KMS Technologies - KJT Enterprises Inc.

Presentation

Strack, K. – M.

1999

Advances in Electrical Logging Tools for Reservoir Characterization

European Association of Geoscientists & Engineers Conference & Technical Exhibition, Helsinki, Finland

Advances in Electrical Logging Tools for Reservoir Characterization

K.M. Strack

EAGE 99

KMS Technologies

& Baker Hugnes - Baker Atlas

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The challenge to the industry

Introduction tools and methods

Case histories

Conclusions

DeepLook: Vision



The Paradigm Shift: information value

Integration information in the 3 D volume

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Scope of the Challenge



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Oil - Resistivity relationship



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Formation Evaluation Trends

• Reservoir/production: Drainage

- <u>Measurements</u>: Stress & structure (fractures, interwell geology), Horizontal well (guidance, assessment), Through-casing (existing reservoirs)
- <u>Modeling & Inversion</u> (logs and integration)
 UNCER
- 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:
 - faster well-site decisions,
 - higher resolution
 - deeper investigation
- Permanent sensors

Outline

Co

Introduction: tools and methods

Case histories

clusions

challenge

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LWD and wireline methods definitions:

- MWD/LWD measurement/logging while drilling
 - sensor is part of the drill string; hostile sensor environment; basic sensors exist; making fast progress, data transmission via mud pulse (few 10 Hz) & memory packages
- Wireline sensor attached to armored long cable
 - delicate instruments with real time surface acquisition; formation samplers to high data rate imaging tools (video).



MWD and wireline induction logs **GOM**



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MWD and wireline induction logs North Sea



KMS99002m

MWD and wireline induction logs North Sea



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Tools & Methods:

- Resistivity logging status
- Meters versus acquisition systems
- Hardware: analog versus 24 bit
- Interpretation:chart versus inversion
- 3D modeling



Meters vs acquisition systems: Induction



Meters vs acquisition systems: Galvanic



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Hardware: Analog versus 24 bit

• <u>OLD</u>

- analog detectors to surface
- balanced (formation sensitive)
- 12 bit
- temperature sensitive
- <u>NEW</u>
 - digital signal processing at sensor
 - high instantaneous dynamic range
 - 24 bits sigma delta
 - high temperature
 - array measurements

Input amplifier noise



Geoinversion: Log integration & upscaling



Induction



Inversion: Process flow



3D Modeling

• <u>OLD</u>

- algorithms not widely available
- Run time too long
- mainly vertical wells
- <u>NEW</u>
 - algorithms more available
 - Super/parallel computer on desktop
 - mostly horizontal wells



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

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Case histories

- Array tool advantage
- 1D versus 2D
- Upscaling
- 3D example
- Multi-component the future

Step change through hardware



Reserves estimate DPIL vs. HDIL

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

7.4 ft 9.2 ft

HDIL data allowed 24% more OIIP be booked.

Step change through software





Inversion: 1D versus 2D





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HDLL horizontal well example



WAL S98208ab

Cross-well time lapse measurements

Crosshole EM Resistivity 4/97



Crosshole EM Resistivity 8/98

Difference (%)



Courtesy of EMI Inc.

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Formation Resistivity - LWD & Wireline

- Ability to enhance both LWD & Wireline resistivity data
- More resistive zones translate into more OIP



Joint inversion of MPR & HDIL data

TCR Colorado test



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Outline

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Conclusions

EM measurement make up majority of borehole measurements. Ideal sensitivity for fluid • MWD/LWD is getting more common. Inter-well space is reached with deeper single well and cross well measurements. KMS Technologies – KJT Enterprises Inc. 6420 Richmond Ave., Suite 610 Houston, Texas, 77057, USA Tel: 713.532.8144

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