Monday, October 18, 2004

Westchase Hilton • 9999 Westheimer
Social 5:30 p.m., Dinner 6:30 p.m.

Cost: $25 Preregistered members; $30 Nonmembers & Walk-ups

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by ***J. Forney, H. San Martin, P. Enwere, J. Vega, P. Acuna, J. Ochoa***
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Shushufindi Field, Oriente Basin: Ecuador's Giant Revisited

Shushufindi Field, Ecuador's giant, was discovered by Texaco in 1970 and has already produced over 1 billion barrels of oil from Cenomanian and Turonian age estuarine and marginal marine sands of the Napo Formation. The structure is a 30-kilometer-long anticline bounded to the east by a north-south-trending reverse fault.

When Shushufindi was returned to Petroproducción after 20 years of development and production, the field experienced significant water breakthrough and there was little documented understanding of the reservoirs and the field's reservoir compartmentalization. Now, nearly 30 years after its discovery, a clear model of the field is emerging.

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The U and T intervals of the Napo Formation represent two cycles of regression and transgression: The sequence boundaries at the base of the U Inferior and T Inferior reservoirs are typically erosional events at Shushufindi associated with Cenomanian and Turonian sea-level lowstands. As sea level started to rise again, estuarine and nearshore facies of the U Inferior and T Inferior reservoirs were deposited in areas within the incised valleys. The U Superior and T Superior reservoirs, along with the A and B limestones, are primarily marine deposits deposited later during the transgression.

Using best practice methods summarized here, a high-quality reservoir model has been constructed for Shushufindi Field. This model which has been used in the reservoir simulation to understand the field's behavior and to optimize its future production.

- Incised valley and channel incisions of the U and T sequence boundaries were defined using 2D seismic. The estuarine reservoirs are deposited within the valleys, partially compartmentalizing the field.
- An inherited northwest and northeast structural grain controls the location of incised valleys and channel systems. Local accommodation space and the proximity of the shoreface influence facies distributions.

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- Six distinct estuarine and near marine facies were identified and characterized based on the core data from 20 wells. These facies correspond closely to the hydraulic units of the field.
- A neural network model was developed between the core facies and log data. Facies were then modeled for each well and facies maps were constructed.
- The relationship between porosity and permeability was established for each facies based on core measurements. Using these relationships, permeability curves were computed from the porosity curves.
- Reservoir models were built using well- and seismic-controlled isopachs and depth maps, coupled with petrophysically-derived hydrocarbon pore volumes.
- Relative permeability data and pressure data were often erratic but interpretable in context of the channel systems and facies: For example, U Inferior's pressure histories are more consistent when grouped along a channel system, suggesting partial compartmentalization of the reservoir.

Shushufindi has several hundred million barrels remaining reserves. The rock quality is very high, commonly having 15%–20% porosity and 2–3 darcy permeability,; and the field has a strong, sustained water drive in most areas. Further development developed through reservoir simulation will focus on minimizing water invasion and on targeting attic oil locations.

Finally, a number of additional exploration targets and plays were recognized in the prolific and high-potential Oriente Basin. There are a number of large undrilled structural features identified regionally, one of which was drilled by Sipetrol with reported success. Major exploration potential still exists in the primary Napo and Hollin plays and additional plays exist as well. With the opening of the OCP pipeline in 2003 providing critical access to market, Ecuador is experiencing a significant new round of exploration and development. ■

Author's note: Ecuador is a microcosm of the world's balancing dilemmas: Loan balances owed to the IMF threatened to topple the economy this last decade, pushing half the population into poverty and resulting in considerable political instability. The environment and indigenous people of the Amazonian Oriente Basin have not benefited from the oil production historically. Can a partnership of government, industry and world's financiers achieve an outcome where all stakeholders benefit?

Biographical Sketches

Jan Forney has explored in many of the most prolific basins of the world, a key player with an excellent track record of identifying new growth potential in these basins. Over 22 years, her experience spans more than 15 countries and includes key roles in the deepwater plays of the Gulf of Mexico and West Africa at Amoco and Texaco and working the stable shelf petroleum systems of the Middle East. At Amoco, highlights include acquiring acreage on Mad Dog and along the Mississippi Fan Foldbelt, helping to acquire deepwater acreage in Angola (Block 18) and a number of successful exploration wells in the Gulf of Mexico and the Emirates. Along with a love for exploration, she also is a strong technical geophysicist who brings a variety of tools to bear. She holds a master's degree from University of Massachusetts, Amherst and a bachelors from Smith College.

Hector San-Martin is an AAPG Certified Petroleum Geologist and Texas State Licensed Professional Geoscientist with over 25 years of professional experience in the oil and gas industry. He received an MS in geology from Imperial College of Science and Technology in London, U.K., and BS in geological engineering from Universidad Central del Ecuador in Quito. He began his career as a geologist in exploration and development projects working for Texaco and subsequently for Tenneco and British Gas. In 1996, he switched to the services side of the oil and gas industry, working for Halliburton in diverse projects across the Americas. He is currently a Senior Geoscientist with the Geosciences and Engineering Group (Core Laboratories) in Houston. He is interested in the integration of well, seismic and engineering data to projects ranging from prospects generation to reservoir management and in particular, the reactivation of mature fields. He is a member of AAPG, HGS, GSH, GCSSEPM and SIPES (Affiliate).

Pauly Enwere is a reservoir engineer and a petrophysicist with over 10 years experience in core-log data integration, reservoir characterization, special core study, NMR core spectrometry and its application to calibrate logging tools. He was the Senior Petrophysicist for Core Laboratories PLC from 1998 to 2004 and performed the petrophysical analysis of the Shushufindi and Libertador projects for Petroecuador. Dr. Enwere earned a PhD in petroleum engineering from the Imperial College of Science, Technology and Medicine (University of London), United Kingdom, in 1991. He joined Core Laboratories after post-doctoral research at the Royal School of Mines of the Imperial College, London. In addition to English Dr. Enwere is proficient in Russian and Spanish.