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Exploration well, Surprise Valley, Fort Bidwell, lithologic column, hydrothermal model

ABSTRACT
A fourth exploration well within Fort Bidwell Indian Community (FBIC) lands has been successfully drilled to a total depth of 4,670 feet. Mud return temperatures and cuttings analysis are consistent with the hydrothermal model on which the well location was based. Wireline surveys have encountered an obstruction just below the casing shoe, and further evaluation of this well and resource awaits clean-out and testing activities.

Introduction to Well FB-4
A geothermal resource has been identified within the land occupied by the FBIC, located in the extreme northeast corner of California (Figure 1). Geologically, it is within the western portion of the Basin and Range Province and sits astride the eastern margin range-front faulting of the Warner Range. The Reservation is adjacent to the west side of the town of Fort Bidwell, and extends about 2 miles westward high into the Warner Range block.

Four wells have been successfully drilled into this resource since the early 1980s using a combination of funds provided by the California Energy Commission (CEC) and the United State Department of Energy (USDOE). The first three wells, FB-1, -2 and -3 have been discussed in a previous paper (Barker et al., 2005). The current paper will present the results obtained to date from the subsequent, deeper well FB-4 drilled in 2007.

The FBIC tribal leadership has chosen to explore this potential resource by leveraging State and Federal funding sources, and hence controlling the destiny of how it is developed. This resulted in the deepest and most recent well, FB-4, being drilled with a combination of CEC and USDOE funds. The well targeted a hypothesized upflow fault which is thought to feed surface manifestations and the thermal waters encountered in the first

Figure 1. Map of Northern California with Location of Fort Bidwell.

Figure 2. Location of Fort Bidwell Exploration Wells.
three wells. As indicated in Figure 2, the well was drilled to the west and up-slope from the first three wells.

Drilling the Well

Well FB-4 was successfully drilled in September and October of 2007 to a total depth (TD) of 4,670 feet (all depths are measured depth from the rig Kelly bushing unless otherwise indicated). The final string of casing was set at 2,785 feet. Figure 3 presents a simplified schematic of the well construction.

The project was under-funded, and the drilling of open-hole was stopped shortly before funds were depleted. No protective slotted liner was run. Maximum mud temperature returns of 152 °F (67 °C) were encountered at 3,200 feet, 415 feet below the casing shoe (Figure 4). After this, drilling occurred much of the time with lost circulation, and mud temperature returns could not be used as a meaningful diagnostic tool.

![Figure 3. Well FB-4 Simplified Schematic (not to scale).](image)

![Figure 4. FB-4 Mud Return-Temperature Kick.](image)

![Figure 5. FB-4 Lithologic Column, Key Drilling Events and Pressure & Temperature Survey.](image)

![Figure 6. Schematic of Original Fort Bidwell Model with FB-4 Obstruction Added.](image)
Petrographic and X-ray diffraction analyses of drilling cuttings have been carried out. These show the lithologic column to be a combination of ash-flow tuffs, rhyodacite flows, andesite flows and paleosols (Figure 5).

Another result of this analysis is the conclusion from clay mineral analysis that suggests that temperatures experienced during hydrothermal alteration have not exceeded approximately 356 °F (180 °C). This conclusion is in agreement with previous assessments that Fort Bidwell appears to be a moderate-temperature hydrothermal system (Atkinson and Vass, 2010, pg. 11). Figure 6 presents a schematic of the original hypothesized hydrothermal system used to locate FB-4, along with the approximate location of the obstruction recently encountered in the well.

**Attempted Testing of the Well**

The FBIC leadership was able to successfully obtain additional leveraged funding from the CEC in order to survey and carry out a flowtest on the well. The initial wireline survey in September 2009 encountered either a ledge or obstruction at 3,065 feet, only 280 feet below the casing shoe. This survey also found a standing fluid level at 300 feet, an encouraging result that indicates FB-4’s pressure is controlled by the same hot water system that the shallower FB-3 found. Survey results are displayed in Figure 5. A subsequent repeat survey with appropriate tools for assessing the nature of the obstruction concluded that the well was bridged. There was insufficient funding in the CEC grant to clean-out the well, so it remains bridged and untested.

**Current Assessment of the Resource**

The current status of the FBIC project to evaluate the potential geothermal resource under the reservation is that a deep exploration test well has been successfully drilled and that so far there is no data that invalidates the proposed geologic model with a hypothesized upflow temperature of 250-300 °F (121-149 °C). Thus, the proposed “play” concept is still valid and confirmation awaits obtaining of additional funds. An estimate of the funds needed has been made by Atkinson and Vass (2010, pp 15-17) – approximately $1,100,000 escalated to December 2011.

In conclusion, the FBIC has succeeded in maintaining control of its geothermal assets and has a sound foundation from which to continue exploration when funding allows.

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**References**

