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RECENT RESULTS FROM TESTS ON THE REPUBLIC GEOTHERMAL WELLS, EAST MESA, CALIFORNIA

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Introduction

The East Mesa KGRA (Known Geothermal Resource Area) is located in the Imperial Valley of Southern California close to the Mexican border. Republic Geothermal Co. has leased lands in the northern part of the geothermal anomaly and has so far drilled six wells, ranging in depth from 7,400 to 9,100 feet. Current plans of Republic Geothermal Co. include putting up a 50 MW power plant based on the resource. Crucial to the success of this venture is a proper understanding of the physical properties of the geothermal reservoir tapped by the wells. Towards the south, the geothermal anomaly is being explored and assessed by the U.S. Bureau of Reclamation (5 wells) and the Magma Power Co. (3 wells).

Towards achieving a proper understanding of the resource at East Mesa, Lawrence Berkeley Laboratory collaborated with Republic Geothermal Co. in conducting a series of three well tests. These included production, injection and interference tests with durations varying from a few days to several weeks and yielded valuable information on reservoir parameters as well as geometry. The purpose of this presentation is to summarize the important findings from the tests. In particular, attention will be restricted to the production-interference tests. The results of injection tests are outside the scope of this presentation.

Geology

The East Mesa resource occurs in a young (tertiary) and geologically active sedimentary basin filled with over 10,000 ft. of sandstones, siltstones and clays. Structurally, the basin appears to be considerably faulted in the East Mesa area and at lest three faults varying in trend from NNW to WNW have

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been identified (U.S. Bureau of Reclamation, 1974). In addition, growth faults, penecontemporaneous with deposition and trending towards northeast have also been inferred (J.L. Smith, personal communication).

Description of Test Wells

In all, seven wells were involved in the well tests; six of these belong to Republic Geothermal and one to the U.S. Bureau of Reclamation. The locations of the wells are given in Fig. 1.

REPUBLIC Geothermal Well Field, East Mesa, California.

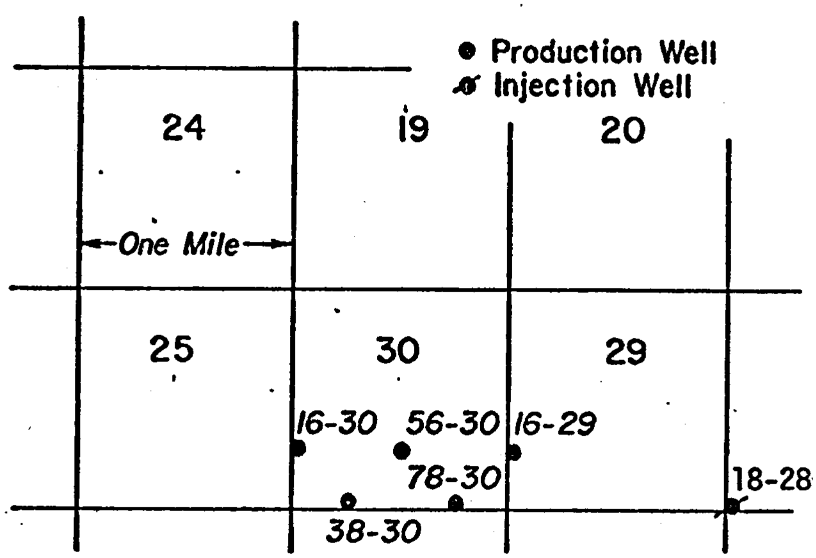

Fig. 1 Republic Geothermal Well Tests: Map location of wells

Two of these 38-30 and 16-29 were alternately used as production wells and one, 18-28 was used for disposal of the produced waters by reinjection. The rest of the wells were used as non-producing observation wells. A brief description of the wells is given in Table 1.

Table 1: Description of Republic Geothermal Wells, East Mesa, California

Well	Total Depth ft.	Slotted Interval Feet	Net Sand feet (in those intervals open during rest)	Date Completed	Remarks
16-30	8,000	1,600 between 6,400 and 8,000 ft.	1,116	July, 1977	
56-30	7,520	2,225 between 5,300 and 7,550 ft.	1,841	June, 1977	
16-29	7,998	1,335 between 6,400 and 7,998 ft.	827	Dec., 1975	
18-28	8,001	1,840 between 5,110 and 8,000 ft.	231	Jan., 1976	No water entry between 6,400 and 8,000 ft.
78-30	7,442	1,520 between 5,900 and 7,450 ft.	1,257	Aug., 1977	
38-30	9,090	2,265 between 6,300 and 8,900 ft.	499	Oct., 1975	Filled to 7,022 ftt.
31-1	6,175	760 between 5,400 and 6,200 ft.	Not Available	June, 1974	Owned by U.S. Bureau of Reclamation

The first two of the three tests conducted were short duration (few days) production-interference tests while the last was a long-duration interference test which lasted for several weeks. The details of the tests are summarized in Table 2. All the tests involved arbitrarily varying flow rates. The flow rates were measured by first separating steam and water and then passing each through separate orifice plates. Pressure differentials in the observation wells (all of which are artesian) were measured with the help of sensitive quartz crystal pressure transducers. The flow data as well as the pressure data were automatically recorded as printouts or strip charts.

Table 2: Republic Geothermal Well Tests: Details of Tests

Test No.	PRODUCTION WELL	Method of Production	Flow Rate (gpm)	Pressure Measurement	Date	Observation Wells and Instruments 1	2	3	4
1	38-30	Valve* control	Step-wise variable * 500, 750, 900, 500, 225	Sperry Sun down-hole pressure monitor	July 14 to July 18, 1977	56-30	16-29	31-1	
						← Paro Scientific well-head transducer →			
2	16-29	Valve* control	Variable 200 to 700	Denver Research Institute and Sperry Sun down-hole pressure monitor	July 26 to July 30, 1977	16-30	51-30	31-1	
						← Paro Scientific well-head transducer →			
3	38-30	Downhole Pump	Variable 200 to 1,000	None	August 22 to Oct. 5, 1977	16-30	56-30	78-30	31-1
						← Paro Scientific well-head transducer →			

* Natural, well-bore flashing flow

Results and Interpretation

All the tests conducted were characterized by arbitrarily variable discharges. At the outset, therefore, it became impossible to use the conventional type-curve matching procedures of analysis which are based on fixed flow rates. Instead, a computer assisted curve-matching procedure recently developed at LBL (Tsang, et al., 1977) formed the backbone of all the interpretation.

The interference data collected during the first test from wells 56-30 (kh=26,300 md-ft; $\phi ch=4.5 \times 10^{-4}$ ft/psi) and 31-1 (kh=35,400 md-ft; $\phi ch=2.07 \times 10^{-3}$ ft/psi) indicated the possible presence of a barrier boundary, that could be represented by an equivalent image of well of 38-30 located 4,600 feet from 56-30 and 2,700 feet from 31-1. In addition, both test 2 and test 3 brought to light the very interesting fact that well 16-30 did not show any pressure response to the production either from 16-29 or 38-30. This is all the more remarkable because well 56-30, whose distance from 38-30 is the same as that between the latter and 16-30, experienced a drawdown of as much as 21·2 psi during the first test and 45 psi during the third. The three pieces of data, namely, the image well distances from 56-30 and 31-1 and the non-response of 16-30 strongly suggest the presence of a prominent, NNE trending barrier boundary as shown in Fig. 2. This boundary apparently does not conform to any of the geologically mapped faults, although its trend parallels those of inferred growth faults.

REPUBLIC Geothermal Well Field, East Mesa, California.

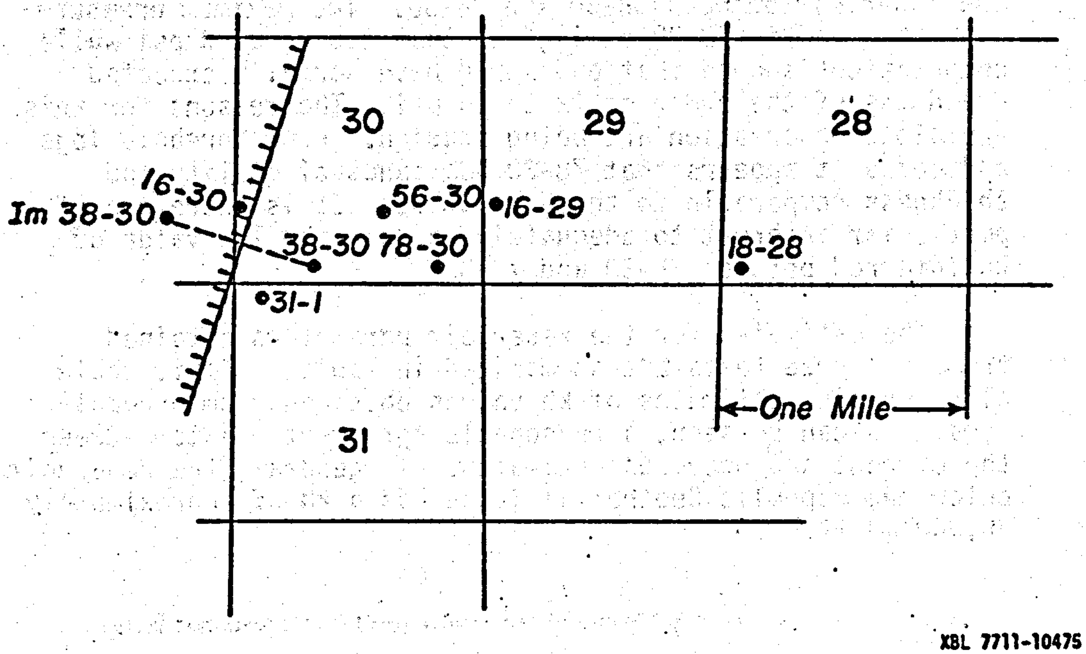

Fig. 2 Republic Geothermal Well Tests: Inferred presence of hydrologic barrier boundary

The production well data collected during test 1 suggested a kh of approximately 25,000 md-ft for the reservoir in the vicinity of 38-30. In addition, the data also indicated a negative skin for well 38-30.

Interference data collected during the third test from 31-1 yielded kh, ϕch and image well distances comparable with those obtained during test 1. However, data from 56-30 indicated somewhat lower kh and lower image well distance (see Table 3) than the first test. It may be noted here that at the start of test 3, the reservoir was still recovering from the effects of 38-30 and 16-29. The discrepancies mentioned may be attributable to the buildup effects of 16-29 which were ignored during the interpretation.

Interference data collected from 78-30 during test 3 indicated anomalously low kh values of 10,400 md-ft for the reservoir between 38-30 and 78-30. The maximum pressure drop observed in 78-30 during the test was about 3 psi while computations showed that one would have normally expected drawdowns of the order of 12 to 15 psi. The reasons for this anomalous observation are being studied. From borehole logs and cores it appears that 78-30 has sands of quality and thickness comparable to those in 38-30. It is therefore of particular interest to adequately explain the low value of kh inferred between 38-30 and 78-30.

The estimates for the reservoir parameters obtained from the three tests are summarized in Table 3. This table also contains estimates of kh values obtained from borehole logs. As can be seen, a reasonable agreement exists between the current and previous estimates. In general, the reservoir below the Republic Geothermal lease has a kh of approximately 30,000 md-ft.

Table 3: Summary of Test Results from Republic Geothermal Wells

Well	Test 1 (38-30 Producing)	Test 2 (16-29 Producing)	Test 3 (38-30 Producing)	Previous Estimates
38-30	kh=24,800 md-ft $\phi c h r_e^2$=1.36 ft^3/psi	--	--	Borehole Logs (Republic) kh=44,000 md-feet Build-up Test (Republic) kh=41,700 md-feet Interference Test (LBL) kh=29,500 md-feet
56-30	kh=26,300 md-ft ϕch=4.5x10^{-4} ft/psi r_i=4,600 ft	To be analyzed	kh=23,600 md-ft ϕch=7.89x10^{-4} ft/psi r_i=3,500 ft	
31-1	kh=35,400 md-ft ϕch=2.07x10^{-3} ft/psi r_i=2,660 ft	To be analyzed	kh=31,700 md-ft ϕch=2.4x10^{-3} ft/psi r_i=2,450 ft	
16-29	kh=21,800 md-ft ϕch=2.36x10^{-3} ft/psi	--	--	Borehole Logs (Republic) kh=30,000 md-feet Build-up Test (Republic) kh=34,700 md-feet
78-30	--	--	kh=10,400 md-ft ϕch=6.68x10^{-3} ft/psi r_i=3,300 ft	

Before concluding, it should be pointed out that interpretations are still continuing and the results presented here are tentative and subject to revision.

Acknowledgements

We would like to thank the U.S. Bureau of Reclamation for permission to monitor pressures on well 31-1.

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References

1. Tsang, C.F., D.G. McEdwards, T.N. Narasimhan and P.A. Witherspoon, "Variable Flow Well-Test Analysis by a Computer-Assisted Matching Procedure", Paper No. 6547, 47th Annual Western Regional Meeting, SPE of AIME, Bakersfield, California, April 13-15, 1977.

2. U.S. Bureau of Reclamation, "Geothermal Resource Investigations, East Mesa Test Site, Imperial Valley, California, Status Report-1974", November, 1974.