DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

Field technician adjusting valve at one of the wellheads.

Reinjection (CFE, IIE, LBL)

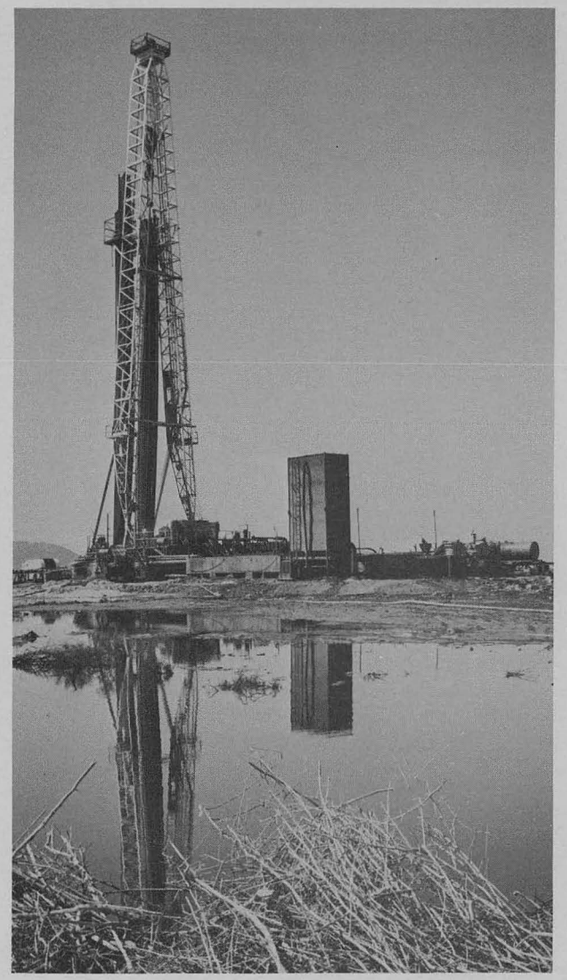
Based on available data, reservoir engineers will study well location patterns to reinject colder brines to recharge the geothermal reservoir. Of principal interest are the resultant temperatures of the produced fluids, the reservoir pressures, the chemical reactions between the reinjected brine and the native fluids and reservoir rocks, and the possible ground surface deformations.

Subsidence (DETENAL, USGS)

Regional as well as local horizontal and vertical ground surface deformations will be monitored periodically in the area. This data, when combined with information available from surveys in the Imperial Valley, will allow scientists to distinguish the deformations resulting from the extraction of geothermal fluids from those related to ground water production and natural tectonic causes.

Dissemination of Results (CFE, DOE)

The results obtained from this multidisciplinary effort will be made available to the international geothermal community by technical reports, in Spanish and English, as well as by annual conferences open to all interested parties. In addition, an open-file data bank on the Cerro Prieto field has been established at LBL to facilitate the study of this and other geothermal systems.

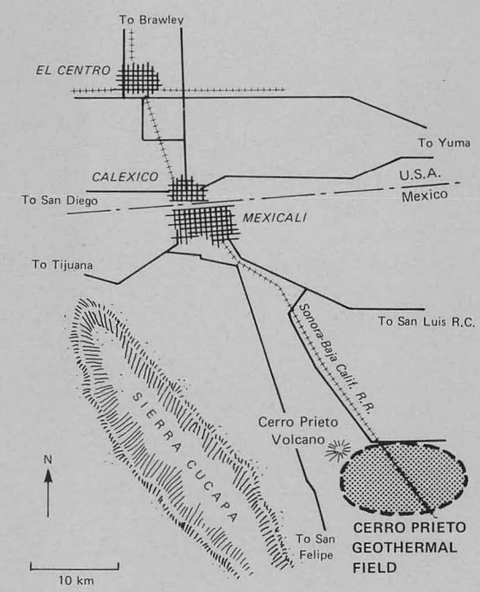


One of the drilling rigs in operation at Cerro Prieto. Note drilling mud cooling tower at the right.

GENERAL DATA

(March 1978)

Electrical power output:	75MW (2 × 37.5MW)
Turbine inlet pressure:	5.27 kg/cm^2 gauge (75 psig)
Exhaust-steam pressure:	89mm Hg abs. (1.7 psia)
Number of wells sending steam to the power plant:	18
Steam production rate:	725 metric tons/hr (1.60×10^6 lb/hr)
Total fluid production rate:	2,392 metric tons/hr (5.27×10^6 lb/hr)
Fluid enthalpy:	315 kcal/kg (568 Btu/lb)
Range of reservoir temperatures:	250 - 350°C (482 - 662°F)
Range of production wellhead pressures:	7.0 - 20.5 kg/cm^2 gauge (100 -290 psig)
Range of total dissolved solids in reservoir brines:	10,000 - 14,000 ppm



Location map of the Cerro Prieto geothermal field.

United States
Department of Energy

Comisión Federal de
Electricidad de Mexico

Earth Sciences Division
Lawrence Berkeley Laboratory

University of California
Berkeley, California 94720

Prepared for U.S. Department of Energy
under Contract W-7405-ENG-48

Pub 257

PUB B-257 c.1

For Reference
Not to be taken from this room
RECEIVED
LAWRENCE BERKELEY LABORATORY
FEB 27 1979
LIBRARY AND DOCUMENTS SECTION

GEOTHERMAL ENERGY STUDY

A Mexican-American Cooperative Project

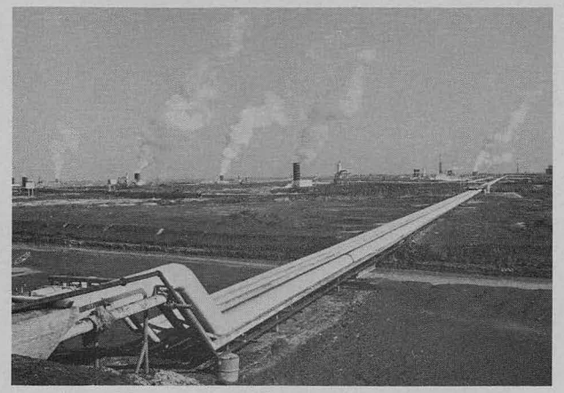
Pub-257 c.1

Mexico's Cerro Prieto geothermal field is the only liquid-dominated geothermal system presently generating electric power in North America. Located about 35km south of Mexicali in Baja California, it is situated in the Sea of Cortez-Salton Trough and named after the nearby Cerro Prieto ("black hill") volcano.

Geothermal studies now being made are part of a cooperative project established and operated through an agreement signed on July 21, 1977 between the United States Department of Energy (DOE) and the Comisión Federal de Electricidad of Mexico (CFE). The Lawrence Berkeley Laboratory (LBL) is coordinating U.S. technical activities carried out under this project. The Coordinadora Ejecutiva de Cerro Prieto of CFE is organizing all Mexican participation.

The Cerro Prieto project incorporates studies of the geologic, hydrogeologic, geochemical and geophysical setting of the geothermal field as well as the study of its structural, reservoir engineering and subsidence characteristics.

Precise gravity measurements being made at a permanent station located on the Cerro Prieto volcano.



View of the well-field. Pipelines in the foreground carry separated water to the evaporation pond.

Production of electric power commenced in 1973. CFE, which manages and operates the field, plans to expand the power output from its current 75 Megawatts (MW) to 150 MW by mid-1979. In 1982 a 30 MW low-pressure turbine will be installed to extract additional energy from the pressurized hot water presently not being utilized. Through the intensive drilling program begun in 1976 to provide steam for the planned power plants, the total generating capacity of the field is expected to reach 290 MW by 1984.

Participating Organizations

Principal scientific, technical, and governmental organizations cooperating in the Cerro Prieto project are:

MEXICO

Comisión Federal de Electricidad (CFE)
Instituto de Investigaciones Eléctricas (IIE)
Dirección General de Estudios del Territorio Nacional (DETENAL)
Centro de Investigación Científica y Educación Superior de Ensenada (CICESE)
Consejo Nacional de Ciencia y Tecnología (CONACYT)

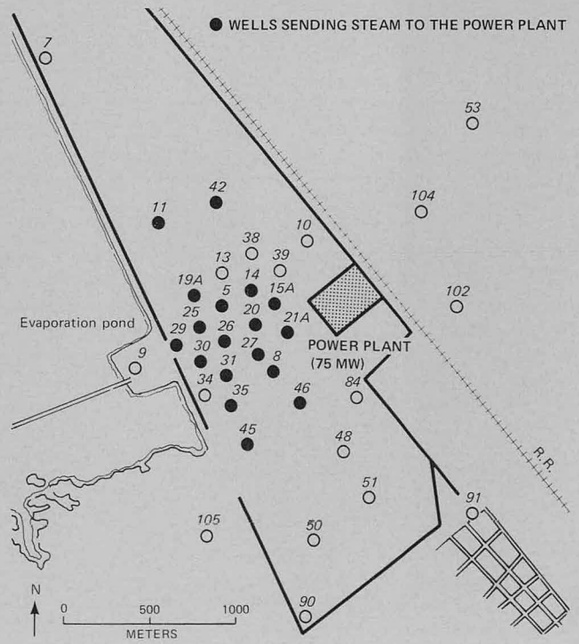
USA

Department of Energy (DOE)
Lawrence Berkeley Laboratory (LBL)
U.S. Geological Survey (USGS)
University of California, Riverside (UCR)

OBJECTIVES OF THE STUDY

The primary objective of the study is to develop an understanding of the geologic setting and hydrothermal circulation of the Cerro Prieto geothermal system. Through the scientific analysis of surface and subsurface geophysical and geochemical measurements, scientists and technicians will develop a thorough understanding of the nature and magnitude of the energy source and will determine the impact of tapping and utilizing a geothermal system of this type and size.

Cerro Prieto is considered an ideal system for studying the long-term response of a liquid-dominated geothermal field in continuous production. Much of the information obtained here should be of value in the study and development of similar sites in Mexico's Mexicali Valley and the U.S. Imperial Valley (California). This information will also benefit geothermal development in other parts of the world.



Location of wells in the main part of the Cerro Prieto geothermal field, as of March, 1978.

ACTIVITIES

Geology and Hydrogeology (CFE, LBL, UCR)

Scientists from these groups will define the geologic structure of the Cerro Prieto system based on petrologic and mineralogic studies of subsurface samples and analysis of geophysical well logs. The data obtained from this study will enable the development of geologic and hydrogeologic models of the Cerro Prieto field.

Geophysics (CFE, LBL, CICESE)

From electrical, gravitational, and passive seismic studies, geophysicists will determine the dimensions and structure of the geothermal system. Appropriate techniques will be developed to monitor changes in reservoir properties and seismicity during fluid production. These changes will then be correlated with production rates and surface subsidence measurements.

Geochemistry (CFE, USGS, UCR, LBL)

Geochemists in this group will determine the age and origin of geothermal fluids in order to estimate possible recharge sources and routes. They will analyze surface and ground water sources in the surrounding area and review previous studies of fluid characteristics to identify zones of differing fluid-chemical characteristics within the geothermal field. In addition, the extent and types of reactions occurring between the reservoir fluids and rocks will be determined.

Reservoir Engineering (CFE, LBL)

Engineering teams using well testing and laboratory techniques will help to determine the size, geometry and physical characteristics of the reservoir. Correlating data from all aspects of the study, the engineers will estimate the maximum safe fluid-production rate and the projected useful life of the reservoir.