

**An Advanced Fracture Characterization and Well Path Navigation System  
for Effective Re-Development and Enhancement of Ultimate Recovery from  
the Complex Monterey Reservoir of South Ellwood Field, Offshore  
California**

Quarterly Technical Progress Report

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## **Progress Report April 1, 2005- June 30, 2005**

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### **Abstract**

Venoco Inc, intends to re-develop the Monterey Formation, a Class III basin reservoir, at South Ellwood Field, Offshore Santa Barbara, California.

Well productivity in this field varies significantly. Cumulative Monterey production for individual wells has ranged from 260 STB to 8,700,000 STB. Productivity is primarily affected by how well the well path connects with the local fracture system and the degree of aquifer support. Cumulative oil recovery to date is a small percentage of the original oil in place. To embark upon successful re-development and to optimize reservoir management, Venoco intends to investigate, map and characterize field fracture patterns and the reservoir conduit system. State of the art borehole imaging technologies including FMI, dipole sonic and cross-well seismic, interference tests and production logs will be employed to characterize fractures and micro faults. These data along with the existing database will be used for construction of a novel geologic model of the fracture network. Development of an innovative fracture network reservoir simulator is proposed to monitor and manage the aquifer's role in pressure maintenance and water production. The new fracture simulation model will be used for both planning optimal paths for new wells and improving ultimate recovery.

In the second phase of this project, the model will be used for the design of a pilot program for downhole water re-injection into the aquifer simultaneously with oil production. Downhole water separation units attached to electric submersible pumps will be used to minimize surface fluid handling thereby improving recoveries per well and field economics while maintaining aquifer support.

In cooperation with the DOE, results of the field studies as well as the new models developed and the fracture database will be shared with other operators. Numerous fields producing from the Monterey and analogous fractured reservoirs both onshore and offshore will benefit from the methodologies developed in this project.

This report presents a summary of all technical work conducted during the seventh quarter of Budget Period II.

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## **Introduction**

The Field Demonstration site for this Class III (basin clastic) Program Proposal is the South Ellwood Field located offshore California. The Monterey Formation is the main producing unit in the South Ellwood Field and consists of fractured chert, porcelanite, dolomite, and siliceous limestone interbedded with organic mudstone. This reservoir has an average thickness of 1,000 feet, and lies at subsea depths of approximately -3,500' to -5,000'.

Venoco and USC jointly submitted an application to conduct a DOE co-operative investigation of the Monterey formation at South Ellwood in June 2000. The DOE granted this application in July 2000.

## **Executive Summary**

Venoco and USC prepared a proposal for a DOE sponsored joint investigation of the fractured Monterey formation. It was agreed that Venoco would construct the geologic model for the field and gather new reservoir data as appropriate. USC would then develop a simulation model that would be used to optimize future hydrocarbon recovery. Joint Venoco-USC teams were established to manage the flow of data and insure that Venoco and USC activities remained synchronized. A co-operative agreement was signed with the DOE on July 31, 2000.

During Budget period I, Venoco worked with USC to develop a new geological and engineering model of the Monterey formation. This cooperative work between USC and Venoco has made several contributions to the tech transfer goal of the U.S. Department of Energy. The most significant of these were; the development of an interactive database on the Monterey Formation, a new simulation algorithm for the description of fracture-controlled Monterey Reservoirs, a pattern recognition method for analysis of well log data, enhanced water shut-off techniques and reprocessing of the 1982 3D seismic survey data to improve the geologic structural model. USC no longer participates in the project after the conclusion of Budget Period I activities.

The primary goal of the Budget Period II is to develop the new fault blocks identified as a result of the field re-evaluation conducted during Budget Period I. A Middle Sespe prospect was identified by an exploration well drilled from a jack-up in 1985. We have used the reprocessed 3D to image the South Ellwood structure at Sespe level. 3120-15RD4 was drilled during 2004-2005 to appraise this Lower Sespe structure. A second exploratory well will be drilled in 2005 to test the North Flank block of the Monterey.

## **Experimental**

Not applicable for the work performed.

## **Results and Discussion**

### **Task II – New Data**

The perforations in 3242-18 were acidized and a new Electric Submersible Pump was run in May 2005. Unfortunately, this caused a significant increase in water cut. We are planning to run a production log to evaluate the potential for a water shut-off.

#### **Task IV-1—Produced Water Re-Injection**

The two existing group separators (V-107 and V-108) will be retrofitted with new internals to allow three phase water separation. NATCO, the original designer of the group separators has designed new vessel internals for retrofitting these vessels. Upgrades will include a new proprietary “Porta Test Revolution” inlet separation device, a higher water weir and new water level control, alarm and shutdown instrumentation. The “Porta Test Revolution” inlet separation device utilizes centrifugal force to separate gas from the liquid without foaming. The higher water weir will allow longer liquid retention time to provide more complete water oil separation. These improvements will reduce the water cut in the oil shipped to Ellwood to approximately 10%. The Revolution devices have been arrived and during a platform shutdown in February 2005 we installed a new production header to direct all Holly produced fluids into a single production separator. Production V-107 was taken off line and cleaned. However since drilling operations are continuing on the Sespe and North flank wells, it was not possible to begin welding the internals in this vessel due to the limitations imposed by Venoco’s simultaneous operations policy. The modification of the two separators was postponed until the end of drilling operations in October 2005. Water injection should begin by the fourth quarter of 2005.

#### **Task IV-2—Downhole Water Separation ESP’s**

Venoco conducted a review of Platform Holly modifications that would be required to accommodate additional ESP wells. Holly is run on shore power and the load factor for the subsea power cable must be closely monitored. We have been reviewing two alternatives. First the drilling rig generators could be modified to run continuously and generate power for Holly in parallel to the grid. Secondly we could raise separator pressure and decommission one of the large Holly gas compressors. This would free up enough spare power to supply five new ESP wells. Current lead times for equipment for either of these options will probably delay implementation of this task until 2006.

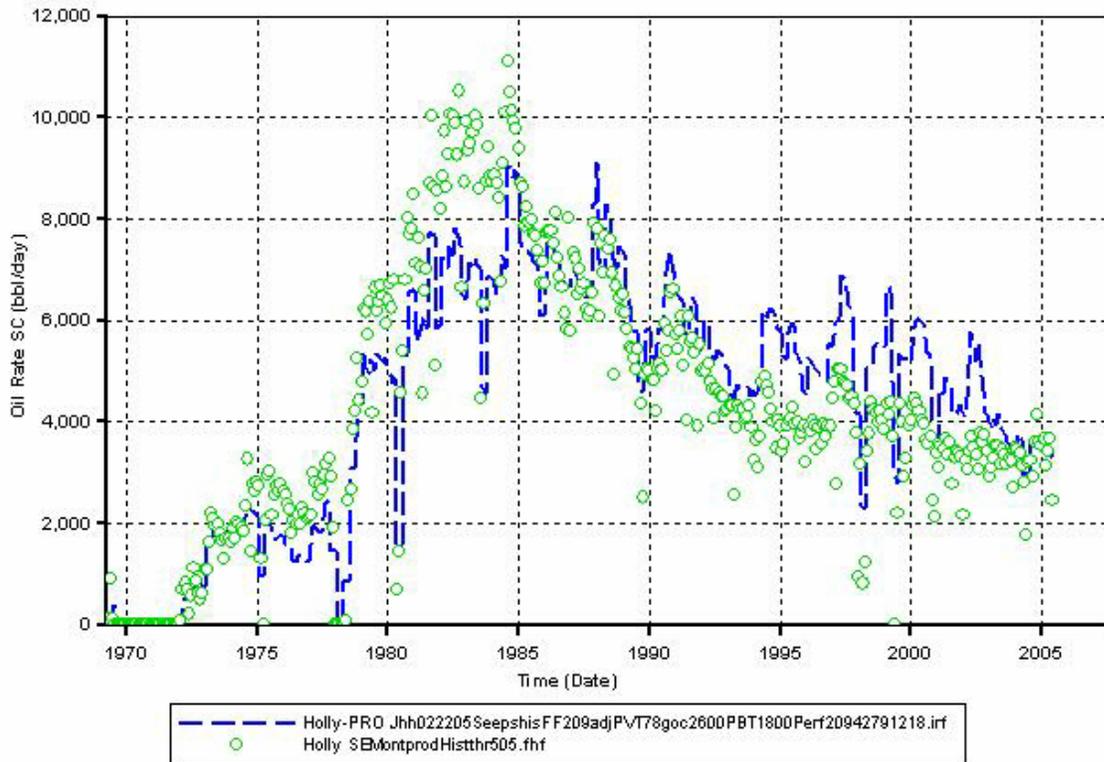
#### **Task IV-3—Development of New Fault Blocks**

##### **South Ellwood 3D Simulation Model**

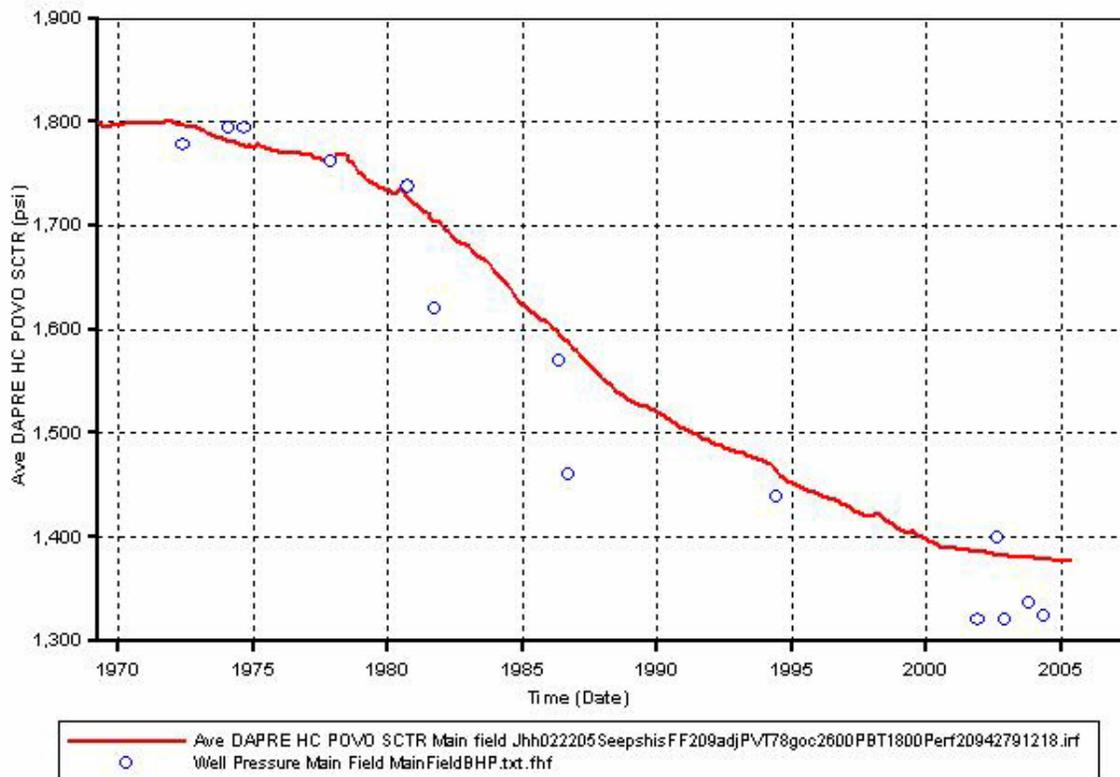
A new reservoir simulation model of the Monterey was constructed using CMG after the geological model was modified to add two new faults and make corrections to the Lower Monterey surface. The model has been history matched and is being used to predict performance for the future North Flank wells. The following figures show the comparison of the model oil production rate and reservoir pressure with the historical data.

# History Match Plots for Oil Production and Reservoir Pressure

## South Ellwood Monterey from GoCad7/04



## South Ellwood Monterey from GoCad7/04



## **Sespe Well 3120-15 RD4**

The Sespe well (originally called 3242-19 RD1) was renamed 3120-15RD4 by the California Division of Oil, Gas and Geothermal Resources since the producing interval is located on State lease 3120. The well reached a total depth of 14247' on January 17<sup>th</sup> 2005. Excellent gas shows were evident in the Middle Sespe, Gaviota and Coldwater formations. A 2-7/8" completion string was run to test a barefoot section in the massive sands of the Gaviota formation from 12965-13650'. This zone tested wet with minor traces of gas. The reservoir pressure was estimated to be 5500 psi. During testing, the tubing plugged with mud. The tubing was cleaned out with coiled tubing and the completion recovered. TCP guns were run and set on hanger to shoot the Middle Sespe sands. At report time, the completion was being run but considerable difficulties were experienced trying to set a packer in the liner with oil based mud still in the hole. Net pay in the Middle Sespe is 338'. If successful, a production test in the Middle Sespe will add up to 12 MMB of reserves.

## **North Flank Well 3242-13 RD1**

The North fault block is a large Monterey fault block that lies just to the north of the main fault block and is downthrown approximately 800' by the N1 fault. Two exploratory wells were drilled into this fault block in the 1970's and it was assumed to be wet. However, the reprocessed 3D seismic data shows that these two wells drilled into the bottom of a syncline. 3242-10 tested a small amount of heavy oil from what is now assumed to be the oil-water contact of this fault block. A considerable reservoir volume lies updip of these two wells trapped against the Red Mountain regional fault. Significant natural seep activity occurs above the point where this north limb terminates against the Red Mountain fault. A smaller rock volume is trapped against the N1 fault to the south. An idle well, 3242-13, will be redrilled to test both limbs of the syncline during the Third Quarter of 2005. The original perforations of this well were squeezed and abandoned during 2004. A successful appraisal well may add up to 20 MMB of reserves.

## **Task V- Project Management**

Project review meetings were held on a monthly basis in Carpinteria. Individuals working on the project during this quarter included:

### **Reservoir Studies:**

Steve Horner

### **Geological/Geophysical Modeling**

Marc Kamerling, Chris Knight

### **Project Management:**

Steve Horner

## **Task VI-Technology Transfer**

Steve Horner presented the Pool Engineering Report for South Ellwood Field to the Conservation Committee of California Oil and Gas Producers on May 4<sup>th</sup>, 2005. He also gave a

presentation on reservoir engineering aspects of the South Ellwood field to an undergraduate geology class at University of California in Santa Barbara.

### **Conclusions:**

This is the seventh quarterly technical report for Budget Period II. Three significant new projects are in progress. An appraisal well was drilled to test the Sespe prospect identified from seismic reprocessing. This well is presently being production tested. A second exploratory well will be drilled to appraise the Monterey North flank block. In addition, we have completed design work to separate and re-inject all produced water back into the Monterey at Holly. Equipment has been purchased to modify the Holly separators and we expect to complete the project by Q4 2005. These projects could add more than 30 MMB of reserves to South Ellwood field.

### **References**

Conglomerates of the Upper Middle Eocene to Lower Miocene Sespe Formation along the Santa Ynez Fault, Howard J.L, USGS Bull 1995-H, H1-37