25-35 | 40 | 2 | Very High | I |
| Keesler | 100 | 30 | 4 | Very High | III |
| Ellington | 200 | 35 | 5 | Very Low | IV |
| Luke | 150-200 | 60 | 3 | High | I |
| Offutt | 35 | 35 | 1 | Very High | III |
| Williams | 200 | 85 | 3 | Moderate | I |

1 I (highest priority) - - IV (lowest priority)

2 UK = Unknown

## RECOMMENDATIONS

The geothermal community is recognizing only one member of the Department of Defense (DOD) as being seriously interested in geothermal energy, the United States Navy. This is due to the work completed during the investigation of the Coso Springs geothermal area of California. The development of this area has been much slower than originally planned because of several factors concerning resource quality and quantity.

The large variety of and the potential for geothermal resources available for USAF utilization is the greatest for any of the United States military agencies. The following recommendations are presently being used to assist the USAF in the goal of investigating, developing and utilizing geothermal resources.

1. Develop funding for geothermal research and development.
2. Make the geothermal community aware of the Air Force's interest in geothermal resource utilization.
3. Make the United States public aware of the Air Force's interest in geothermal energy. In recruitment advertising show the need for energy awareness and the possibility of learning about energy and the career possibilities in energy fields.
4. Use the information presented in this report to develop a specific timetable for a geothermal energy program.
5. New legislation dealing with geothermal energy in the Congress should be followed carefully and comments made to the appropriate members to enhance the Air Force's geothermal program.
6. Air Force/DOD should plan for eventual tie-in to existing power grids in order to wheel power from an Air Force/DOD geothermal-electric plant to other installations. The assumption is made that one or more DOD installations will eventually be producing geothermal-electric power excess to local base facility energy needs. To provide the most economical use of the excess capacity, arrangements could be made for feeding power into existing power grids for wheeling to other DOD installations.

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