

## Realtime Geopressure and Wellbore Stability Monitoring while Drilling

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The Present And Future Of GeoPrediction

### Main points



- 1. Why bother with PPwD? Isn't the prognosis good enough?
- 2. Can it be justified?
- 3. PPwD as part of the Drilling process
- 4. Make the most of your valuable data and knowledge
- 5. Some case histories
- 6. Summary / Conclusions





Any Pore Pressure Prognosis inherently involves uncertainty

- Offset Well Data Uncertainty
  - Distance / Geologic complexity
  - Offset MW don't necessarily reflect PP
  - May be no relevant offset data available
- Seismic Data Uncertainty
  - Low resolution, 500'-2000'
  - Not always suitable for PP Prediction
- Geological Uncertainty
  - Formation properties
  - Formation depth / thickness

## Why bother with PPwD?



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In 2004\* geopressure and wellbore stability related problems were estimated to be costing the industry **\$8billion/year** 



- Stuck Pipe
- Kicks
- Lost Circulation
- Sloughing Shale
- Flows
- Wellbore Instability
  - = 41% of total NPT

## Why bother with PPwD?



In 2009 an update of this study \* showed similar statistics and an average of \$2.5m Non-Productive Time cost per well



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\* Eliminating Non-Productive Time Associated with Drilling Trouble Zones, OTC 20220

#### PPwD can = \$\$\$ saved







Financial savings can be made at all levels in the well process. Not just the big-ticket items:

- Kick / Blowout
- Lost circulation
- Stuck pipe / Twist off / Sidetrack
- Correct casing shoe depth

But also the 'smaller' stuff:

- Avoid Circulating time
- Avoid trip in HPHT conditions for LWD failure
- Reduce need for 10-10-10 tests
- Help diagnose ballooning/breathing = avoid MW increases



A picture says a 1000 words...



## PPwD as part of Drilling Process



Prognosis			
Seismic	Drilling		
Regional Studies Offset Wells	Mitigate Predrill Uncertainties Safe & Efficient Drilling Optimise MW & Casing Plans	Post-well QC'd final data set	
	Proper use of offset well data Document lessons learned Good quality borehole		

#### The PPwD process





#### The PPwD process





#### WITSML Reader

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#### **Geopressure Application**





### Make the most of your data



#### Display and analyse ALL data in relation to each other Start with the calibrated regional parameters as guides for monitoring while drilling

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## Make the most of your data



#### Time-based data can be imported via WITSML High resolution for detailed events analysis



### **Some Case Histories**



- 1. Norske Shell, 1998 Deepwater well, Norwegian North Sea
  - Shell estimated savings of \$7,000,000 due to pore pressure work on well
  - AAPG, Birmingham, England 1999 "Optimising Well Casing Design In A Frontier Deepwater Basin Using Real Time Pore Pressure Prediction Whilst Drilling" – James, Horbeek, Taklo and Doyle
- 2. Shell Brunei, 1999 Deepwater well, S. China Sea
  - "Prevented at least one kick and reduced drilling time"
  - Internal Shell Magazine article, then published in OFFSHORE Magazine "Real-time pore pressure calculations from MWD: Successful application in the South China Sea"
    - Doyle, Kuyken and de Lange
- 3. BP Norge, 2002 Deepwater well, Norway
  - Saved a contingency casing string; helped define well TD
  - SPE Paper 79848, Amsterdam 2003 "Plan for Surprises: Pore Pressure Challenges during the drilling of a Deepwater Exploration Well in mid-winter in Norway" - Doyle, Berry and McCormack
- 4. Norsk Hydro, 1996 HPHT well, Viking Graben, Norway
  - First use in N. Sea of Seismic While Drilling, combined with Basin PP Modelling
  - Saved contingency 16" liner and set 13 3/8" casing 500m deeper than planned
  - PP Workshop, Pau 1998 "Case study Comprehensive approach to formation pressure prediction and evaluation on a Norwegian HPHT well " - Doyle

## Summary

From drillingcontractor.org – "Real-time data offers critical tool to redefine well control, safety" by Pritchard

- All well control events are predictable and avoidable
- The more complex the geological environment, the more uncertain the PP and FG... Effective monitoring helps ensure the successful navigation of the drilling margin
- Monitoring must evolve to be proactive. Multiple specialists should be involved



#### Summary, contd

- Real-time data can not only improve process safety but can also improve decision quality around management of change and risk management
- Data systems must use intelligent agents to ensure process safety before the event occurs
- Industry leaders are challenged in their ability to effectively monitor key drilling parameters....For those who may be old enough to remember what Well Listening means, they are challenged not only with drilling the well but also mentoring a younger generation unfamiliar with the art and science of rotary drilling.





# Real-time Pore Pressure Surveillance while Drilling reduces:

- Uncertainty
- Risk
- Cost



#### Thank you – Any Questions?

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#### Norway, North Sea 1995-1998

#### Viking Graben – Real-Time drilling support of Geopressure prediction ahead of the bit



Actual Fm tops and PP estimate at bit are fed into Basin Model to update ahead of bit prognosis and reduce uncertainty