

## **Kern River Field: A History of Using Innovation to Keep a Brownfield Green**

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### **Abstract**

The Kern River Field is one of the largest fields in the state of California and the US, and one of the world's largest thermally enhanced recovery projects. Located northeast of Bakersfield, California in the San Joaquin Basin, the field was discovered in 1899 and has produced more than 2.5 billion barrels. The field has a history of testing and utilizing new innovations and technologies to fuel the well factory in a brownfield. These technologies are utilized in all aspects of the drilling program from opportunity analysis to execution, and have extended the life of one of California's great oilfields. This paper will focus on four of the key innovations that have enabled the Kern River Field to continue to produce for over 117 years: 1) a robust subsurface dataset and surveillance program; 2) a world class 4-D full-field geostatistical model; 3) a successful horizontal drilling program, and 4) fault and deep sand plays.

One of the most critical pieces of technology for the current and future success of Kern River Field is the extensive subsurface dataset that includes over 12,000 wells with traditional open-hole log suites, over 650 observation wells that monitor temperature and oil/gas saturation, over 300 wells with conventional core, as well as outcrops of several of the producing intervals. This dataset is utilized in a 4-D full-field geostatistical model that monitors reservoir changes over time, provides input for reserves estimation, and aids in the identification, targeting and ranking of remaining opportunities. A number of innovative tools and technologies have been created based on data generated by the full-field model and are employed for opportunity identification, ranking, and selection. These include a multi-property geobody analyzer used within the full field model, fuzzy logic (a type of artificial intelligence) ranking, and an observation well database. Each of these tools are utilized to identify areas of the field with potential remaining oil, whether these areas are draining adequately, and how each area ranks relative to the others.

The horizontal drilling program at Kern River has been one of the field's great success stories. Horizontal opportunities are generated largely from the full-field model opportunity analysis tools. Since 2007, over 800 horizontal wells have been drilled. These wells account for just 5% of all producing wells in the field, they account for approximately 25% of the production.

Structurally, the main productive interval of the Kern River Field is relatively simple consisting of a gentle homoclinal dip to the southwest. However, several internal faults exist within the field. The majority of the internal faults are normal faults with the upthrown block to the east, which traps oil migrating downdip. The presence of trapped oil has been confirmed by both the observation well program as well as production trends. Several successful drilling packages have exploited the internal faults with both vertical and horizontal wells. Production from these wells is greater than the field average. Deeper targets within the field, such as the Veddar sands, are segregated into discrete fault blocks. Several wells have been drilled to prove several of these fault blocks within the field.