KMS Technologies - KJT Enterprises Inc.

Presentation

Strack, K. – M.

1999

The next paradigm: Integrating borehole & surface geophysical techniques for better reservoir characterization

University of Houston

The next paradigm: Integrating borehole & surface geophysical techniques for better reservoir characterization

1999

K.-M. Strack

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(After AFES, Strack 'Pie in the Sky', 1998)

Presentation challenge: ???

How do convey what I would be doing in the future without -

- overloading an unknown audience
- bragging about my great achievements
- knowing future technologies
- over promising

???

Presentation Objective

- Display a vision based on data points.
- Tie existing to my own experience.
- Link to AGL/UofH objectives.

.... Or just share my dream

Outline

- Paradigm Shift
- Array tools: The Present (my past)
- 3D volume integration: The Future
- Conclusions

The Paradigm Shift: log analysis



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The Paradigm Shift: information value



Integration information in the 3 D volume

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Meters vs acquisition systems: Induction



Meters vs acquisition systems: Galvanic



WALS98209c

Aray tools:...

- Model based interpretation
- State-of-the art acquisition system (24 bit, high data rates, full waveforms)
- Software processing for improved S/N



Nonlinear Optimization

Parameter subspace

Parameter subspace 2

Initial Guess

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Inversion: Process flow



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Reserves estimate **DPIL vs. HDIL**

DPIL HDIL

Reservoir Thickness:		270 ft
Net Pay (ft)	103.6	130.1
Net Pay	38.4%	48.2%
Por. Feet	15.4 ft	18.9 ft
Hyd. Feet	7.4 ft	9.2 ft

HDIL data allowed 24% more OIIP be booked.

Step change through software





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- Objectives
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How from Today to 'Pie in the Sky' (10 years)

- Future technology already exists
- Future is a different use of existing components
- Aligned along maximum benefit (economic, technical)
- Virtual computing brings revisiting

Path

- Identify objectives
- Identify components... delivery vehicle: 3D cube

DeepLook: Vision



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Scope of the Challenge



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Formation Evaluation Trends

- Reservoir/production: Drainage
 - Measurements:

 NMR (fluids, texture), Susceptibility (mineralogy), Stress & structure (fractures, interwell geology), Horizontal well (guidance, assessment), Through-casing (existing reservoirs)

- Modeling & Inversion (logs and integration)
 UNCERTAINTIES
- Deep investigation techniques: The Next Generation
 - Cross-well techniques...selective cases
 - Single well/ cross-well seismic
 - Single well EM
 - Borehole gravity

JOINT technology gives answer

Shopping list:

- Optimum use of MWD & wireline
 - MWD: routine and steering
 - wireline: imaging and deep
- Advanced logs: mineralogy, downhole analysis..
- Downhole laboratories & factories

– tie with SWD to seismic cube

Glue to the Information puzzle



Glue components:

• **3D VSP**

- Cross-well seismics
- Hole-to-surface EM
- Borehole gravity
- Sub-seismic fracture mapping
- Geostatistics

3D VSP integration

3D Time surface seismic migration processed by ELF

3D VSP Migration (depth-to-time conversion) pasted into surface seismic migration

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Reservoir Connectivity Mapping (RCM)



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Reservoir Connectivity Map

Gypsy Pilot Site with pre-survey geologic correlations



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Directional Sensitivity - EM



Can pinpoint location of compact target in uniform host, plus sign and magnitude of conductivity contrast

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Surface-to-hole EM



Borehole Induction Logs



Oil-Water Contact model - EM



X

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EM - Resolution Analysis - OWC Model



Tx Position (m) wrt Borehole

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Traditional Oil and Gas production



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BHGM-Derived Densities for 3 Annual Surveys in the RABI Oil-Rim

Repeat BHGM densities across Rabbi field gas/oil contact in Gabon.

Porosity: 24%, Gas ρ: 0.082 g/cc, Oil ρ: 0.780 g/cc.



Structural Effect of Salt Overhang



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BHGM field (black) & model (red) response to Slight Overhang



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Final interpreted Shape of Salt Dome with field and model BHGM responses



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Sub-seismic fractures from STAR



POST-STUDY DRILLING STRATEGY

Avoid 'super fractures' with injectors and producers - ENE well trajectories

Maximize contact with matrix and small fractures - inclined wells





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Fractured reservoir example





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Creating the 3-D Reservoir Model



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Conclusions

- Advances driven by state-of-the-art
- Economic drive fuels the progress
- Integration provides added value
- General technologies (i.e. computing) will provide environment & continuous changes
- Objective: populations of 3D cube (tie to geology & seismic)



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