

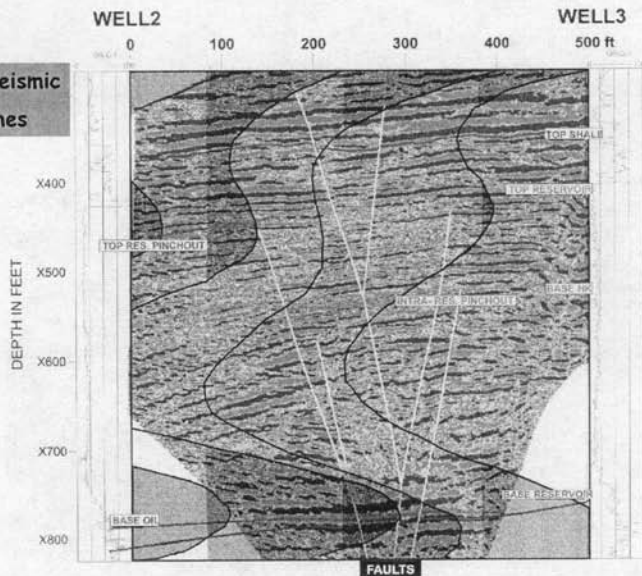
# Using logs & data: INTEGRATE

- Integrate logs & seismic
  - ⊗ Human
  - ⊗ Pseudo - correlations
- Integrate different physical measurements
  - ⊗ Density - GWC
  - ⊗ Resistivity - OWC
- Integrate physical parameters:
  - ⊗ Anisotropy (borehole!)
  - ⊗ Rock physics & fluids

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## UAE: x-well & surface seismic

- Cross well & surface seismic
- Xwell resolution 10 times



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After Sheline, 1998

# Roadmap

- 4 talks - main hall
- 2 posters in both halls coffee break 9:50-10:40
- @10:30 open mic for posters
- 3 talks - main hall

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## The need for an integrated seismic/EM system

K.-M. Strack<sup>1</sup>, E.L. Majer<sup>2</sup>

1 KMS Technologies - KJT Enterprises Inc.

2 Lawrence Berkeley National Laboratory

Pau, May 1, 2001

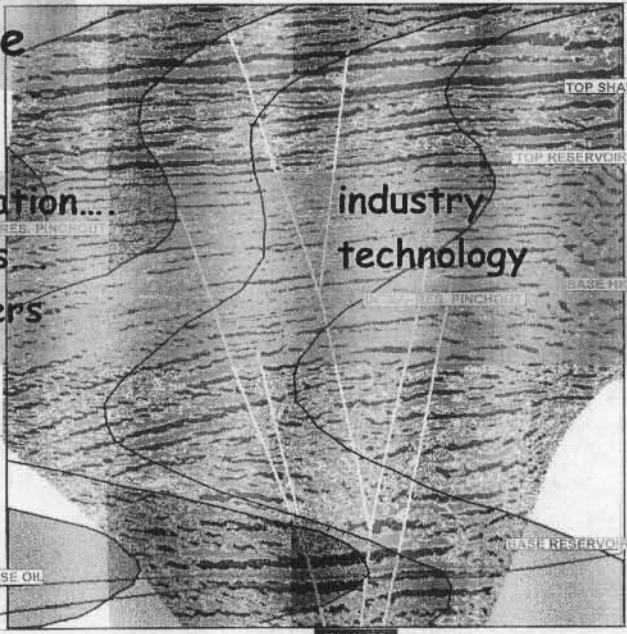
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# Outline

X400

DEPTH IN FEET  
X600  
X700  
X800

- Motivation...
- Status
- Partners



industry  
technology

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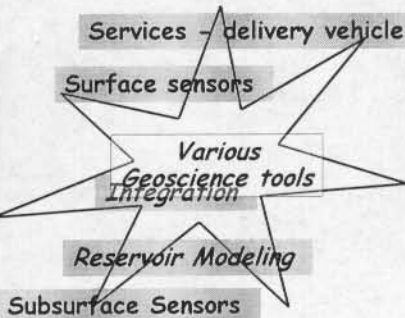


## The Challenge



Bypassed production  
Mis-positioned wells  
Low well productivity  
Expensive testing  
Reserves uncertainty  
Aquifer drive ??

< 35%



70%+ recovery  
Optimal well targeting  
Right facilities  
Minimum water production

70%

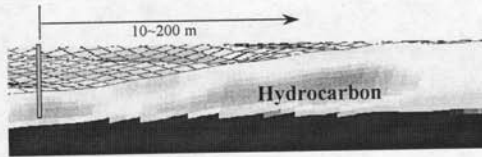
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# Mission Statement

To create a significant & fundamental improvement in the oil industry's ability to:

- measure reservoir fluid properties
- monitor fluid movement
- predict reservoir (rock) properties at 10 to 200 m from existing wells.

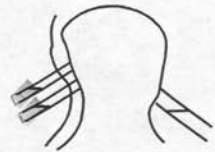
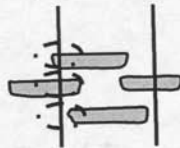


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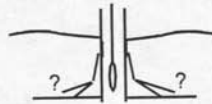


# Class of problems

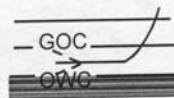
- Find pockets of hydrocarbons



- Monitor production



- Control / steer well path



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## Outline

- **Motivation**
- **Status**
- **Partners**

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## Project Objectives & Goals

- **Accurate fluid characterization for commercial quantities up to 200 m away from wellbore... SINGLE WELL**
- **Integrate EM into existing seismic systems**
- **Commercial solution**
  - ☒ **Easy to use and deploy**
  - ☒ **Global accessibility**
  - ☒ **High resolution**
  - ☒ **Rapid results for drilling guidance**

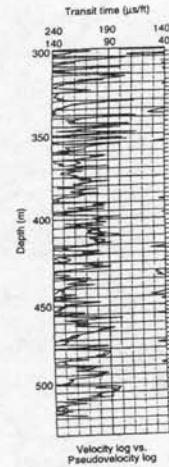
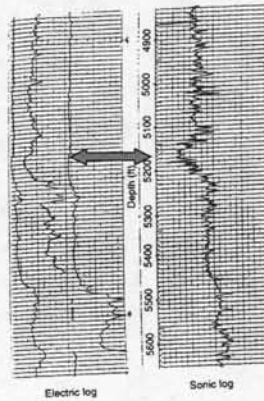
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# Seismic - EM correlation

## Feature correlation

- Logs often correlate
- Pseudo logs used
- Res. Logs used for AVO calibration



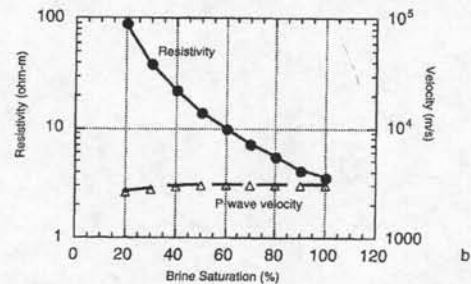
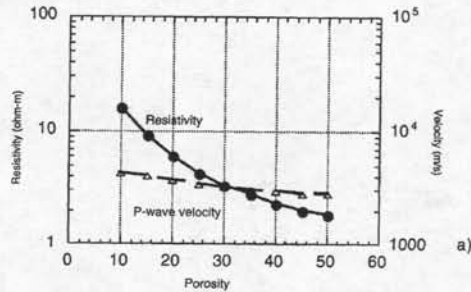
2 logs

After Strack & Vozoff, 1996

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# Resistivity & velocity versus porosity brine saturation temperature

...but seismic waves have travel times (versus EM diffusion) & sensitivity decreases linear (versus exponential)

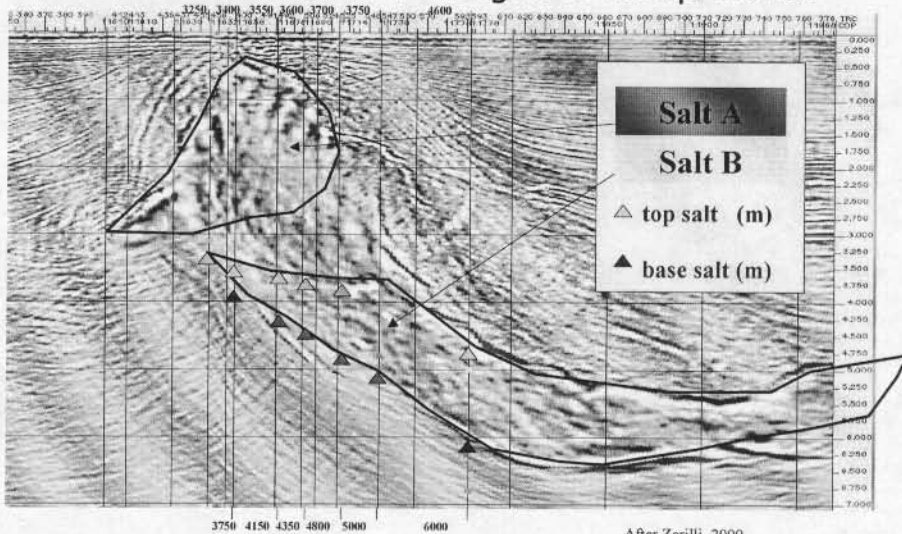


After Wilt & Alumbaugh, 1998

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# Synergy: GOM seismic - MMT

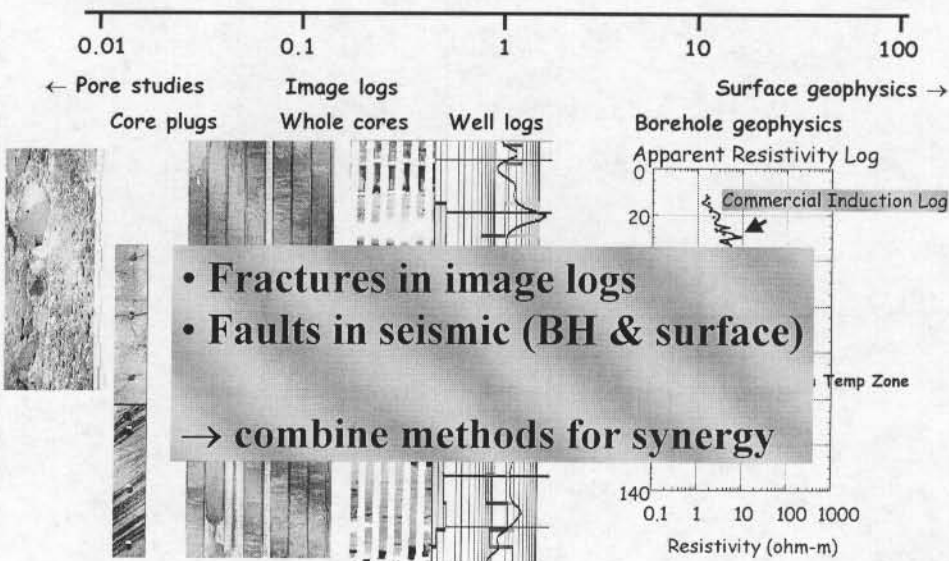
## 3D PoSDM-RTM - MMT integrated interpretation



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After Zerilli, 2000  
Courtesy ENI-AGIP

## Issue: Upscaling...upscaling...



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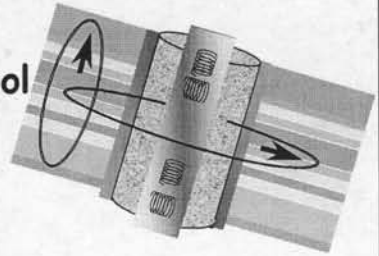
## Status: Single well EM tools

### Very limited commercial success:

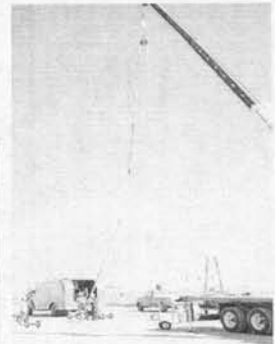
- Deep resistivity for many years (ULSEL - SLB)
- Deep induction in 80s (MPI)
- Specialty tools (EMI-SLB: MAIL & SCIL)

### NEEDED

- 9 component integrated tool (deviated wells)



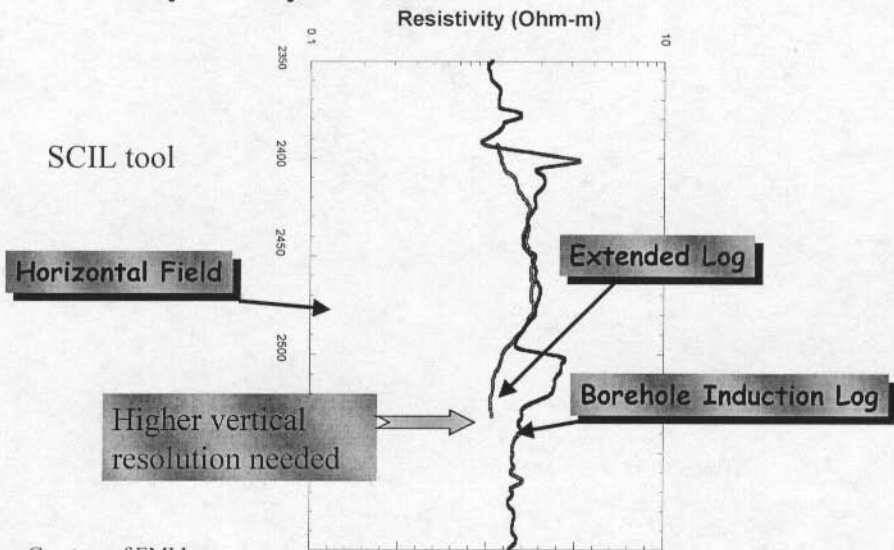
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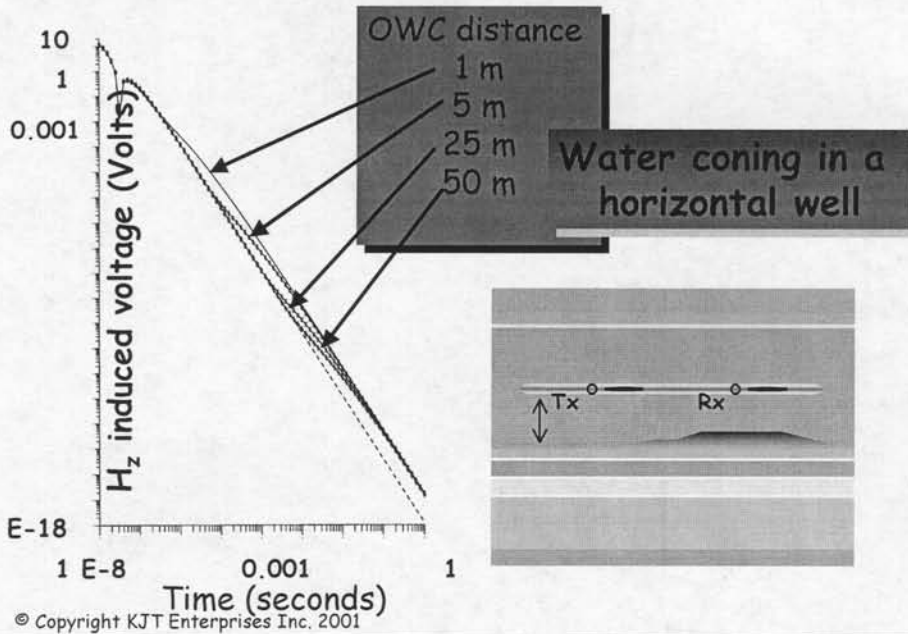


# Frequency Domain

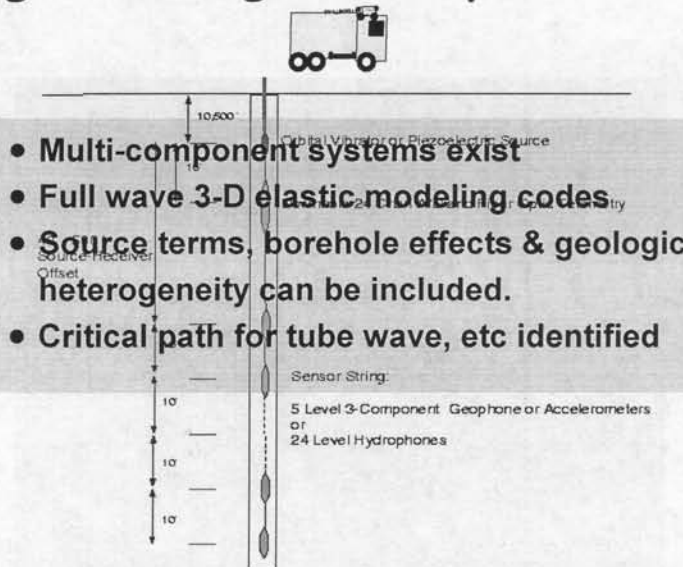


Courtesy of EMI Inc.

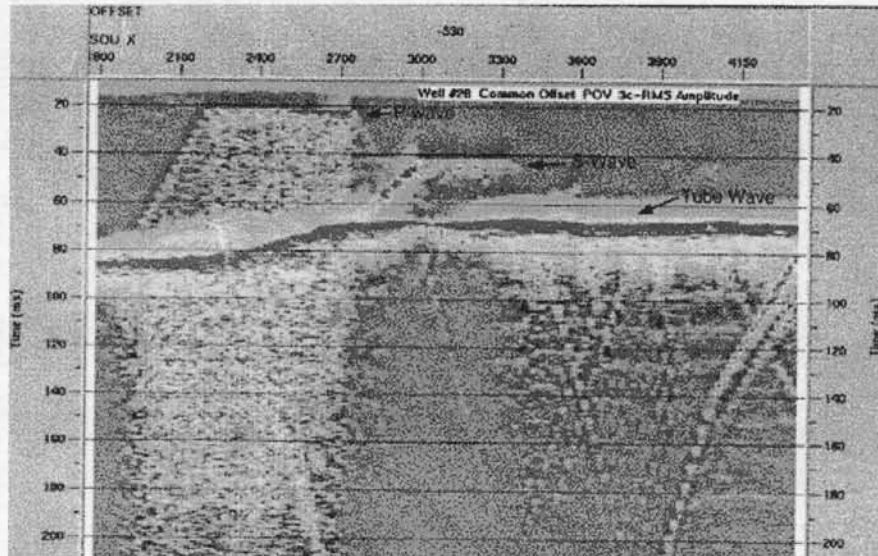
## Time domain difficulties



## Vehicle for integration: Integrated single well system

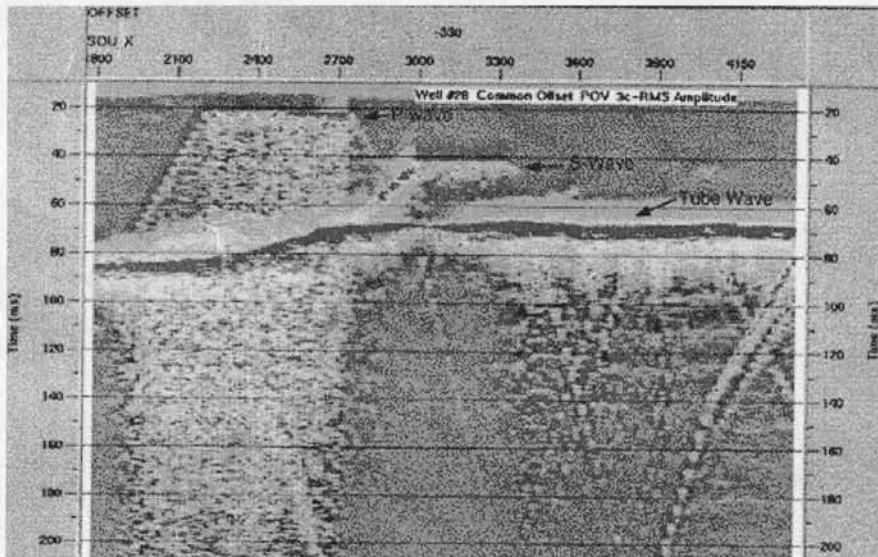


# Large scale SWS example



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# Large scale SWS example



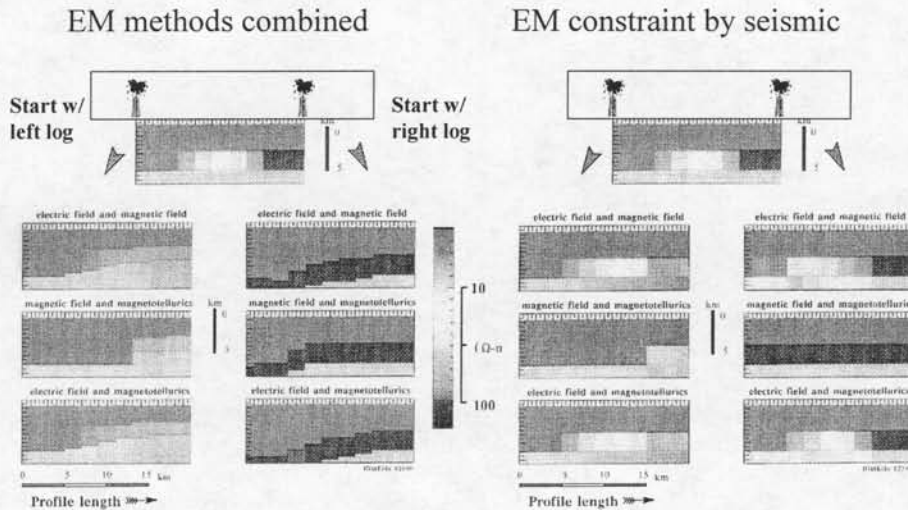
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## Commercial Solution - deliverables

- Acquisition
  - ⊗ Similar to known systems                      seismic integrated
  - ⊗ Easy to QC    real time image
- Processing - within 24 hours
  - ⊗ Little difference from known methods
  - ⊗ Stable results    conductivity image
- Post-processing    integrated model

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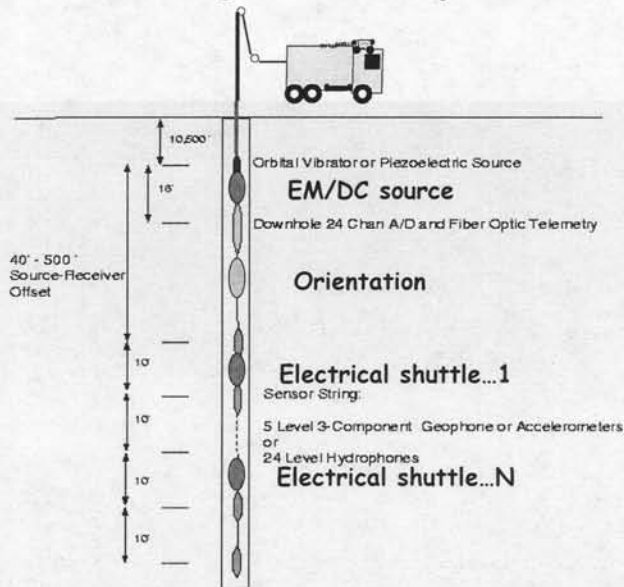
## Example of Synergy



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After Strack, 1992

# Integrated single well system



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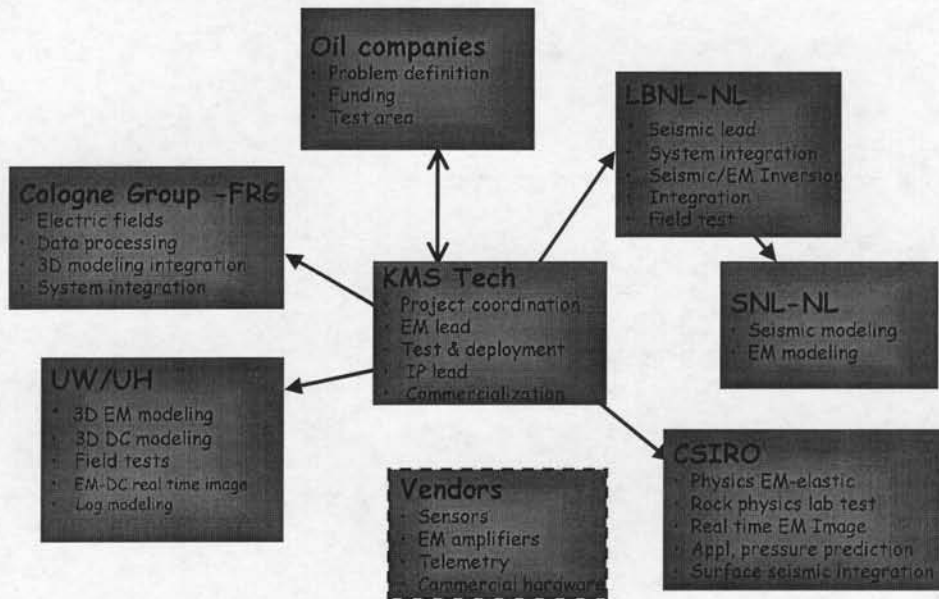
## Outline

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## Consortium tasks & structure



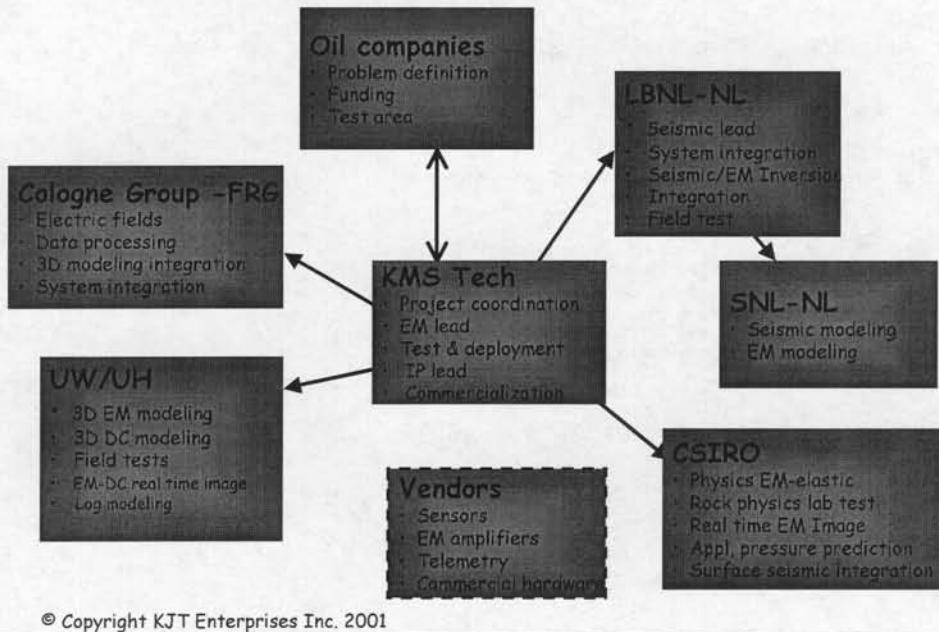
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## Summary

- Several breakthrough (aperture, feasible signal)
- Choice allows path to LWD
  - ⊗ Optical wireline → Coil tubing & wireline → LWD
- Choice address technology transfer issue
  - ⊗ Seismic integrated system
  - ⊗ Seismic integrated processing
- Next:
  - ⊗ HW integrated modeling
  - ⊗ 3d value statement

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