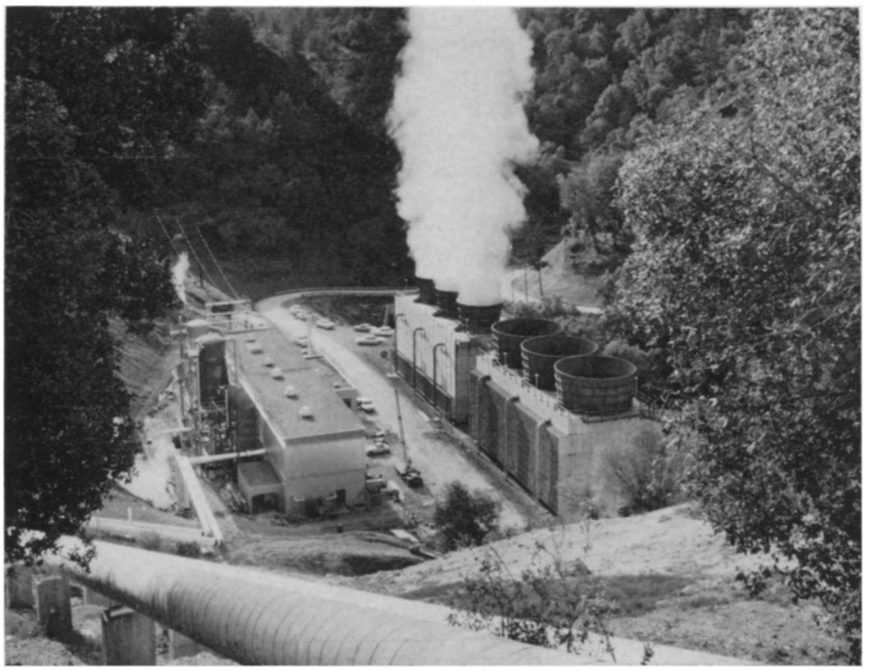
The earth's heat: A new power source

Geothermal reservoirs in the West may provide nonpolluting energy

by Richard H. Gilluly



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Pacific Gas and Electric's plant at Geysers, Calif.: 600 megawatts by 1975.

The current short-term energy crisis (SN: 11/14, p. 379), the long-term finiteness of fuel resources and the increasing success of environmentalists in stalling the building of new generating plants are causing utility engineers to look more and more to geothermal reservoirs as a possible source of electrical energy. Tapping these naturally occurring pools of hot water beneath the earth's surface would cause few of the pollution problems created by conventional or nuclear generators and could supply huge quantities of energy.

Most geothermal development to date has been in nations such as Japan and Italy where there is a shortage of fossil fuels. But the picture is changing rapidly.

"The United States has not been so hungry for sources of energy other than fossil fuels or the atom," says an Interior Department official. With the increasing emphasis on environmental pollution, however, a new attitude is developing toward geothermal power, he says. Engineers who once scoffed at it as a pipe dream are now taking a second look. And the increased interest is reflected in activity such as the formation of new companies devoted to geothermal prospecting, as well as in new interest by giant energy firms. The United States Tax Court has declared geothermal resources eligible for a percentage depletion allowance of the kind that has made oil companies the envy of other energy producers.

Another large stimulus has come from a report this year from the University of California at Riverside. The report concerns itself with a single geothermal site, California's Imperial Valley (SN: 2/1/69, p. 113). It indicates that if the geothermal resources there were fully utilized, 20,000 to 30,000 megawatts of electric generating capacity could be installed. Other nations—both those traditionally interested in geothermal power and some newcomers to the field—are also taking a new look at geothermal resources, and the Soviet Union is now carrying out wide-scale mapping of temperature gradients to discover the best areas for geothermal prospecting.

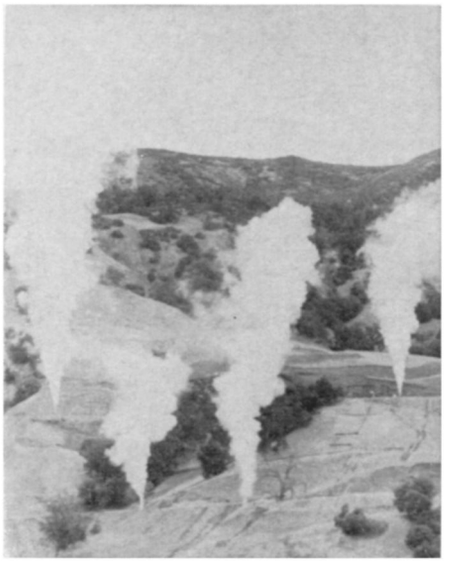
The source of geothermal energy is the molten rock, or magma, in the earth's interior. When underground water comes into contact with the magma, hot water and steam are produced. Among the conditions necessary for the existence of a tappable source of geothermal energy are a large chamber of magma relatively close to the surface and large and porous underground reservoirs with channels connected to the heat source. Where these conditions exist, as in Imperial Valley, wells of a depth within the means of current technology will produce geothermally heated water. There is also a possibility, not yet fully confirmed, that the geothermal energy might be a self-renewing resource.

Dr. Robert W. Rex, director of the UC study, estimates the average cost of the thermal energy to be about two cents per million British thermal units, compared with the 20 to 30 cents and more that energy from fossil-fuel or nuclear sources costs.

Capital costs involved in developing this energy for power would probably be comparable to those for ordinary fossil-fuel plants. The same turbine-generator arrangement would be used. Substituting for the boiler of fossil-fuel plants and the reactor and heat exchanger of nuclear plants would be wells and flashing units that would collect the hot water and steam from the geothermal reservoirs and convert it to the clean, dry steam—with no condensed water in it—necessary for electric generation.

The Imperial Valley geothermal resource became more attractive when the salinity of most of the geothermal reservoirs was shown to be lower than earlier thought. The brine, largely sulfate free, of those portions of the Imperial Valley sources not near the Salton Sea has a relatively low salt content of 1.5 to 2.5 percent. In the ground, the brine has a temperature of 500 degrees F. and a pressure of about 2,000 pounds per square inch. About 20 percent of this brine can be converted in flashers to the hot, dry steam needed for power production. But there is enough heat in the remaining brine to distill about 90 percent of it into fresh water before the dissolved solids begin to precipitate in the residue. The leftover, highly concentrated brine can be pumped into wells isolated from the useful geothermal reservoirs. With full use of the capacity of the Imperial Valley resource, it might be possible to produce 5 million to 7 million acre-feet of fresh water annually from the wells—a valuable by-product for irrigation and other uses in the water-short lower Colorado River Basin.

Generally speaking, any thermal electric power plant is most useful for producing base-load power, or meeting constant demand. It takes a long time to heat up a boiler and turbine, and the



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Steam wells vented for cleaning.

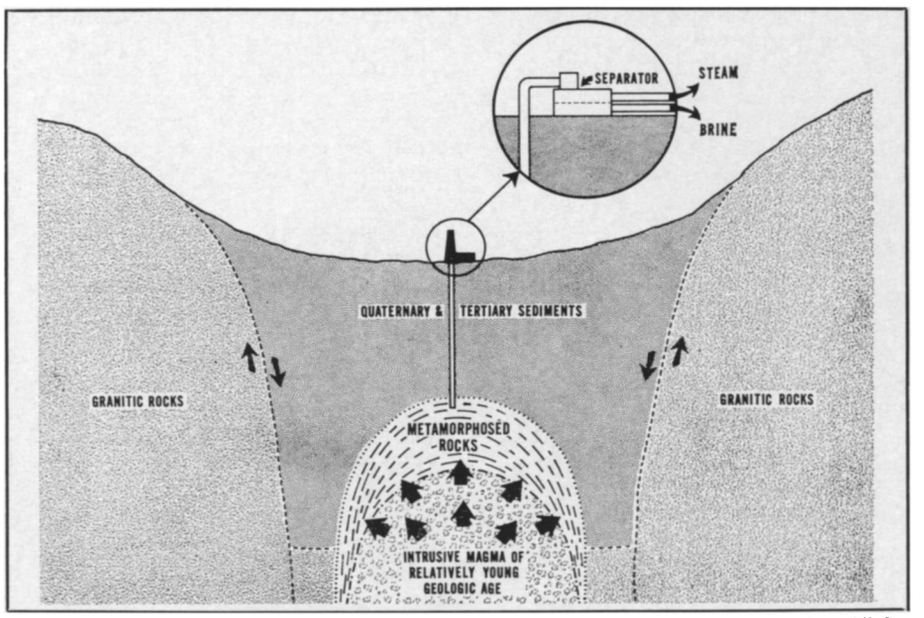
thermal plants cannot be as flexible in adjusting to fluctuating needs as hydroelectric plants, which can be turned on or off with the flick of a switch. However, says Dr. Jim Combs, a member of Dr. Rex's team, the geothermal plants might be made far more responsive than the usual thermal plant. They do not rely on boilers, and by hooking in additional, standby wells, it might be possible to use them for producing peaking power. Since the economics of the power business are such that the costs of amortizing the necessary capacity—including standby—are often a larger part of the cost of electricity than is the cost of the energy itself, this possibility could make the geothermal resources yet more valuable.

Pacific Gas and Electric Co. in northern California today is the only United States commercial producer of geothermal power, although there have been geothermal plants in Italy and New Zealand for some years, and Mexico and Japan are also operating or installing plants. The present PG&E plant, located at Geysers in northern California, is relatively small, but the company plans to have an installed geothermal capacity of 600 megawatts by 1975, making the geothermal resource a major part of its total installed capacity.

There are a number of other companies interested. Union Oil Co., Signal Oil Co. and Occidental Oil Co. have geothermal holdings. But, according to Dr. Combs, it is likely that smaller companies will do the initial development work.

Already there are several companies in the United States working on geothermal power. One, the Magma Power Co., has a small pilot plant in Brady, Nev., using a system of heat transfer that eliminates some of the possible disadvantages of geothermal power. The system brings hot water and steam from a geothermal reservoir to the surface, but the steam itself does not actually operate the power plant. Instead the steam and hot water are used to heat isobutane—and the isobutane turns the plant's turbine. Then the hot water is pumped back into the reservoir.

Dr. Dallas Peck, the U.S. Geological Survey's assistant chief geologist for geochemistry and geophysics, says that such a heat transfer system eliminates two possible sources of environmental damage: leftover brine, which in some cases might be toxic and difficult to dispose of, and possible sinking of the ground caused by removing the subsurface water. Dr. Peck says Russian engineers are experimenting with a similar heat transfer system, using Freon instead of isobutane.



Pure Oil Co.

Imperial Valley formation: Magma heats water, producing steam for power.

Holding up major development in the United States right now is lack of a clear-cut policy for leasing of geothermal resources on Federal lands—where most of these resources are found in the 11 Western states. But a bill establishing leasing policies is now in conference committee and is expected to pass this session. The bill will free one million acres having a rich geothermal potential that were set aside in the 11 states by the USGS in 1966 due to the lack of clear legislative mandate for leasing.

The magnitude of geothermal power development in the United States after passage—if the bill is not vetoed by President Nixon as an earlier one was by President Johnson—is difficult to assess, although there is bound to be significant development. Companies are far more conservative in their estimates than Dr. Rex, but, because they want the bill to secure the lowest possible rates, they would naturally take such a stand. Dr. Donald White of the USGS estimates a total potential of from 15,000 to 30,000 megawatts throughout the West. And Reid Stone of USGS suggests that the power plants will be large enough to serve only local needs—although he concedes that such local needs will sometimes be nearly equal to the power needs of cities the size of San Francisco.

However, Stewart French, a lawyer with the Senate Interior Committee, believes that geothermal power will become a source of energy of national significance. The Federal Power Commission, in testimony on the bill, agreed.

The international importance of geothermal power is growing, too. United Nations technical assistance teams have traveled to 19 countries to assess geothermal resources. More detailed assessment is going on in Chile, El Salvador and Turkey. Dr. Peck points out that geothermal power may be particularly useful to underdeveloped nations in Central America and East Africa that lack fossil fuels and thus are badly hindered in industrialization efforts.

Geothermal power is not entirely without environmental impact. It is impossible to produce power without giving off waste energy, and waste heat from power plant condensers—even those which use Freon or isobutane—will have to be discharged either into waterways or the atmosphere. But advocates have no doubt that this is a minor impact contrasted with air pollution created by fossil-fueled plants. The outlook is for major development of geothermal resources soon. □