



**Department of Energy**  
San Francisco Operations Office  
1333 Broadway  
Oakland, California 94612

**REPORT OF MEETING ON GEOTHERMAL RESERVOIR RESEARCH AT EAST MESA FIELD, CA  
MAGMA POWER CO. AND DOW CHEMICAL USA - DOE, LBL, LLNL, AND UURI  
OCTOBER 1, 1985**

SUMMARY

A second technical working meeting was held at Lawrence Berkeley Laboratory on October 1st, by DOE with Magma Power Co. and their partner Dow Chemical USA, to complete the identification of potential cooperative research at the East Mesa Geothermal Field in Southern California. Magma is the operator of the southern half of the field, which was recently unitized. The participants reached consensus on geothermal research tasks of mutual interest to Magma and Dow, and DOE in four areas: injection, fracture determination and mapping, reservoir definition, and optimum production/injection strategy.

BACKGROUND

(See Minutes of Magma-DOE meeting, April 25, 1985, same subject.)

PARTICIPANTS

- Walt Haenggi - Dow Chemical USA, Minerals Manager
- Tom Hinrichs - Magma Power Company, Vice President
- Fred Teeters - Dow Chemical USA, Reservoir Engineer
  
- Anthony Adduci - DOE-SAN Geothermal Branch Chief
- Sally Benson - LBL Geologist-Reservoir Engineer
- Norman Goldstein - LBL Geophysicist
- Susan Halfman - LBL Geologist
- Bill Holman - DOE-SAN Geologist, Loan Guarantee Program
- Paul Kasameyer - LLNL Geophysicist, Geothermal Manager
- Marcelo Lippmann - LBL Reservoir Engineer, Geothermal Manager
- Martin Molloy - DOE-SAN Geologist, Geothermal Manager
- Joe Moore - UURI Geologist-Mineralogist
- Marshall Reed - DOE-HQ Geologist, Geothermal Manager
- Susan Stiger - EG&G-ID Geothermal Injection Program Manager
- Mike Wright - UURI Geophysicist, Technical Vice President

EAST MESA BACKGROUND AND RESEARCH OBJECTIVES

DOE-HQ/Marshall Reed opened the meeting by stating DOE's geothermal program objectives of increasing research cooperation between Laboratories, and conducting cooperative research with the geothermal industry. DOE needs field data to conduct comprehensive geothermal research (required to carry out its legislated mandate). For the past ten

years, the US geothermal industry has been extremely proprietary in protecting with its own data. As a consequence, DOE has conducted cooperative research with the major geothermal nations of the world: New Zealand, Iceland, Italy and Mexico. Because of budget reductions, foreign field work is becoming too expensive; nor can DOE afford to pay well testing and logistical support at US fields. Therefore, DOE welcomes opportunities to conduct cooperative research with US field operators at recently unitized US reservoirs, on a "no transfer of funds" basis - as long as these efforts do not compete with private consulting companies.

Research objectives of DOE's Brine Injection Program concern the breakthrough, in time, of three fronts: pressure, chemical, and temperature. Stanford, UURI, LBL and LLNL are developing tracers and geophysical methods, designing tests, and interpreting data to monitor front movement in porous, fractured, and dual permeability (fractured-porous) reservoirs. (Injection research is closely related to reservoir research in formation evaluation, reservoir modeling, detecting and measuring fractures, optimum field management, and long-term production trends - conducted by the same DOE investigators.) DOE geothermal research emphasizes "non-textbook" layered reservoirs, contribution of fractures, effect on matrix permeability of hot fluid withdrawal/injection, and detection of fluid conductivity contrasts.

Magma/Tom Hinrichs responded that Magma has unitized the south part of the East Mesa geothermal field. All the leases are blocked in, and the situation is not as competitive as before. The unit includes federal leases at East Mesa; BLM represents the interest of the government in seeing the reservoir developed. Dow is the major owner of Magma, providing financial and reservoir services at the East Mesa and Salton Sea geothermal fields. Powerplant start-up is underway at Salton Sea; cooperative research there has not been evaluated by the companies, but is not unlikely. Magma has drilled 16 wells, installed a flash crystallizer, and is operating near the former DOE Geothermal Loop Experiment Facility.

For some time, Magma and Dow have been fighting problems in their 10 MW East Mesa binary geothermal powerplant. Now that the binary plant has been rebuilt and is operating satisfactorily, Magma's and Dow's priority has turned again to the reservoir. Drilling has established the range of production zones and depths. Shallow injection (2,000-3,000') is being carried out; a deep production well (6,000-6,500') was recently converted to injection. However, the production and injection plans are not optimized at this time. Good wellfield development history is available, incl. production/injection volumes and pressures, flow rates, etc. Magma and Dow are working on a good picture of the geology now. Their goal is to add two powerplants (with SCE) in the next 4 years, using the window of economic opportunity provided by Standard Offer #4.

Magma and Dow are prepared to participate in cooperative research at East Mesa with DOE in a number of ways (see minutes of April 25th meeting with DOE). They anticipate cooperation with DOE in well tests and injection testing to gather and analyze reservoir data, hopefully leading to pilot tests of improved techniques.

Magma and Dow's primary interests are:

- fracture determination and mapping, esp. orientation,
- reservoir definition
- injection: fluid migration rates through the reservoir,  
                  watching movement of fronts in the same horizon,
- knowledge of any barriers in the field (which will require zone  
          pressurization,
- preferential permeability distributions and flow zones affecting  
          breakthrough fronts/times, and
- prediction of precipitation in the reservoir.

Three separate geologic interpretations exist for East Mesa: the original BLM report, RGI's, and Magma's; no one has placed these in a single framework. DOE wells at the East Mesa Geothermal Test Facility are available for cooperative research with Magma and Dow. Flow rates and pressure data are being recorded. Fluid level drawdowns are noted as a result of nearby production wells.

#### DOE CONCERNS

SAN/Tony Adduci stated DOE's concern with publication of the actual conditions of temperature, pressure, etc. of the reservoir in order to advance geothermal research for the benefit of the US geothermal industry, including Magma-Dow. These data require sufficient identification of field locations, formation parameters, and equipment characteristics for the geothermal industry to make sense out of the reservoir model.

Proprietary data can be so marked; proprietary analysis programs like computer models can be identified and protected. There are legal penalties to protect handling of proprietary data by the government and DOE researchers. The proprietary designation can be changed. However, HQ/Reed would like to set a time limit for release of any proprietary data. Patent provisions can take into account that the cooperating parties have been conducting separate activities, and that inventions resulting from cooperative efforts go with the party initiating or performing the majority of that effort. At DOE's Geothermal Test Facility, for example, industry tests their patented equipment at a government site without losing their patent rights.

#### MAGMA CONCERNS

Magma and Dow are only sensitive to estimates of East Mesa geothermal reservoir reserves (e.g. fluid, thermal energy, and lifetime vs. investment). Joint research may involve making models of reservoir production, etc., however, Magma and Dow request that DOE participants not publish their view of East Mesa geothermal field reserves.

## SUMMARY OF SHARED RESEARCH INTERESTS

In summary, technical discussions between Magma and Dow, and DOE have defined the following areas of mutual interest in injection and reservoir research at the East Mesa geothermal field:

### Injection

- well testing (technology development)
- water/rock interaction
- fluid/fluid interaction (fluid geochemistry)
- fluid migration rates
- breakthrough times of 3 fronts: pressure/chemical/thermal
- zone repressurization

### Fracture Determination and Mapping

- orientation of fracture zones
- evaluate geophysical techniques
- permeability over length, i.e., barriers vs conduits

### Reservoir Definition

- geologic framework
- barriers in field
- well testing (technology development)
- permeability distributions/anisotropy
- verification of techniques

### Optimum Production/Injection Strategy (heat sweep)

- well placement and depth
- maximize ultimate production over lifetime
- (not economics).

The ultimate usefulness of such DOE-industry research will be to maximize production from geothermal reservoirs, by pressure maintenance and delay of cold water breakthrough.

## CONCLUSION

Magma and Dow, and DOE are nearing consensus on cooperative geothermal research at the East Mesa reservoir. Together, the parties need to:

- identify tasks (including any for consulting companies),
- set time goals,
- see what is expected, one from the other,
- establish project management responsibilities, and
- prepare a formal agreement covering proprietary data, patent rights, and liability.

ACTION ITEMS AND RESPONSIBILITIES

Laboratory and university researchers will identify and draft specific task proposals (incl. field operations required from Magma) for review by DOE-ID and SAN. ID/Stiger and SAN/Molloy will screen these task proposals and recommend an integrated East Mesa research program to HQ/Reed, eliminating efforts that are already completed or not of interest. DOE labs and universities will put together "wish lists" of East Mesa research for DOE-HQ within areas of shared research interest, and summarize for Magma the kinds of field operations needed to carry it out at East Mesa.

DOE-HQ/Reed expects to reach budget decisions by early November; he expects that any additional FY'86 funding will come from the DOE-ID Geothermal Injection Technology Program.

By November 30, Magma and Dow expect to have a general history of East Mesa operations to date, a listing of detailed information available for their wells and powerplant, and a summary schedule of events for 1986 - to help in planning field experiments.

DOE-SAN will develop a draft a Cooperative Research Agreement with Magma and Dow, covering technical and administrative relations on geothermal research at Magma's East Mesa Field.

Finally, the participants expect to meet approx. November 15th to plan the East Mesa joint research program for Fiscal Year 1986.



10-16-85

Martin W. Molloy, Ph.D  
Program Manager,  
Geothermal Reservoir Technology

cc: Magma/Hinrichs  
Dow/Haenggi, Teeters  
HQ/Reed  
EPSCo ID/Prestwich; EG&G/Stiger  
SAN/Adduci, Holman  
LBL/Lippmann, Benson, Goldstein, Halfman  
Stanford/Gudmundsson, Horne  
UURI/Wright, Moore  
LLNL/Kasameyer  
USGS/Nathenson