BACA PROJECT

DATA AND REPORTS

WELLS

GL03898

No.	Transfer Date	Release Date	Title
1.	A	A	Summary sheet for Baca Wells No's 1-3.
2.	A	A	Baca Wells No's 4-16 summary sheet.
3.	A	A	Well summary reports and Drilling Histories--Baca Wells No's 4-16.
4.	B	B	Lithology logs--Baca Wells No's 4-16.
5.	A	A	Temperature and Pressure Surveys--Baca Wells No's 4-8 and 10-16.
6.	B	B	Electric logs for Baca Wells No's 10-14.

Exploration

VI. GEOTHERMAL ENERGY POTENTIAL OF THE VALLES CALDERA

A. GENERAL STATEMENT

The preceding section of this report was devoted primarily to a tabulation of facts with as little speculative material as possible. With the exception of well data, this section is more interpretive and leads to a generalized model of the Valles Caldera hydrothermal system. The general conclusion proposed is that the Valles Caldera is an excellent prospect for geothermal development including the production from vapor-dominated, and liquid-dominated reservoirs. The general model consists of a high heat flow area, the caldera, situated in the path of a deep ground-water system tending to flow from north to south across the caldera. Heat flow near the center of the caldera is sufficient to cause boiling and separation of vapor-phase water. This area is prospective for the production of dry steam. The most likely area for production from a liquid phase reservoir, which requires a potentiometric surface near the earth's surface, and a porous and permeable reservoir, is immediately north of the vapor phase prospective area.

B. SUMMARY OF WELLS DRILLED TO DATE

1. Bond #1, T.D. 3675 feet

(More complete descriptions of all wells are in the Appendix)

Of the five deep wells within the Valles Caldera, four were drilled as geothermal tests. The earliest well, the Westates-Bond #1, was drilled in 1960 as a petroleum test. Drilled largely with mud, the Bond #1 well furnished the first evidence of a high-temperature, low pressure hydrothermal system in the Valles Caldera. Lost circulation zones were encountered at depths of 1204 feet, 1338 feet, and 3650 feet, the latter so serious that the mud system was converted to air. The well was abandoned at a depth of 3675 feet because the air supply could not keep the hole unloaded. During drilling, high mud flow line temperatures were observed: 170°F. at 1698 feet increasing to 194°F. (boiling at wellhead elevation) at 2966 feet.

In 1967, the well was cleaned out to 1920 feet, at which time it flowed surges of steam and water. Downhole temperature and pressure measurements indicated a liquid water phase in the lost circulation zone at 1338 feet. The formation pressure, about 100 psig, is considerably below a hydrostatic column extending to the surface. The formation temperature is about 250°F., below the temperature at equivalent depths in other wells.

Deeper permeable zones apparently are also liquid filled,

for the temperature surveys show that some of the test fluid was coming from below 2900 feet, but pressures appear too high and temperatures too low to allow a vapor-phase separation.

It is concluded that the rocks penetrated by the Bond #1 well contain liquid water at elevated temperature, and significantly less than hydrostatic pressure.

Baca #1, T.D. 2560 feet
Baca #3, T.D. 2200(?) feet

The Baca #1 well is the first well in Valles Caldera drilled to establish geothermal steam production. With 13-3/8 inch casing emplaced to 461 feet, the well encountered steam zones at 1441 - 1500 feet. As measured by Rogers Engineering Company, the zones flowed 85,000 pounds of steam per hour with less than 5% liquid water content. Their estimate of reservoir conditions was 310° - 320°F. and 65 psig reservoir pressure, a saturated steam zone. Rogers' estimate of the formation temperature is in good agreement with the temperature calculated from the sodium-potassium content of the effluent water: 338°F. The well was deepened to 2560 feet and the hole was lost while attempting to run casing.

The Baca #3 well, a twin to the Baca #1, was drilled to re-establish production from the steam zones discovered in the Baca #1 well. At a total depth of 1983 feet, with 1179 feet of 9-5/8 inch casing, the well had a flow of 11% steam and 89% water, chiefly from zones below 1900 feet. The water zone apparently was depleted rapidly, for one day later the well was flowing 50% steam. After tests, 7 inch casing was hung from 1000 feet to 1983 feet and the well was drilled to total depth, about 2200 feet. A down-hole temperature survey recorded a maximum temperature of 390°F. at 1800 feet and a water level between 800 feet and 900 feet.

The Baca #1 and #3 wells establish that low pressure-high temperature conditions are available in the Valles Caldera suitable for formation of saturated steam reservoirs. Although the wells, as drilled, did not discover commercial production, data from the Baca #4 well indicates the Baca #1 - #3 location is probably on the fringe of a saturated steam reservoir and may be prospective for dry steam production from greater depths.

Baca #2, T.D. 5658 feet

The Baca #2 well is the deepest geothermal test in the Valles Caldera, and is the only well to penetrate Paleozoic sediments and Pre-Cambrian granite. The well was drilled with mud to a depth of 3445 feet with lost circulation

temperature hydrothermal system at the Baca #4 location. The potentiometric surface of the deep water zone is approximately 2000 feet deep. The above-sea elevation of the potential water table is about 300 feet lower than the potential surface in the Baca #2 well, showing that subsurface water tends to flow from the Baca #2 location towards the Baca #4 location, and proves that the deep hydrothermal system operates independently of the near-surface drainage effects of Redondo Peak, the dominant topographic factor in Valles Caldera.

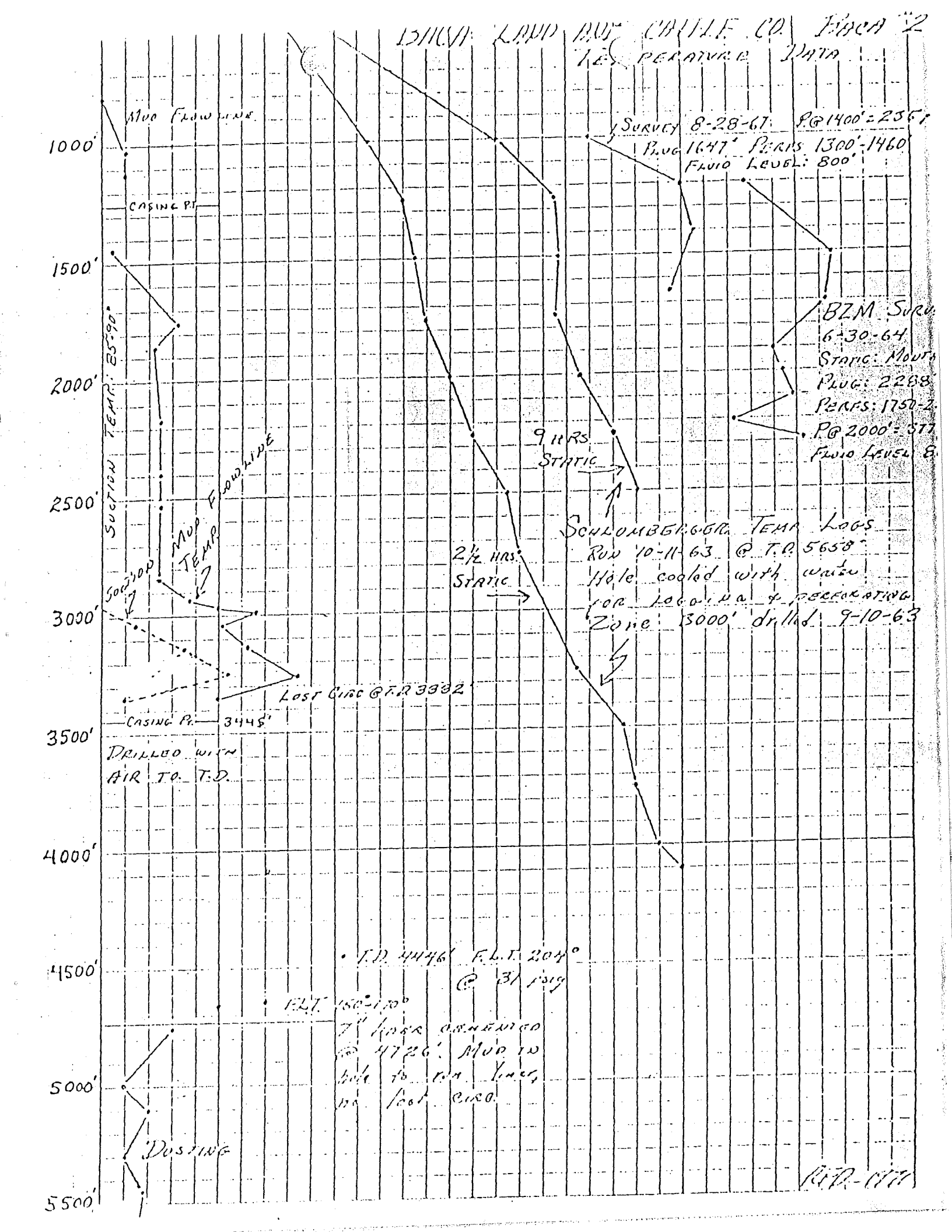
Observed downhole temperatures are comparatively very high, over 532°F. at 4820 feet. White (1971) reports that of about 100 hydrothermal systems explored by drilling, only about 10 demonstrably exceed 480°F. (250°C).

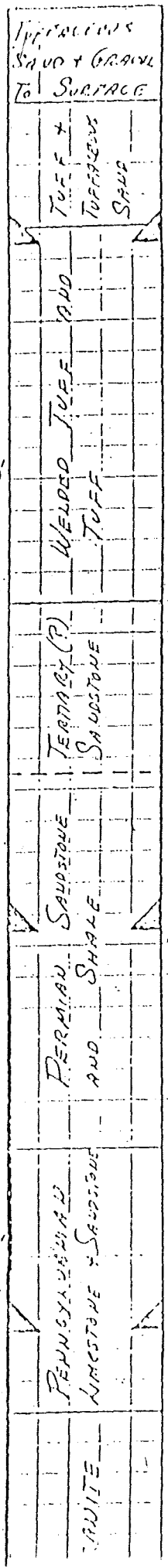
Little data are available on the formation pressure of the major dry-steam producing zones. On one occasion during shut-in, the wellhead shut-in pressure rose to over 500 psig, indicating a formation pressure of over 500 psig at the highest permeable zone open to the well bore. That zone is at a depth of 3468 feet and the zone produces dry steam. (The temperature of the zone is therefore greater than 465°F.) Assuming that the deeper, hotter dry-steam producing zones contain saturated steam, the reservoir pressure at a depth of 4900 feet (in excess of 530°F.) is about 885 psig.

Because of the influx of deep water, no good data are available concerning the potential flow of dry steam above the water-zone. The well flow, on the basis of visual observation, appeared to be in the order of 100,000 pounds of steam per hour.

The Baca #4 well proves the existence of an areally large, very hot, under-pressured hydrothermal system in the Valles Caldera. Temperatures in Baca #4 well and Baca #2 well, about three miles apart, are about the same on an above-sea elevation basis. The well also proves the existence of a vapor-dominated reservoir conducive to the production of dry steam. The areal extent and commercial utility of the vapor-dominated reservoir will be determined by future drilling.

Data from the Baca #4 well also proves that the pressure regime of the deep hydrothermal system is related to the deep groundwater flow of the regional Rio Grande drainage basin, and is largely independent of local topography.


DIXON LAND AND CATTLE CO. FIGURE 2
TEMPERATURE DATA
Mud Flowline
Casing Pt.
Suction Temp: 85-90°
Mud Flowline
Mud Temp
90°-100°
Lost Circ @ T.D. 3382'
Casing Pt. 3445'
Drilled with air to T.D.
Dusting
T.D. 4446' F.L.T. 204°
@ 31 hrs
F.L.T. 150-170°
7" liner cemented @ 4426'. Mud to bottom liner, no lost circ.
Survey 8-28-67: P@ 1400' = 236°
Plug 1647' Perfs 1300'-1460'
Fluid Level: 800'
BZM Survey 6-30-64
Static: Mouth
Plug: 2288'
Perfs: 1750-2
P@ 2000' = 377
Fluid Level 8
9 hrs Static
Schlumberger Temp Logs
Run 10-11-63 @ T.D. 5658'
Hole cooled with water for logging & perforating
Zone 3000' drilled 9-10-63
2½ hrs Static
1000'
1500'
2000'
2500'
3000'
3500'
4000'
4500'
5000'
5500'



BACA LAND AND CATTLE CO. - BACA #2

ELEVATION: 8500'

T.D.: 5658'

DRILLED: JULY - OCTOBER, 1964

SUMMARY

DRILLED WITH MUD TO 3445'
LOST CIRCULATION @ 1163' + 3332'

DRILLED WITH AIR 3445' - 4726'
T.D. 4446': F.L.T 204° F @ 31 psig
T.D. 4725': F.L.T 140° w/h. circulating

SET 7" liner 4726' - 3397'

DRILLED WITH AIR TO T.D. 5658'
DUSTING, LOW TEMP. returns

SET PLUG AT 4658'
COOLED WELL WITH WATER, Logged well - Temp, Gamma-Neutron
PERFORATED MANY ZONES 2400' - 3100'
WELL FLOWED 100 gal/min water @ 196° F. = 60,000 #/hr.

SET PLUG AT 2288'
PERFORATED 1950' - 2300' (??)
FLOWED HOT WATER
RIG RELEASED 10-26-64

6-30-65 TEMPERATURE SURVEY
STATIC WELL

SET PLUG 1647', PERFORATE 1300' - 1460'
FLOWED HOT WATER