GEOPHYSICS

Uncorking Earth's Steam Kettle

Combining the fiery heat of the volcano with the wild beauty of a geyser, geothermal steam has become a valuable natural resource for many nations and a cheap power source.

"IT'S A STRIKE!"

A tense group of oil men heard the familiar rumble far beneath the earth's surface as the well started to come in. Excitement mounted.

Released from the earth's pressure by the drill, a gusher erupted into the air. Suddenly surprise wiped every other expression from their faces. The gusher was not oil, but steam!

The wildcat well was soon plugged in and abandoned. But the accidental discovery revealed a valuable natural steam field, about 15 miles square near the Salton Sea in California's Imperial Valley.

This one field, discovered in 1958, may someday generate hundreds of thousands of kilowatts of electricity for the entire Southwest.

Low-Cost Power Source

Nations all over the world, worried about the cost and declining reserves of fossil fuels, are turning to the earth's free heat as a low-cost power source.

Italian steam wells, which have been in operation 60 years, generate more than 300,000 kilowatts of electric energy to run trains in the Italian state railway system.

Natural steam wells heat more than half the homes in Reykjavik, the capital of Iceland, where the cost of importing fossil fuels is high. They also heat indoor swimming pools and greenhouses, as vegetables and flowers must be grown indoors instead of out. The overall amount of geothermal power used in Iceland would be equivalent to 160 metric tons of petroleum per day.

Steam wells at Wairakei, New Zealand, produce almost 200,000 kilowatts of electricity to heat hospitals, hotels, high schools. The Japanese once used geothermal heat to produce salt by evaporating the seawater. More than 21,000 pounds of salt were produced yearly.

Other areas of the world where fertile steam fields exist include Alaska and Hawaii, as well as Central and South America, Indonesia, Russia and other countries where volcanoes have been active recently.

The steam itself is found in the earth's crust where molten rock, or magma, ordinarily formed at great depths, has worked its way close to the surface to produce volcanic activity.

Even after a volcano quiets down, the buried molten rock gives off heat that slowly works its way to the surface and into the atmosphere. If a fault, or crack in the earth's structure, crosses a section of this shallow molten rock, the heat rises rapidly along this new channel to the surface.

When this happens, ground water surrounding the magma and the hot volcanic gases mix together. Sometimes the combination produces superheated or "dry" steam and sometimes a "wet" steam, consisting of steam and hot water. The steam penetrates the surface through geysers, fumaroles (natural chimneys) and hot springs.

As the hot water and steam rise, the heavier, colder water near the surface flows downward to be heated in turn, thus forming a huge natural heat-convection system and a valuable power source.

The free heat provided by the earth can be harnessed to a turbine-generator unit, which provides power in the same way as steam produced in a boiler with gas or oil. Electric energy generated by natural steam is called geothermal power.

Geothermal power is particularly valuable in the California-Nevada area where water is scarce. Once the heat is used by the turbine, the water that condenses is valuable for chemical use or in irrigation.

Other substances occasionally come up with the steam and have to be removed. For example, in Larderello, Italy, ammonium bicarbonate, boric acid, borax, carbon dioxide and other chemicals are extracted as by-products from the steam.

A mile-deep well in the Salton Sea area drilled in 1962 tapped a volcanic-like water rich in potassium and lithium.

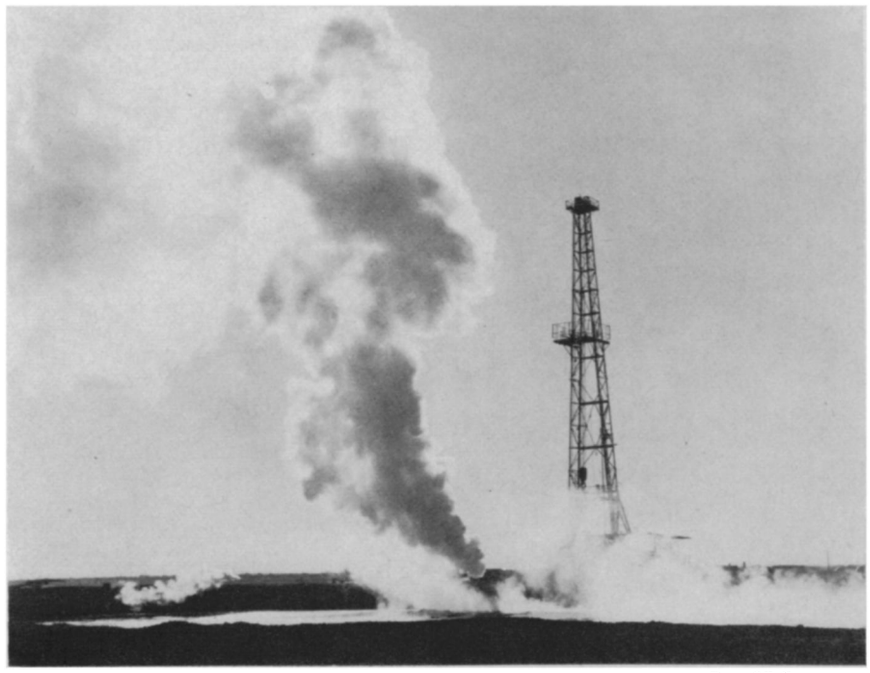
Normally, the reservoirs of fluid contain water that has filtered down from above. A study of carbon-14 isotopes in the Steamboat Springs, Nev., thermal system has shown the descending water spends at least 30,000 to 300,000 years underground.

Although the minerals are valuable themselves, geologists believe this is man's first sample of an "active" ore solution and may show them how the world's concentrations of ore metals were formed many years ago.

Because the temperatures at the bottom of the wells are so high—believed to exceed 800 degrees Fahrenheit—young, sedimentary rocks may be changing into metamorphic rocks at high enough levels for scientists to study. These processes normally occur 25,000 to 30,000 feet below the surface.

Geysers, fumaroles and hot springs have fascinated man for centuries, both for their healing powers and as unusual natural phenomena. But the real story of harnessing natural steam for power began in Larderello in 1904.

Once only a barren, inhospitable region reeking of hydrogen sulfide, covered with



Pure Oil Company

FUEL FROM THE EARTH'S FURNACE—Uncapped steam from River Ranch No. 1, the world's deepest steam well, located near Brawley, Calif., explodes into the air in all its glory from 8,100 feet deep in the earth. Steam from the well, which was drilled by Earth Energy, Inc., Brawley, Calif., a subsidiary of the Pure Oil Company, must first pass through a separator to remove the rich mineral brine that comes up with the steam.

ground pools of boiling water and over all a mass of heavy steam, Larderello became a popular spot in 1846. A French family, de Larderel, obtained permission from the Grand Duke of Tuscany to exploit the condensation pools (lagoni) for natural boric acid.

More than half a century later, a small dynamo, coupled with a three-fourth horsepower generator, fed five electric light bulbs. For the first time in history, light was produced from natural steam.

Drilling Began in 1921

The United States became interested and first drilled for steam in 1921. The Geysers, a resort spa famous for its hot springs and steam vents, about 75 miles north of San Francisco, was selected. Enough steam was found to make the project feasible, but there was no market for steam at that time and it was abandoned.

Thirty years later, aroused by the success of geothermal power in Italy and New Zealand, United States interest in drilling for steam revived. Today more than 40 wells have been drilled in California alone and potential thermal areas studied in most of the western states.

Since June 1960 steam wells at The Geysers, owned by Magma Power Company and Thermal Power Company, Los Angeles, have been producing 250,000 pounds of steam an hour to operate a 12,500 kilowatt plant for the Pacific Gas and Electric Company, San Francisco. It is enough to serve a community of 50,000 people. It would require 1,680 barrels of oil or 10 million feet of gas per day to generate an equivalent amount of electricity.

The hottest and deepest steam well in the world, River Ranch No. 1, is located in the Salton Sea area. Earth Energy, Inc., Brawley, Calif., a subsidiary of Pure Oil Company, Palatine, Ill., drilled the well to a depth of 8,100 feet, finding a brine rich in minerals in the process.

Although drilling for steam is very much like drilling for oil, equipment has to be somewhat altered to withstand the volcanic heat which produces the steam.

Special geochemical and geophysical prospecting methods are being developed to locate thermal areas, decide where and how deep to drill and find out if there is enough steam to make the project economical.

By analyzing chemicals and minerals present in the steam when it reaches the surface, scientists can estimate the temperatures and depths at which steam exists.

Major Power Source

Geophysical methods include gravity and magnetic surveys which locate thermal areas and heat sources buried within; temperature surveys to determine where to drill; and electric resistivity surveys which outline the major faults in the geologic structure.

Geothermal heat as a future major power source is still in the pioneering stage. Although the steam cannot be transported very far from the steam fields to be turned into power, any populated areas or industries can benefit from geothermal power.

The capital cost involved in building a power plant that will produce 13,000 kilowatts of electricity is too great if fossil fuels are used. But small electrical plants are feasible with geothermal steam.

Industries, especially mining companies, can make use of low-cost power available close to the mine itself.

In new developing nations, lack of power and technology poses a major problem. Geothermal steam could be the answer.

The use of geothermal power in these smaller nations to a large degree depends on whether they can raise the capital necessary for the initial investment. The future of geothermal power in the United States will be furthered through the leasing of Federal lands.
liquids (because its source is boiling water) or solids (because of minerals in the steam)?

Man has succeeded in harnessing the earth's free, volcanic heat and turning it into a useful resource. What its impact will be several decades from now is largely up to God, risk capital, and Congress to decide.

• Science News Letter, 86:154 Sept. 5, 1964

METALLURGY

Rapid Cooling Produces Superconducting Alloy

➤ A NEW SUPERCONDUCTING ALLOY has been made at California Institute of Technology, Pasadena, by an ultra-fast cooling technique that opens the way toward developing other such alloys. The alloy was made by combining gold and germanium, not of themselves superconducting, in a molten state, then cooling the metal in less than one-thousandth of a second.

A superconductor at temperatures near absolute zero, which is 459.7 degrees below zero Fahrenheit, carries an electric current indefinitely without apparent loss of energy. This property is becoming useful in computers, and other applications are being tested.

Science News Letter, 86:155 Sept. 5, 1964

BACTERIOLOGY

Bacteria Identified By Paper Color Changes

➤ CHEMICALLY TREATED STRIPS of paper can be used to identify disease-causing bacteria much more rapidly than conventional biochemical means with a newly developed test system.

The strips change color when exposed to various kinds of bacteria, including *Proteus* and *Salmonella,* although further testing may be necessary for exact identification. Warner-Chilcott Laboratories, Morris Plains, N. J., developed the papers.

• Science News Letter, 86:155 Sept. 5, 1964

Do You Know?

The launching *force* of an aircraft carrier catapult is enough to throw a heavy auto 3,000 feet into the air.

The use of chemical injections to solidify loose *soil* dates back to the early decades of this century.

In more than half of the United States there is no public facility for the treatment of *mentally ill* children.

• Science News Letter, 86:155 Sept. 5, 1964