ON THE USE OF NUCLEAR EXPLOSIVES FOR STIMULATION OF GEOTHERMAL HEAT

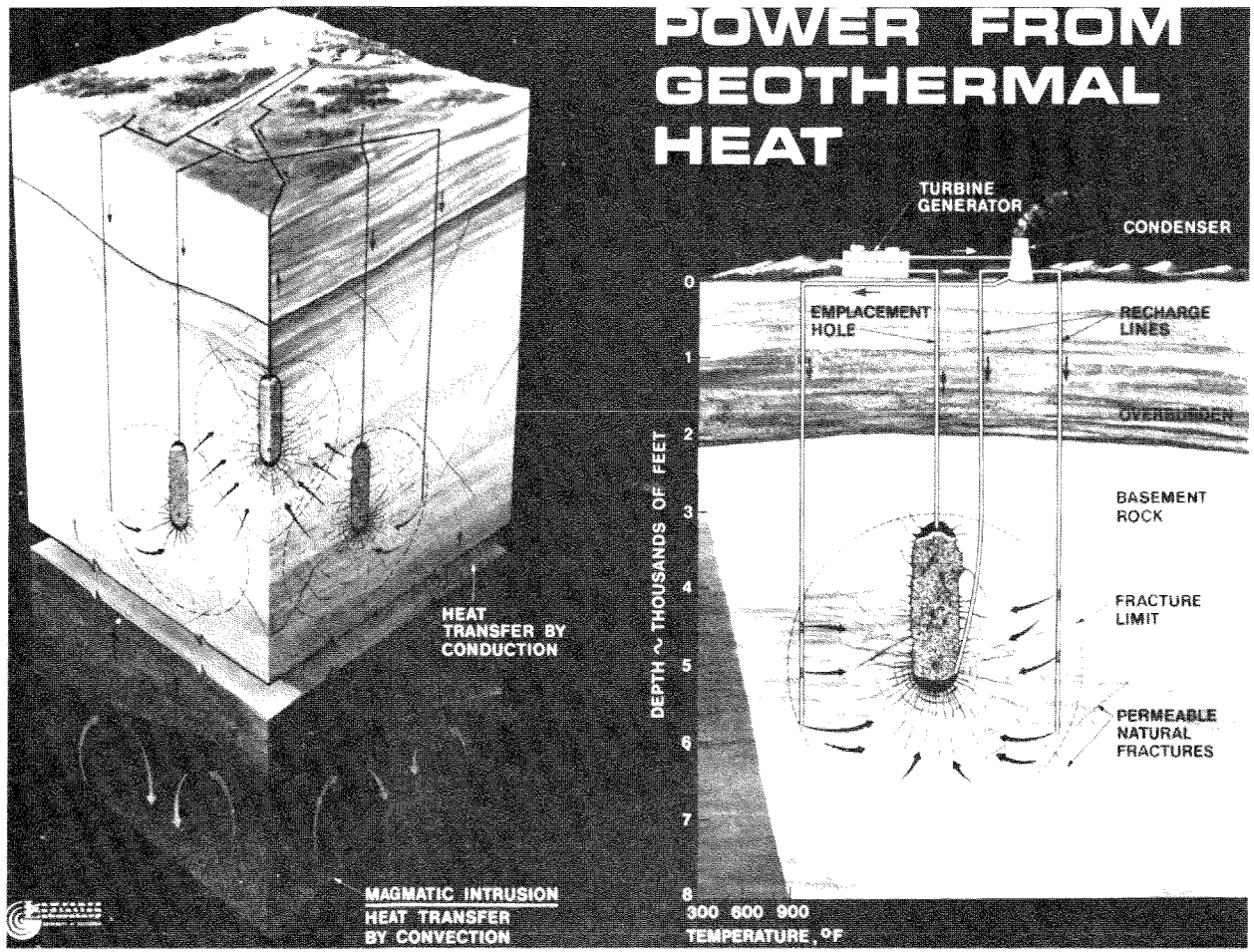
Milo D. Nordyke
Lawrence Radiation Laboratory, University of California
Livermore, California

Many areas of the world exist where high temperature isotherms supported by heat flow from the core of the earth occur very close to the surface of the earth. Commercial exploitation of these sources of energy has only recently become practical and is limited to those areas where a natural system of fracture acts to collect heat from a large volume of rock and sufficient natural water is available to act as a heat transfer agent. Recent studies have indicated many more areas of geothermal heat are available than had been identified previously.

The nuclear application envisages the creation of a chimney and associated fracture system with a nuclear explosion, introduction of water into the chimney-fracture system, and removal of superheated steam for the generation of electrical power. Three phenomena are considered: utilization of the heat content of the rock in the chimney and fracture zone; heat flow from the surrounding medium to the fracture zone or chimney by conductivity; and interconnection of a preexisting network of fracture by the highly permeable chimney and fracture zone.

A 1-Mt example is examined showing that over 10^9 kWh are available in the chimney, and over 10^{10} kWh in the central portion of the fracture zone. Using the current commercial value of 2 mills/kWh for such steam, the above heat has a worth of over $30,000,000. In addition, heat flow into the fracture zone would represent over $1 million per year additional value. Interconnection of fractures drawing heat from far removed volumes would be very site-dependent and difficult to estimate, and have not been included. Use of an array would permit circulation between chimneys with the resultant utilization of the heat energy contained in the intervening volume.

Ground shock associated with such an application would probably require development of a 30 to 50 year supply before the power plant is constructed. Radiological safety problems would be confined to operation of the power plant.


POWER FROM GEOTHERMAL HEAT
TURBINE GENERATOR
CONDENSER
EMPLACEMENT HOLE
RECHARGE LINES
OVERBURDEN
BASEMENT ROCK
FRACTURE LIMIT
PERMEABLE NATURAL FRACTURES
DEPTH ~ THOUSANDS OF FEET
0
1
2
3
4
5
6
7
8
300 600 900
TEMPERATURE, °F
HEAT TRANSFER BY CONDUCTION
MAGMATIC INTRUSION
HEAT TRANSFER BY CONVECTION