



Geopressured Geothermal Well Tests: A Review

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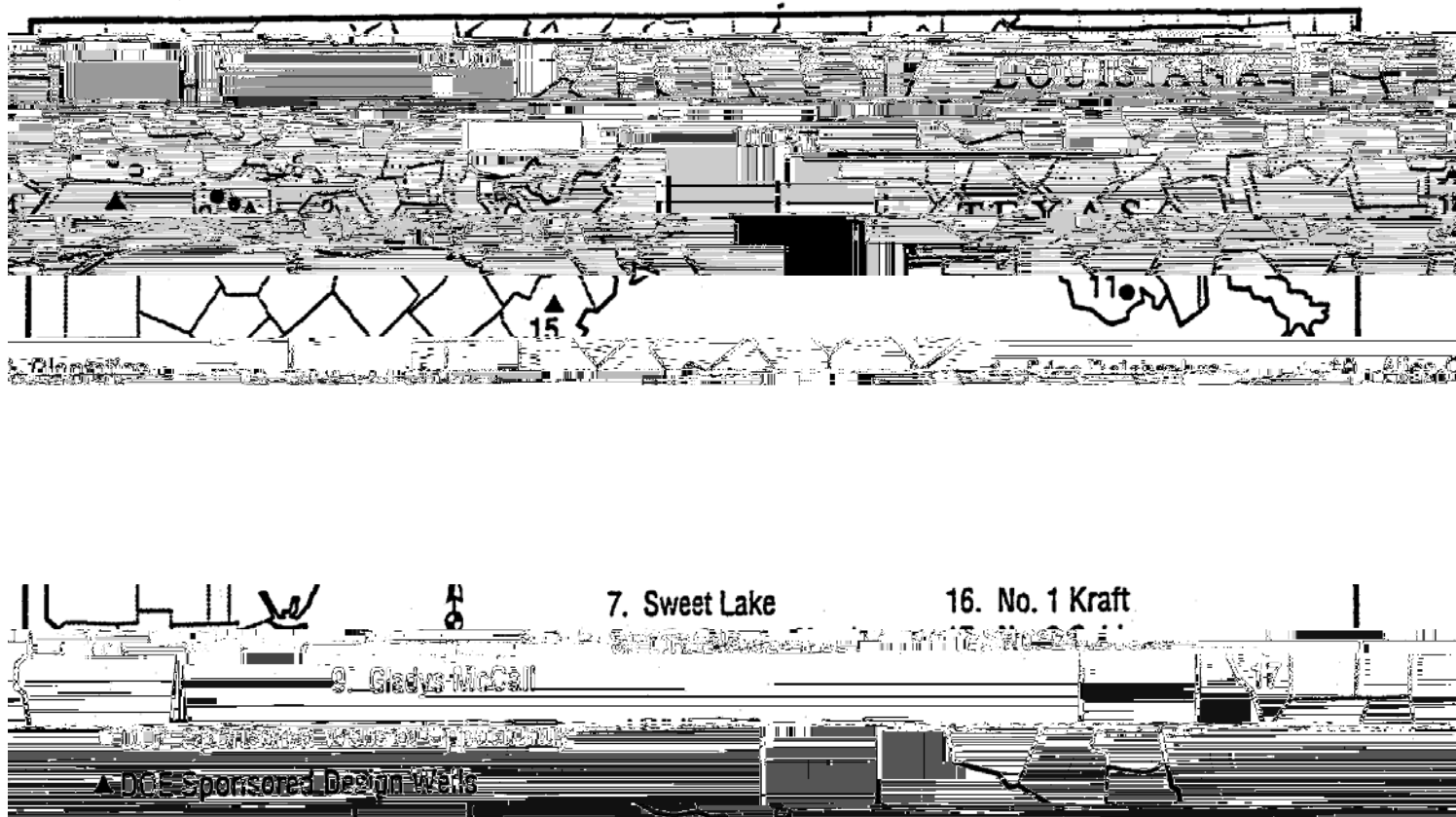
Geopressured-Geothermal Energy Resource Base

- Wallace, Kremer, Taylor and Wesselman, USGS Circular 790, 1979.
- Thermal energy contained in sedimentary rocks (northern Gulf of Mexico Basin): $107,000 \times 10^{18}$ Joules

DOE Geopressured-Geothermal well testing program (1)

- From FY1976 to FY1993, DOE sponsored a Geopressured Geothermal well testing program in order to determine the potential of this resource for commercial exploitation.
- Total program costs were over \$195 million dollars (current dollars). The budget peaked at \$36 M in FY1980.
- Program Summary Report
C.J. John, G. Maciasz, B.J. Harder (1998), Gulf Coast Geopressured-Geothermal Program Summary Report Compilation

Wells of Opportunity (Figure from John et al., 1998)



Wells of Opportunity – Results (1)

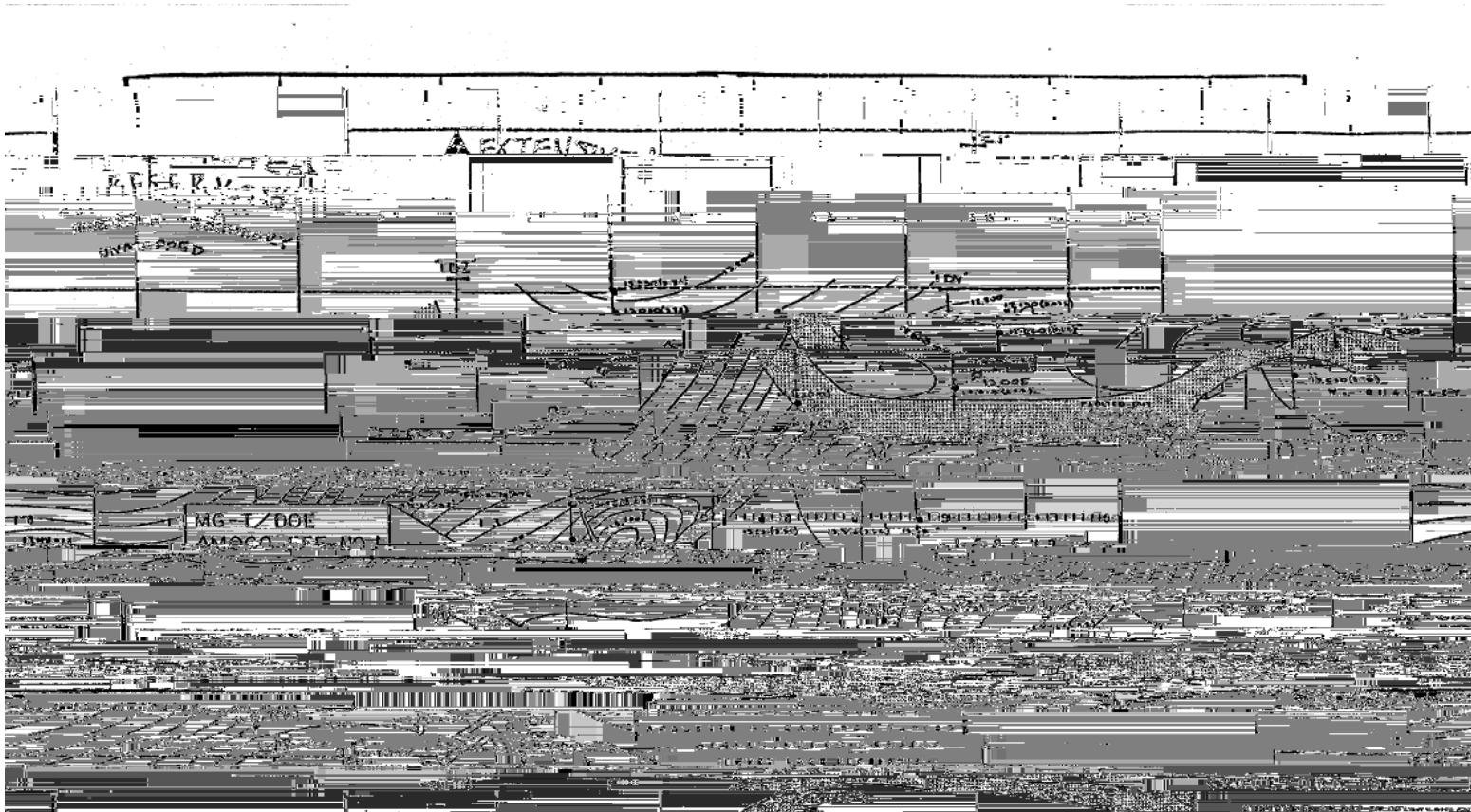
- John et al. (1998)
- R.E. Klauzinski (1981), Testing of six “wells of opportunity” during 1980 and 1981, Fifth Conference Geopressured-Geothermal Energy
- 9 wells produced for short periods (a few days)

Maximum flow rate: (1950-15,000) BPD
(13 – 99) m³/h

Wells of Opportunity – Results (2)

- Reservoir temperature: (238-339) °F
(114-171) °C
- Salinity: (12,800 – 207,000) mg/l
- Permeability: (12-104) md
- Restricted flow zone due to the presence of faults close to the well (100-1000 ft)

MG-T/DOE Amoco Fee No. 1 Well (1)



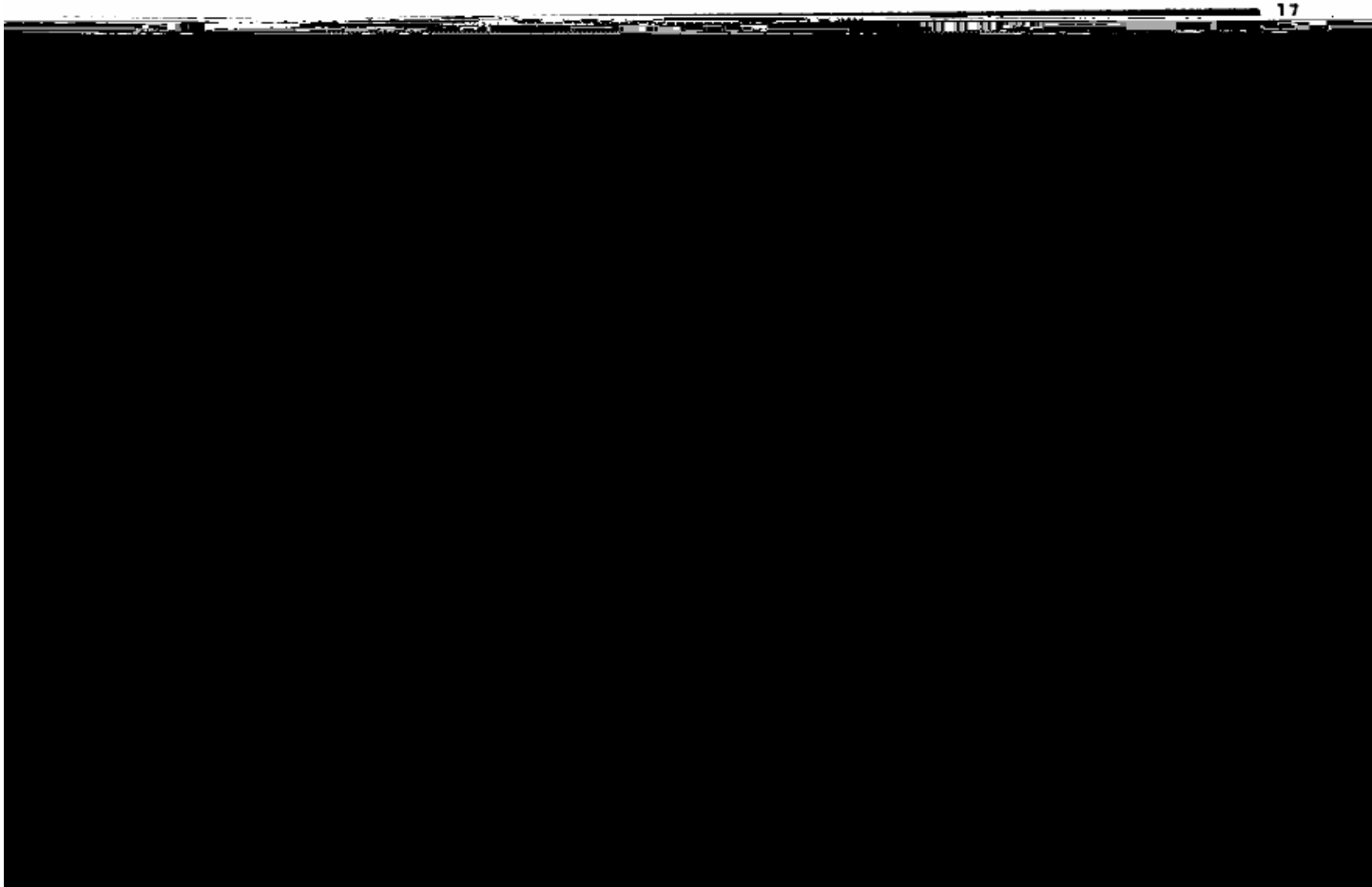
MG-T/DOE Amoco Fee No. 1 Well (2)

- Eight potentially productive sands in the Miogyp sequence (15,000-15,640 ft)
- Fifth sand (15,387-15,414 ft) selected for primary testing
- Flow testing

Phase I: Initial Flow test (3 days) and subsequent shut-in (~8 days)

Phase II: Reservoir Determination Test (~17 days)

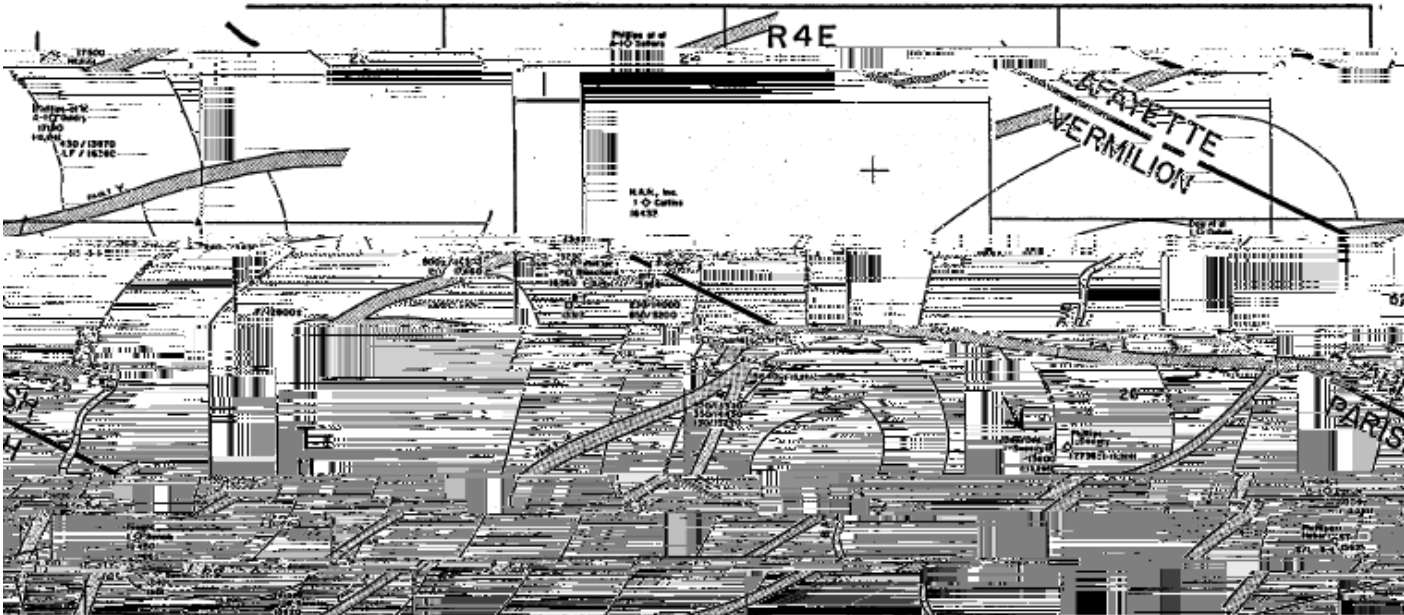
MG-T/DOE Amoco Fee No. 1 Well (3) Reservoir Determination Test



MG-T/DOE Amoco Fee No. 1 Well (4)

- Initial pressure: 12,053 psi (15,337 ft)
°F
- Salinity: 165,000 mg/l
- During the 17 day flow test, brine discharge rate declined from ~16,000 BPD
by ~3500 psi.
- Well unable to sustain discharge at high rates

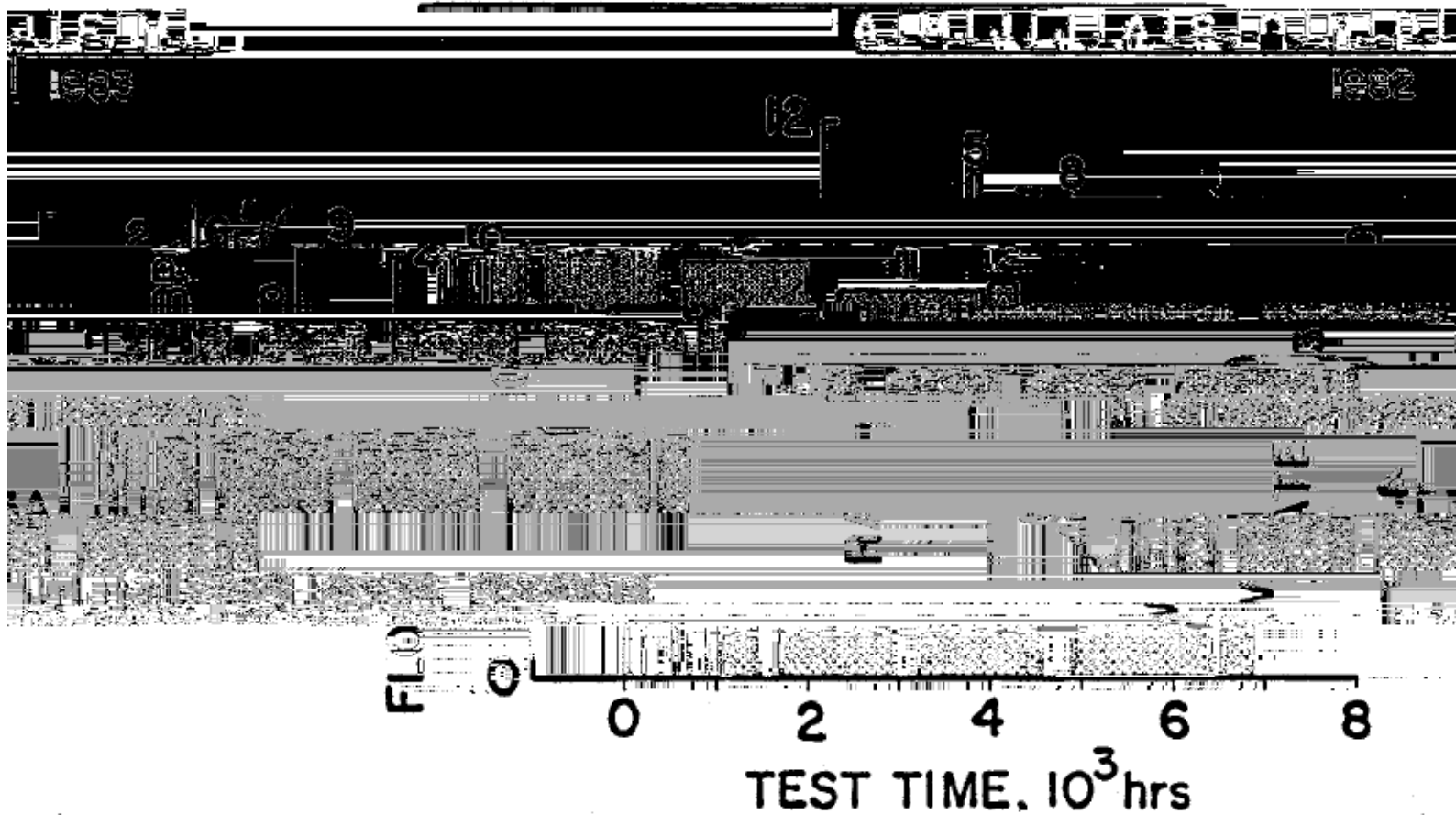
DOW-DOE L.R. Sweezy No. 1 Well (1)



DOW-DOE L.R. Sweezy No. 1 Well (2)

- Test designed to determine the production characteristics of a small Geopressured reservoir from initial fluid withdrawal to final depletion
- Total well depth: 13,612 ft
Perforated intervals: 13,349-13,388 ft
13,395-13,406 ft
- Initial pressure: 11,410 psi (13,395 ft)
Temperature: 237 °F
Total dissolved solids: 99,700 mg/l

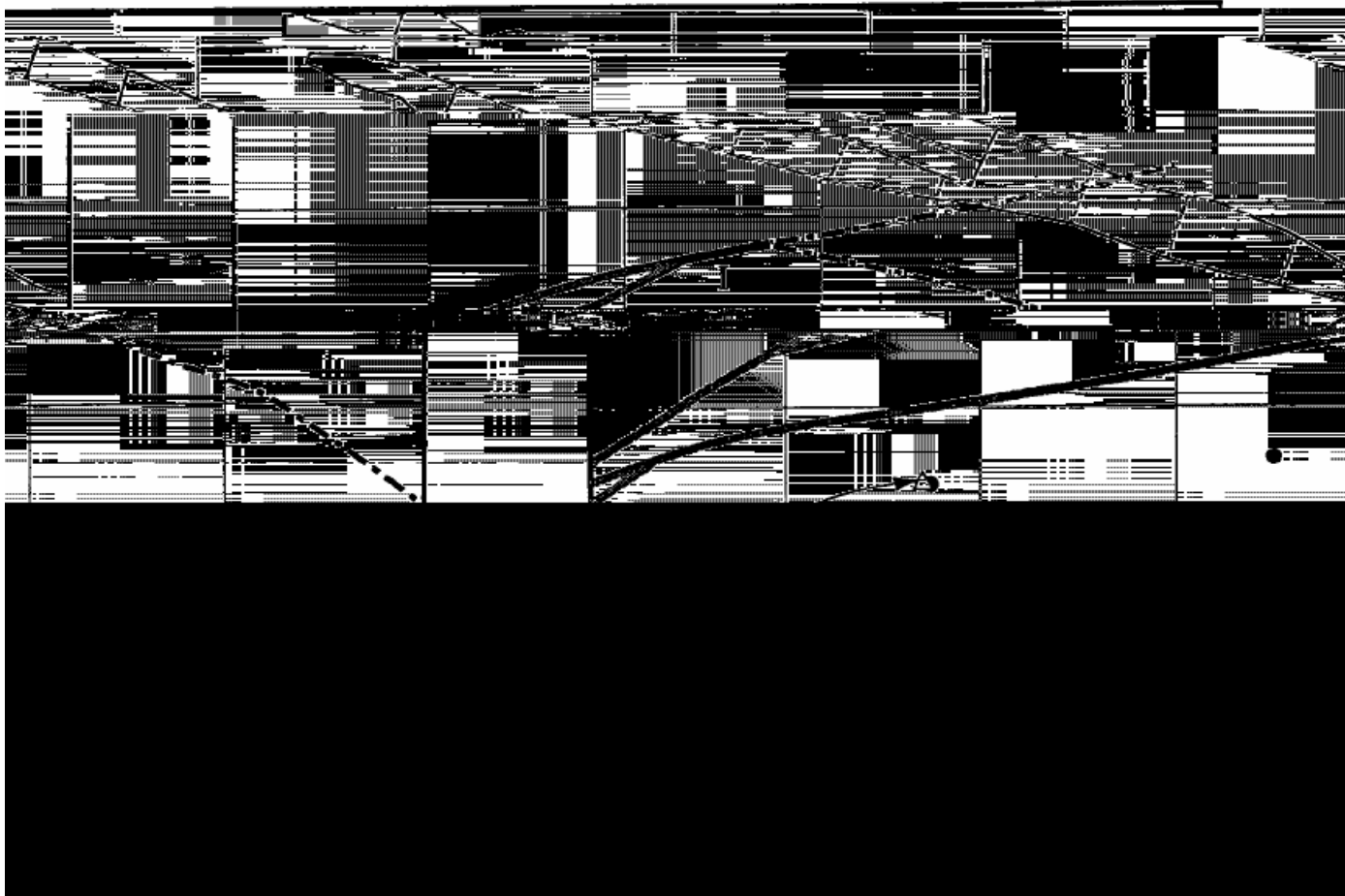
DOW-DOE L.R. Sweezy No. 1 Well (3) Flow Tests



DOW-DOE L.R. Sweezy No. 1 Well (4)

- To avoid excessive sand production, production kept below ~10,000 BPD.
- After a surge in sand production, well abandoned in early 1983.
- Total fluid production: 1.85 million barrels
($0.294 \cdot 10^6 \text{ m}^3$)
- Inferred reservoir volume: 1.8 billion ft^3
($52 \cdot 10^6 \text{ m}^3$)

Technadril-Fenix & Scisson-DOE Gladys McCall No. 1 Well (1)



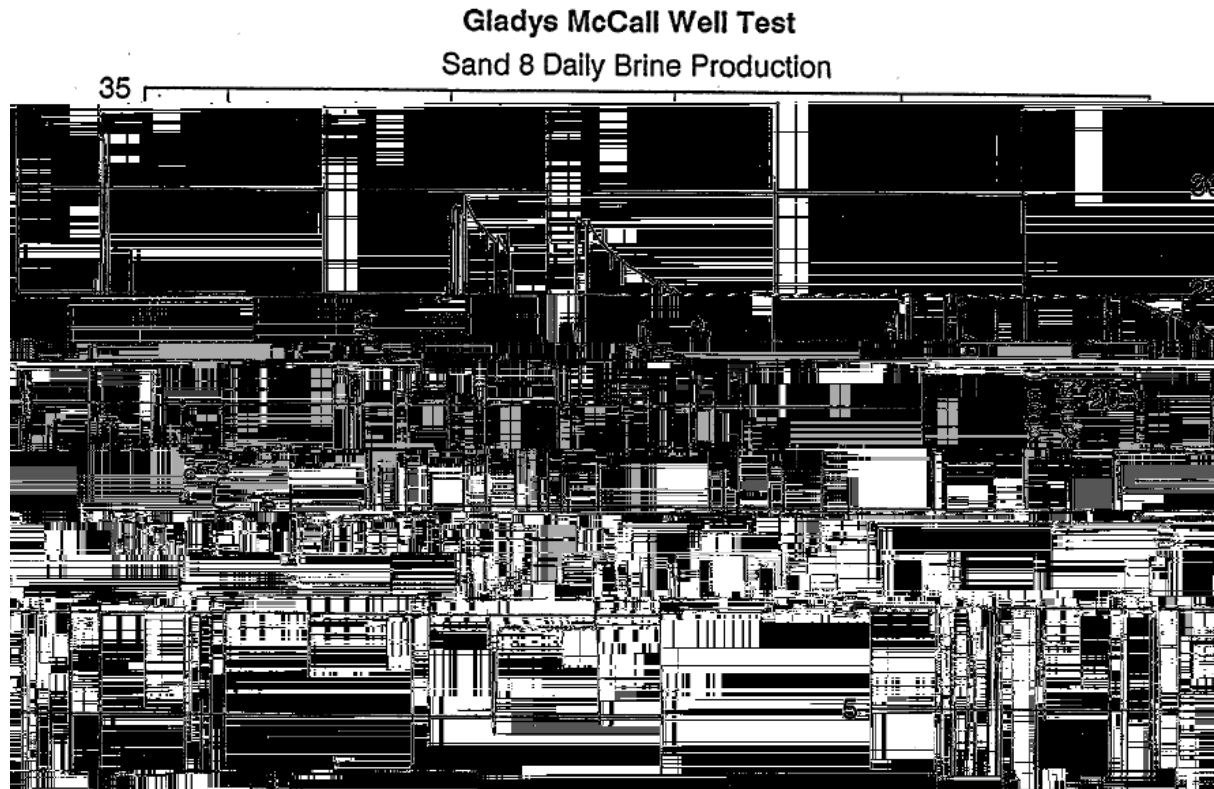
Technadril-Fenix & Scisson-DOE Gladys McCall No. 1 Well (2)

- Test designed to demonstrate long-term production potential of a Geopressured reservoir
- Total well depth: 16,510 ft
Target sands: 14,412-16,320 ft (~1150 ft sand)
- Sand 9: 15,508-15,630 ft, rapid pressure drawdown, sand zone sealed off

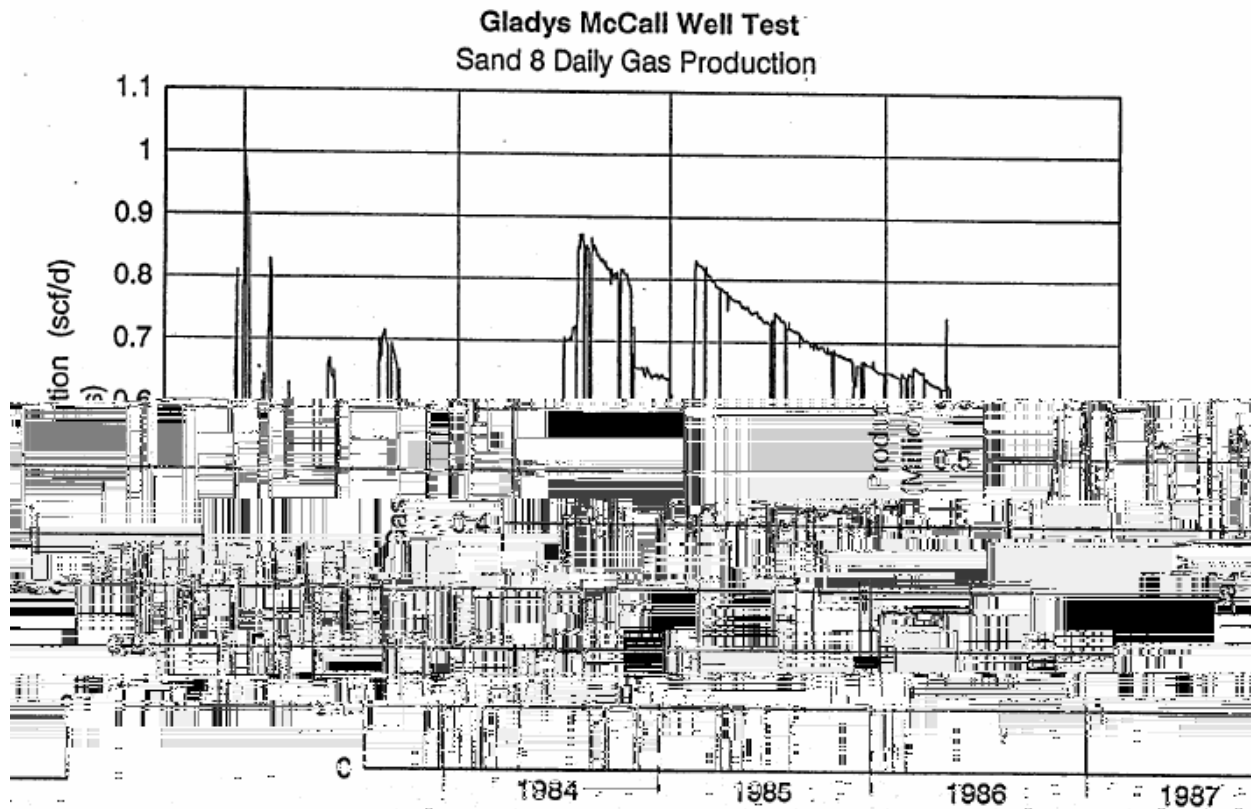
Technadril-Fenix & Scisson-DOE Gladys McCall No. 1 Well (3)

- Sand Zone 8: 15,158-15,490 ft (332 ft)
Initial pressure: 12,784 psi (15,100 ft)
Temperature: 289 °F
Total dissolved solids: 97,800 mg/l
- Production at various rates from October 1983 to October 1987
Maximum discharge rate: > 30,000 BPD
Average discharge rate: 19,600 BPD

Technadril-Fenix & Scisson-DOE Gladys McCall No. 1 Well (4)



Technadril-Fenix & Scisson-DOE Gladys McCall No. 1 Well (5)



Technadril-Fenix & Scisson-DOE Gladys McCall No. 1 Well (6)

- Total brine production: 27.1 million barrels
($4.3 \cdot 10^6 \text{ m}^3$)
- Total gas production: 676 million scf
($19.1 \cdot 10^6 \text{ m}^3$)
- Gas/ brine ratio: 24.9 scf/bbl
- Estimated reservoir pore volume: 7.8 billion barrels ($1.2 \cdot 10^9 \text{ m}^3$)

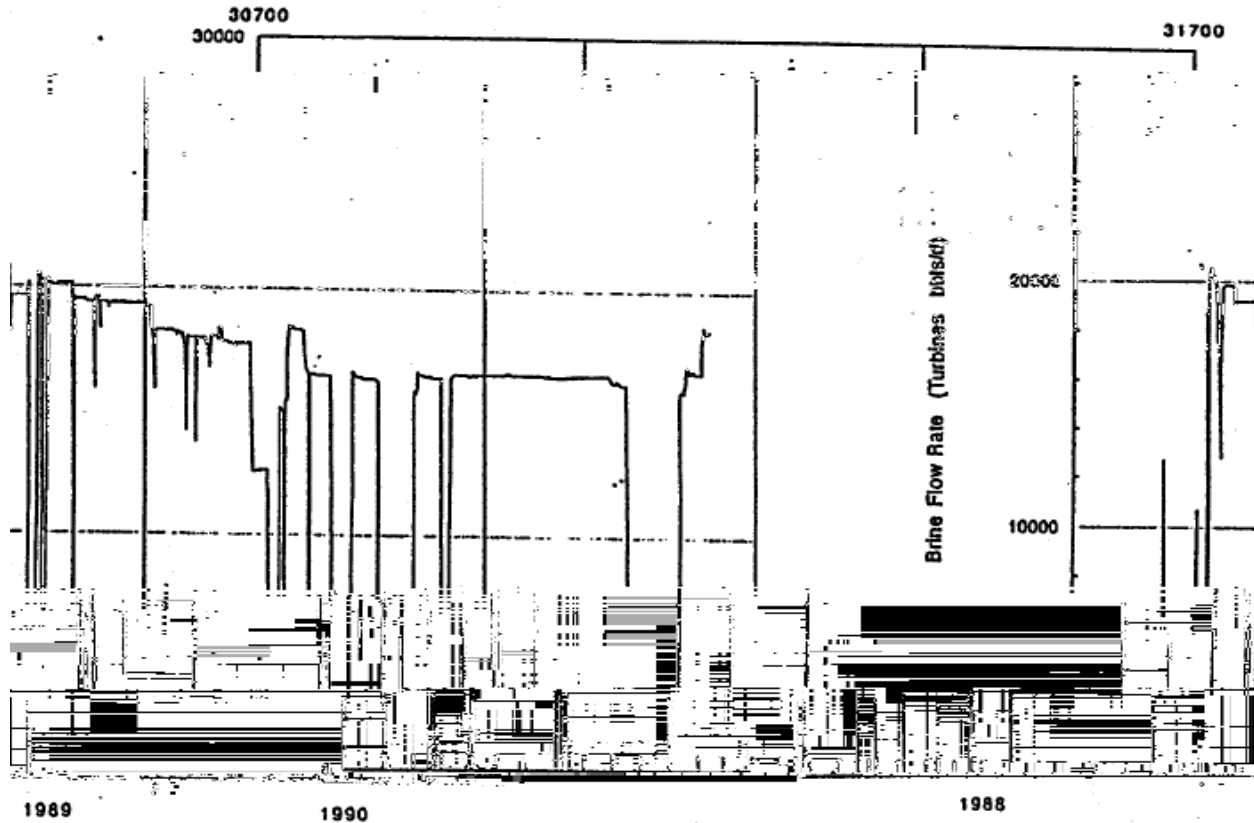
Pleasant Bayou No. 2 Well (2)

- Total depth: 16,500 ft
Perforated interval: 14,644-14,704 ft
(Frio Formation)
Initial pressure: 11,168 psi (14,674 ft)
Temperature: 306 °F
Total dissolved solids: 130,000 mg/l
- Initial Testing: 3 short-term flow tests in
1979-1981

Pleasant Bayou No. 2 Well (3)

- Long-term flow test 1
September 1982-April 1983
Total brine production: 3.5 million barrels
Average production rate: 18,200 bpd
- Long-term flow test 2
June 1988 – August 1990
Total brine production: 11.9 million barrels
Total Gas production: 232 million Scf
Gas/brine ratio: 19.5 scf/bbl

Pleasant Bayou No. 2 Well (4)



Pleasant Bayou No. 2 Well (5)



Pleasant Bayou No. 2 Well (6)

- G. M. Shook, An integrated approach to Reservoir Engineering at Pleasant Bayou Geopressured-Geothermal Reservoir, Idaho National Laboratory Report, 1992.
- Key conclusion: Pleasant Bayou No. 2 well capable of producing at 20,000 bpd for several years.

Pleasant Bayou No. 2 Well (7)

- Hybrid Power Plant (1 MW net)

Produced methane burned to produce electricity.

Gas engine exhaust and produced brine used in a binary power plant to generate additional power.

- Power plant operated for ~121 days (October 1989-May 1990)

Conclusions (1)

- Wells of opportunity (i.e. abandoned hydrocarbon wells) generally incapable of sustaining production at high rates.
- Design well test program demonstrates the existence of large (~1 cubic mile) Geopressured reservoirs.
- Two of the design wells produced at ~20,000 BPD for several years.

Conclusions (2)

- Because of the high salinity, it will be necessary to inject the waste brine.
- Design wells completed with 7-inch liner in a 8.5-inch hole. Production through a 5-inch production tubing. A different completion scheme may be needed to sustain production rates greater than 20,000 BPD.
- Hybrid power plant at Pleasant Bayou site was not optimized for electric power production.

Conclusions (4)

- Ref: J. W. Pritchett, Electrical Generating Capacities of Geothermal Slim Holes, DOE/ID/13455, October 1998.
- With an inlet temperature of 300 °F and a brine supply rate of 20,000 BPD, a binary power plant can generate (0.85 – 1.1) MWe.

Conclusions (5)

- With a brine production of 20,000 bpd, it is reasonable to expect a gas production rate of ~400,000 scf/day.
- Assuming a thermal to electric conversion efficiency of 40%, 400,000 scf/day of natural gas may be used to generate about 2 MWe.