Petrophysics: Use of "Newer" Technologies for Reserves Determination… What do You Need to Know?*

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Abstract

In the past the SEC imposed specific requirements on the appropriate use of technologies for some aspects of reserves determination. Even for aspects where there were no specific exclusions of technologies, there often existed a hesitancy to use "newer" technologies. The new revisions to the SEC guidelines allow companies more freedom to utilize technologies they feel are appropriate provided the technologies can be demonstrated to be a "Reliable" Technology.

The presentation poses a series of basic questions that should be addressed when a company considers using a "new" technology; using multi-component resistivity devices as an example technology.

It is important to understand what the specific objective is when using a technology. Also as reserve calculations are not usually made on a single well, it is necessary to consider if the results can be legitimately integrated with data from wells lacking the "new" approach. Suggestions on validating the results obtained and building a case as a Reliable Technology are also made.

References

Federal register/Vol74, No. 9/Wednesday, January 14, 2009/Rules and Regulations p. 2192.

Kriegshäuser, B., Fanini, O., Forgang, S., Mollison, R., Yu, L., Gupta, P., Koelman, J.M.V., and van Popta, J., 2000, Increased Oil-In-Place in low resistivity reservoirs from multicomponent induction log data: Transactions of the SPWLA 41st Annual Logging Symposium, paper A.

AAPG GTW: Geoscience Aspects of Estimating Petroleum Resources and Reserves

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- **THE PAST** **Specific requirements and guidelines on the appropriate use of technologies for some aspects of reserves determination**

- **NOW** **More freedom to utilize technologies; provided that…you can document that the technologies used meet the definition of a Reliable Technology**

  - **"Reliable" technology is a grouping of one or more technologies (including computational methods) that has been field tested and has been demonstrated to provide reasonably certain results with consistency and repeatability in the formation being evaluated or in an analogous formation.**

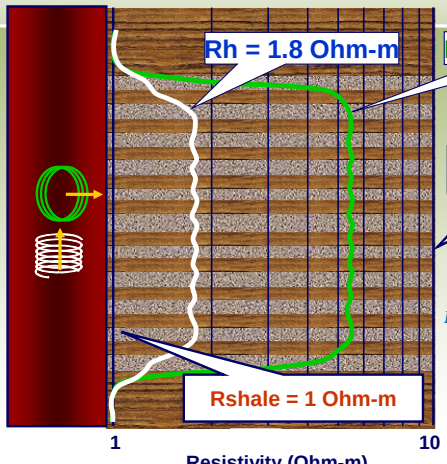
    S-X 210.4-10 (a)(25) Reliable Technology
    Federal register/Vol74,No. 9/Wednesday,January14,2009/Rules and Regulations p2192

- **GREAT !!!!** **So What Do You Need To Know?**
  - **What do you do to confirm the reliability of a technology?**
  - **Have you utilized these "new" technologies appropriately in your evaluation?**

Let's look at the second question first using an example "new" technology

Presenter's Notes: Here is another visual example.
In this thinly bedded formation the HC-bearing sands are 10 ohmm and the shales 1ohmm in a 50-50 mix. If you log this formation using a standard type induction tool, the log will read 1.8 ohmm.
However if you would have a secondary measurement of the vertical resistivity - it would record 5.5 ohmm.
The combination of both resistivities enables one now to compute the true resistivity of the sand fraction, allowing to reliably compute water saturation even in this environment.

Sand-Shale Resistivity Model



Isotropic Laminar Sand Resistivity Component

$$R_{sd} = R_h \cdot \frac{R_v - R_{sh}}{R_h - R_{sh}}$$

Isotropic Laminar Shale Volume

$$V_{lamr} = \frac{R_{sd} - R_v}{R_{sd} - R_{sh}}$$

Have you utilized these “new” technologies appropriately?
Questions to ask yourself…

- **Question 1: Why are you using this technology?**
  - Traditional petrophysical approaches can underestimate HCIP in thin bedded reservoirs
- **Question 2: What evaluation parameter(s) is the technology providing?**
  - Sand fraction water saturation and porosity
  - Gross sand and net pay sand thicknesses
- **Question 3: Is the “new” approach alone used to determine the answers?**
  - You have a consistent data set
  - You must “just” establish that the technique yields acceptable answers and is a reliable technology.

Example technology:
multi-component resistivity devices

Presenter’s Notes: Traditional petrophysical approaches can underestimate HCIP in thin bedded reservoirs

The properties of the non-reservoir shale layers are causing the calculated interval porosity values to be low and the calculated water saturations to be too high

What evaluation parameter(s) is the technology providing?

Sand water saturation and porosity

Gross sand and net pay sand thicknesses

Interpretation models allow the net sand thickness and sand porosity to be computed

Have you utilized these “new” technologies appropriately?
Questions to ask yourself…

- **Question 4: For each reservoir, if the parameter value used for each well is obtained from varying technologies can they be legitimately mapped or integrated in the reserve determination?**

An old idiom states “you can’t compare apples and oranges”

- **Sometimes yes… sometimes no**
  - If you have only used it once or twice in a multiple-well field it may be challenging to show it is consistent and reliable.
  - The larger the variance in the result between the new approach and the old should be considered.

Presenter’s Notes:

Question 4: For each reservoir, if the parameter value used for each well is obtained from varying technologies can they be legitimately mapped or integrated in the reserve determination?

Using this example technology there may be several existing approaches whose objective is to identify the actual sand thickness and associated sand porosity and water saturation values.

These would yield higher sand porosities, lower water saturations and a lower “net pay thickness” than a basic conventional sand approach.

Multi-component resistivity interpretation methods may yield answers that be comparable to the other approaches and legitimately integrated with them.

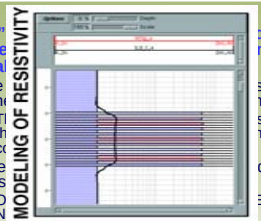
Have you utilized these “new” technologies appropriately?

- **A “basic” traditional evaluation may yield results that may be difficult to be legitimately integrated with multi-component analyses without substantial additional information**
  - There are some existing approaches whose objective is to identify the actual sand thickness and associated sand porosity and water saturation values.
    - These would yield higher sand porosities, lower water saturations and a lower “net pay thickness” than a basic conventional sand approach. Multi-component analyses may compare well to these.
  - These approaches have been documented in technical presentations of several technical professional societies.
    - One example is a session on Thin Bed Evaluation at the 2004 SPWLA Symposium In Noordwijk, Netherlands.
    - The approaches include the use of formation imaging, forward modeling and Monte Carlo inversion modeling as well as multi-component analyses.

An example of a basic evaluation is illustrated next.

Have you utilized these “new” technologies appropriately?

1 ft beds
Rsd = 50
Rsh =1



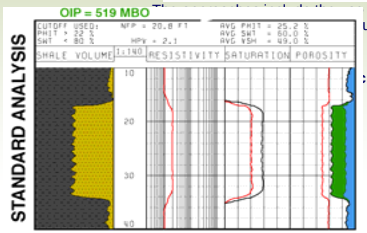
ϕ_{sd}=.30, ϕ_{sh}=.14, Rw=.04, m=n=2

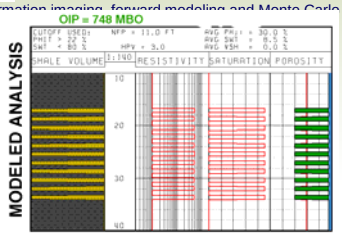
nent analyses without substantial

- These … d in technica … technical profes…
  - O… Evaluation at … m In N…

… of formation imaging, forward modeling and Monte Carlo … ulti-cc…

: eval…

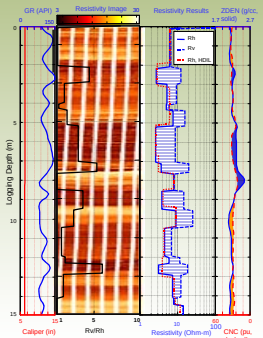




Have you utilized these “new” technologies appropriately?
What if the answer to Question 4 is “NO’?

- **Use of new technology can not just happen. It takes careful planning throughout the entire reservoir/field data acquisition program**
- In general, the more heterogeneous the reservoir and/or “complicated” the parameters being determined, the more supporting technical data must be acquired to validate new approaches.
- The type of supporting data will be a function of the parameter being evaluated.

Comparison of Imaging response to Rh & Rv



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What do you do to confirm the reliability of a technology?

- **Assemble actual examples which validate the use of the "new" technology.**
  - **Utilize the work of others.** Published technical papers may provide consistent successful applications of the technology ☺
    - Use these published studies as a guide to what information to acquire
  - **IF your validating data is obtained from "analogous formations" remember to assemble/acquire sufficient evidence to support that conclusion**
    - Confirm that your reservoir depositional environment is similar to the analog examples cited.
    - Confirm that reservoir petrophysical properties are also comparable to the examples

☺ in the actual formation being evaluated or an analogous one

What do you do to confirm the reliability of a technology?

- Conduct an internal validation of the “new” technology by comparing results (in multiple wells) from “traditionally” accepted technologies to the “new” approach ☺
  - Acquire enough coverage with the new technology to allow validation accounting for reservoir complexity
  - Keep in mind an approach does not have to be 100% reliable

in the actual formation being evaluated or an analogous one