Geoscience II presents wellbore analysis tools

DRILLING SALT FORMATIONS

RATE OF PENETRATION (ROP) increases significantly if salt formations are drilled using undersaturated fluids. This is especially true when drilling riserless. Of primary concern is the amount of hole enlargement that will occur.

However, if managed, then a step-change in drilling performance and environmental-compliance can be achieved, particularly in riserless "pump-and-dump" drilling operations, by eliminating unnecessary fluid discharges to the seabed.

The authors will present, in detail, the results of a comprehensive and large-scale laboratory testing program performed on outcrop salt samples that replicates drilling salt formations with undersaturated drilling fluids with flow rates of up to 1,000 gpm.

The laboratory-testing program includes tests performed in a CT-scanner to map hole enlargement in real-time, as well as variously sized borehole leaching tests in samples of up to 15 ½-in. diameter and borehole diameters of up to 6-in.

An analytical hole enlargement prediction model will be presented that incorporates the effects of ROP, pump rate, drill-fluid saturation, dissolving salt drill-cuttings and salt leaching from the borehole wall. This model can accurately predict the results of the scaled laboratory tests for a wide range of flow rates and fluid saturations.

Predictions of field performance will be made, and the implications of the predicted hole geometry discussed. The authors will also present a matrix of options whereby salt formations may be successfully drilled with seawater or partially-saturated fluids, and will discuss the implications and cost-effectiveness of doing this in deepwater wells.

The authors will present significant new information of relevance to drilling salt. No laboratory testing of this kind has yet been published in the drilling literature. The analytical model builds upon significant expertise within Sandia National Laboratories gained from understanding mechanisms of salt cavern leaching. Extending the salt leaching formulation to consider drilling conditions is a significant advance in this area of science.

Drilling Salt Formations Offshore with Sea Water Can Significantly Reduce Well Costs (IADC/SPE 87216) **S M Wilson**, **P M Driscoll**, **BP America Inc**; **A D Black**, **J W Martin**, **A Judzis**, **TerraTek Inc**; **B Ehgartner**, **T Hinkebein**, **Sandia National Laboratories**.

MANAGING TEMPERATURES

Thermal effects on wellbore stresses can have a significant impact on effective fracture gradients. Changes in wellbore temperatures caused by various drilling operations provide for these thermal effects. For example, circulation on bottom usually results in lower bottom hole temperatures than the static geothermal temperature.

The successful drilling of a deepwater well offshore West Africa is evidence that with the application of new 3-D seismic technology, modeling, and the proper expertise, pore pressures and fracture gradients can be accurately predicted without direct offset well information. The well was designed with the assistance of Triton Engineering and drilled by Transocean's Deepwater Discoverer. IADC/SPE 87219

This cooling effect reduces the wellbore stresses resulting in lower effective fracture gradients, resulting in costly lost circulation events in many cases. Minimizing the cooling effect reduces the potential for these lost circulation events. In addition, increasing wellbore temperatures can increase effective fracture gradients and the corresponding pore pressure/fracture gradient margin allowing for fewer casing strings than would otherwise be required.

Managing wellbore temperatures to increase effective fracture gradients can result in significantly lower drilling costs and/or risks and could have a large impact on deepwater and high pressure - high temperature wells.

The authors will present results from leak-off tests at various temperatures and examine the effects of operational factors on wellbore temperatures to minimize the cooling effect and/or increase effective fracture gradients.

Increasing Effective Fracture Gradients by Managing Wellbore Temperatures (IADC/SPE 87217) **C J Naquin**, **S T Ellis**, **Landmark Graphics Corporation**; **M E Gonzalez**, **J B Bloys**, **J Lofton**, **G P Pepin**, **ChevronTexaco Petroleum Technology**; **J H Schmidt**, **FracDogs Inc**; **P E Laursen**, **Halliburton Energy Services**.

EXTENDED REACH DRILLING

The drilling of extended reach wells (ERW) has become almost common practice in the oil industry. Although it still poses many technical challenges, successful applications such as the one at Wytch Farm, UK, spurred the interest in ERW by the operators.

In parallel with the push for even further lateral displacement of wells, another technology frontier emerged for drillers: extended reach drilling (ERD) in deepwater.

Extended reach wells drilled from fixed platform installations in shallow water usually are aimed to reach outer parts of reservoirs that otherwise could not be developed economically.

In deepwater, ERW allows the use of dry completion platforms such as a TLP or spar. It improves flow assurance and reduces the cost of the well and the future interventions.

The authors will provide an overview on the effects of water depth on extended reach drilling in two sections.

The first section is aimed at providing a general overview and examine the direct impact of water depth on several aspects that include wellbore stability, KOP positioning, torque/drag and ECD versus fracture pressure gradient.

Important Aspects Related to the Influence of Water Depth on Extended Reach Drilling (IADC/SPE 87218) **L R Rocha**, **H L Freier**, **Petrobras**; **R M de Andrade**, **Landmark Graphics**.

REMOTE WELL PLAN

The successful drilling of a deepwater well offshore West Africa is evidence that with the application of new 3-D seismic technology, modeling, and the proper expertise, pore pressures and fracture gradients can be accurately predicted without direct offset well information.

The nearest wells from which hard data could be obtained for analyzing the lithology of the West Africa location were significantly shallower wells drilled just off the shelf in shallower water depths, making the data less than reliable for comparison.

Seismic interval velocities obtained at the selected location were quickly identified as the key to predicting pore pressures and fracture gradients. The use of 3-D data allowed the well planning team to examine a broader area around the prospect and provided a more thorough analysis of the potential for abnormal pressures.

The careful selection of professionals with the appropriate technical expertise, experience and knowledge of the region also played a critical role in validating and fine-tuning the predictions made and the subsequent well design work that followed.

The author will discuss the limited data available at the project's initiation, the use of data extrapolated from a very limited number of regional candidate wells drilled at similar water depths, the use of 3D data in analyzing seismic interval velocities, and how all of these factors contributed to the accurate prediction of the pore pressure and fracture gradient environment of a deepwater location with limited data from offset wells.

Pore Pressure/Fracture Gradient Prediction Challenges: The Successful Design and Implementation of a Remote Exploratory Well Plan (IADC/SPE 87219) **D C Hradecky**, **Noble Corporation**.

WELLBORE STABILITY

The Valhall field is an overpressured, undersaturated Upper Cretaceous chalk reservoir located in the North Sea offshore southern Norway.

The author will review the wellbore stability aspects based on the first 20 years of drilling at Valhall, presenting key learning's applied through the field development in areas such as mud weight design, trajectory planning, fluid selection, LCM design, novel real-time stability monitoring and integrated earth modeling.

Due to the high overpressure and weak rock the learnings from drilling Valhall should have some relevance for HPHT developments. The author will also give an indication of the economic impact of wellbore instability problems in a development like Valhall.

Drilling Wellbore Stability in the Compacting and Subsiding Valhall Field (IADC/SPE 87221) **T G Kristiansen**, **BP Norge**.

WELLBORE STABILITY ANALYSES

During wellbore stability analysis it has often been observed that unrealistic results appear. For example, by increasing the inclination of a simulated wellbore, the critical collapse pressure may exceed the critical fracturing pressure, clearly a faulty result.

When these results appear, they are often ignored. This problem has been seen in many cases both from operators and service companies. The magnitude of the in-situ stress tensor comes from several sources.

Overburden stress is derived from bulk density logs or cuttings measurements, whereas the maximum and minimum horizontal stress comes from inversion of fracturing data or from various LOT interpretations.

The pore pressure is indirectly determined from many sources of data. Since all these are independently derived, consistency may not always be expected. The author will present a new method to constrain the magnitudes of these data to realistic values.

A field case of a HPHT field offshore Norway shows the application of the bounds, and demonstrates improvement in modeling when consistent in-situ stress data are used. It is a case from an offshore oil field with known borehole stability problems.

The result of the new approach is an improved correlation between the model and the fracturing and collapse behavior throughout the entire well. The method can also provide default parameters for the initial prognosis for wildcat drilling when no data is available. Another example will demonstrate this and show how the default model reduces uncertainty in predictions.

Bounds on In-Situ Stress Magnitudes Improves Wellbore Stability Analyses (IADC/SPE 87223 – Alternate) **B S Aadnoy**, **Stavanger University**; **A K Hansen**, **Shell Norway**.

DEPLETED ZONE DRILLING

The issue of drilling depleted zones is increasing in importance as more wells are drilled in mature fields.These producing zones are typically produced or producing reservoirs overlaid and interbedded with shale layers. Pressure overbalances have been reported as high as 13,000 psi but are more typically of the order of a few thousand psi.

Wellbore stability problems associated with drilling in these zones can be linked with drilling-induced and pre-existing fractures. The authors will describe an approach that links a fracture-fluid-flow model with experimental characterization of fluids in a range of flow conditions and in a fracture generation apparatus. The understanding gained is used to develop guidelines for minimizing losses into fractures.

Depleted Zone Drilling: Reducing Mud Losses into Fractures (IADC/SPE 87224 – Alternate) **L Bailey**, **J Adachi**, **O H Houwen**, **G H Meeten**, **P W Way**, **Schlumberger Cambridge Research**; **F B Growcock**, **R P Schlemmer**, **M-I LLC**.