Power From the Salton Trough

California's Imperial Valley contains a strategically located geothermal resource. A group from the Lawrence Livermore Laboratory is working on ways to tap it.

by Dietrick E. Thomsen

The heat within the earth manifests itself at the surface in a number of ways, some of them quite spectacular. Volcanoes, geysers and hot springs all testify to its existence. Historically mankind has used geothermal resources variously. Geysers and volcanoes—when they weren't burying cities—have long been tourist attractions. Hot springs attract those seeking therapy for their aches and pains. In Iceland, where there is a shortage of both fossil fuels and firewood, the inhabitants have learned to use geothermics for various things, from heating buildings to boiling the wash.

Lately there is a good deal of interest—in many countries besides Iceland—in using geothermal resources to produce electric power. The places where systems are under study or experiment include Italy, New Zealand, Mexico and the United States.

One of the potentially richest and most strategically located of American geophysical resources lies in the Imperial Valley—Salton Sea area of California. The valley lies near one of the largest population concentrations in the country, the Los Angeles–San Diego area, which has a ravenous appetite for electricity. According to a group of scientists and engineers from the Lawrence Livermore Laboratory who are working on a project to tap the resource, the valley's hot brine wells, if properly utilized could supply southern California's power needs for a few decades at least.

The Imperial Valley gets its geothermal resources probably in large measure because it lies along the boundary between two geotectonic plates, the North American and the Pacific. The East Pacific Rise, which is the plate boundary, is mostly underwater. However, it comes up the Gulf of California and strikes land in Mexico, running up the Mexicali Valley, site of Mexico's Cerro Prieto geothermal area, and the Imperial Valley, and cuts north by northwest across California to go back to sea somewhere around Cape Mendocino. The famous San Andreas fault is one of its geological manifestations.

The uplift and lateral spreading characteristic of the plate boundary cause the formation of a trough in the surface and the upwelling of hot magma into contact with crustal rocks. Such a procedure is seen by geophysicists as the basis of volcanism, and there is plenty of evidence of volcanism in the valley. If water seeps down into contact with the hot rocks, geysers and hot wells can result.

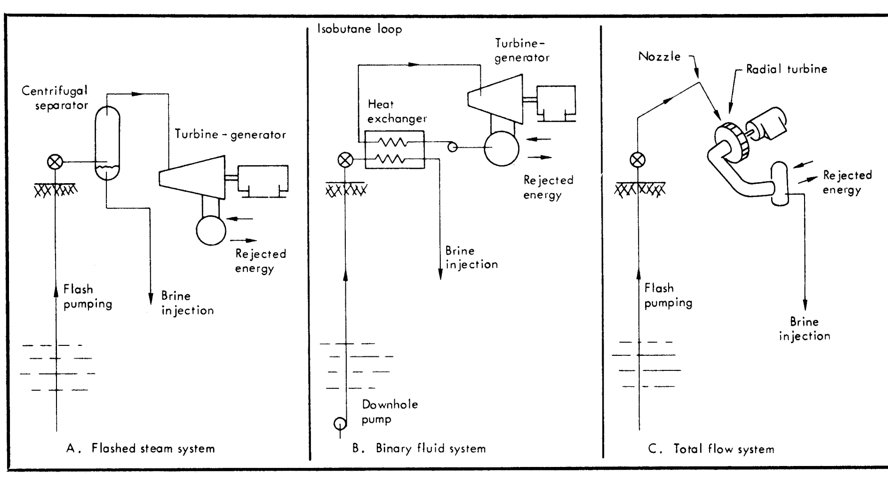
The Imperial Valley's brine is apparently made from water that runs off mountains around the valley and possibly from some that seeps in from the Colorado River. Thus, the meteorlogical water cycle continually replenishes the brine deposits.

A report to the U.S. Atomic Energy Commission by A. L. Austin, G. H. Higgins and J. H. Howard stresses that "The most important point regarding the mechanism for generating geothermal heat in the Salton Trough is that the 'motor' driving the system is of global proportions. It is virtually certain that it will continue to maintain the fundamental geothermal system of the Salton Trough for an indefinitely long period despite any exploitation of this resource. The regeneration rate is presently unknown, however."

What this means is that the heat is likely to be there for aeons. If water drains into the brine deposits fast enough to compensate for what is removed, use of power plants could go on for a long time. Just counting on the water believed to be in the reservoir now, Austin, Higgins and Howard conclude: "It appears reasonable . . . that the Salton Sea geothermal area reservoir could produce satisfactorily over the 20-year time span needed to justify the costs of construction of electric power plants." Four thousand wells would give a theoretical power capacity of 92,000 megawatts for 20 years. At present the total electrical capacity of the United States is about 340,000 megawatts, so it is clear that the Salton Sea area could supply a large chunk of power.

To put the numbers another way, Anders W. Lundberg, who quotes a more conservative estimate of 60,000 megawatts for 20 years, says that that could supply all of southern California's needs at the 1972 consumption rate. Since two-thirds of California's power is produced by burning fossil fuels, those fuels would be available for use elsewhere.

But the brine of the Salton Sea area presents very stringent chemical and physical conditions for engineering. Its temperature and salinity are both more extreme than those in many other places where geothermal engineering is under consideration. Technology successful here might be easily exportable to locations where requirements are not quite as severe. It should be pointed out that there are competing approaches under study elsewhere that may also prove widely feasible.



Austin, Higgins, Howard


Pictogram Co.

Women of Reykjavik use, or used to use, the geothermal energy of a natural hot spring to get the dirt out of their laundry.

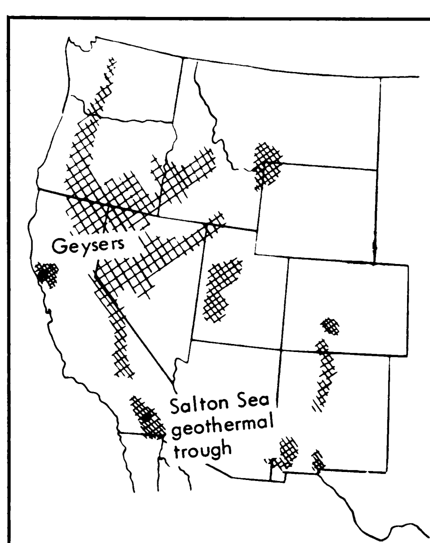
Nobody would want to boil the wash in the Salton Sea brine. Its salinity is 25 percent by weight (compared to 3.5 percent for seawater). In addition to sodium chloride it contains chlorides of 13 other elements. It comes up from thousands of feet below the surface (4,000 to 16,000 depending on location) at temperatures around 300 degrees C. It is highly corrosive, will deposit scale on iron surfaces and may saturate and deposit salts.

There are basically three ways of taking something like this and using its heat to make electricity. One now in use at Cerro Prieto in Mexico, begins by allowing the brine to flash. That is, the sudden reduction in pressure as the brine rises in the well causes part of the superheated water to vaporize instantly. The steam is run through a turbine connected to an alternator; the remaining brine is conducted away. The method reduces corrosion problems in the turbine so that conventional turbines may be used, but at the cost of losing a good deal of heat carried by the rejected brine.

A second method is to run the hot brine through a closed-circuit heat exchanger, in which the brine gives up heat to a second fluid (isobutane or freons, perhaps), and the second fluid drives a turbine. This too gets rid of some corrosion problems, but at the cost of some efficiency.

"We are going after total flow," says Lundberg. That means taking what comes out of the wellhead, a mixture of steam and hot brine and shooting it into a turbine. One gets a higher efficiency this way—Lundberg estimates 60 percent greater utilization of available energy than by other means—but the engineering of turbines that can take it is a formidable problem.

At these temperatures and with such a mix of driving substances tolerances of moving parts become ticklish. Then one must also coat the surfaces with a substance that will withstand the effects of the brine. "The only materials surely corrosion-resistant to the Salton Sea brine are ceramics, tantalum, plastics and perhaps zirconium," Austin, Higgins and Howard conclude. They note that Teflon or similar high-temperature plastics may prove satisfactory.



Austin, Higgins, Howard

Geothermal resource areas in the U.S.

The work is moving forward steadily. In a trailer at Livermore, the visitor can see a tabletop model of the turbine arrangement. Under construction at the laboratory is a test facility to try out turbine nozzles and blades. It will be used with naturally clean water at near 300 degrees C. to study the physics of the problem separately from the chemistry. It is expected to be in operation by early fall says Cecil C. Gardiner Jr. Meanwhile there are groups in the field studying aspects of the chemistry and geology.

By the end of fiscal year 1975 Lundberg expects to show a 100-kilowatt capacity machine and run it at Livermore and somewhere in the field. By fiscal year 1980 he wants to have a 10-megawatt system in the field. This would be a field experimental facility capable of facing all problems but small enough not to be too expensive. If this works, the project will then go on toward commercial production: A 200-megawatt plant would be the minimum to justify constructing transmission lines over the mountains to the coastal cities. At that point the technology could be transferred to commercial interests.

The day may never come when you can plug your electric razor into Old Faithful. That geyser is likely to remain a cherished tourist attraction. But there may be a day when a transformer station in Los Angeles could be inscribed: "This electricity comes to you courtesy of the East Pacific Rise." □