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The First

SPE Norway magazine

To gather members
To share knowledge

Engineering in Arctic
Environmental compliance
Geo Estimations for Field Development
Well Engineering

The electronic version is available on the page of your section website.

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Inside this issue

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Dear SPE Norway members,

We are facing the end of yet another year and finally, after few years with downturn, the outlook is positive. Stabilized oil price has paved path to optimism and shifted focus from cuts to innovation, digitalization and process efficiency. You will see these topics reflected in this year's last magazine issue.
We are also happy to see the growing activity in local SPE sections that constantly strive to involve Oil&Gas community in knowledge sharing and networking. The sections provide a valuable platform not just for experienced professionals but also for students and young professionals who have just entered the industry. I would like to encourage all of you to be active in supporting your local section by engaging in it's development and actively participating at the events. For those, who are contributing their free time to organize SPE events, your engagement is the best reward.
Finally, I'd like to wish everyone nice holidays. Whether you will spend it offshore with your colleagues or at home with your family – hope you will have time to reflect on everything you have achieved this year and to be proud of yourself!

On behalv of the Editorial tean,
Giedre Malinauskaite

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Leak detection - Identification of source of low rate sustained annulus pressure

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Introduction:

This article demonstrates one of the largest challenges many Operators face – low rate leaks in casing annuli. Such leaks show the barrier isolation failure and are critical to fulfill the requirements of regulatory for abandonment or to continue well operation in a healthy manner. With the current development of the logging tools, the source of the sustained annulus pressure can be identified if it builds up more than 1 bar a day. The cases below were published previously by Operators to demonstrate the capabilities of Spectral Noise Logging to investigate the source of low rate build up and leak off.

Spectral Noise Logging for leak source identification:

The passive noise logging is a well-known technique to identify different events downhole. The noise generated by the fluid or gas moving through channels, fractures, pores or wellbore is captured by the sensitive hydrophone. The logging is done via stations while pulling out of the wellbore to reduce the influence of the noise from the tool movement and hence focusing instead on the minor events, such as low rate channeling and contributing reservoir. The captured noise data is then transformed into the spectral panel which describes the frequency and the amplitude of the noise source. The fluid noise spectrum and volume is strongly dependent on the fluid type, pressure, temperature, and flowrate. Although the noise intensity increases linear with increasing flow rate, the noise frequency spectrum depends not on the flow type or velocity but on the type of media or channel through which the fluid moves.

Downhole High Precision Temperature data for tracking the flow:

Leaks in well completion components are conventionally detected by shut-in and bleed-off /leak off temperature logging with subsequent qualitative and quantitative interpretation of temperature logs. The problem in interpreting temperature logs is that they respond to various events and, in many cases, one cannot distinguish if it is vertical flow, lateral flow or some residual effects. In many cases of low rate leaks the behind-casing communications had undetectable differences between shut-in and bleed-off / leak off temperatures, temperature logging was helpless in identifying leak sources, but the temperature gradient change helped to identify the long-term events, such as crossflow or continuous annulus building up / bleed off channeling and pressure source formation.

Survey planning:

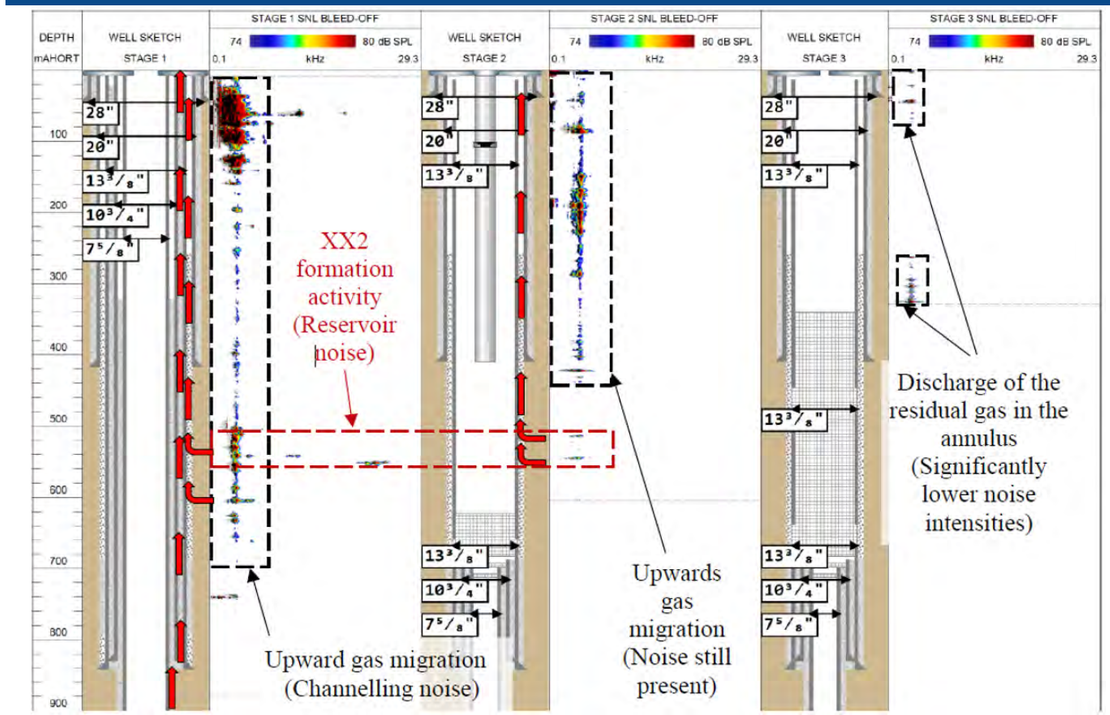
The minimum criteria for the successful leak detecting and tracking of the path to the leak source are typically 1 bar per day. If the pressure build up is not monitored but there is a continuous leakage of the surface the minimum leak rate is defined as 10 liters per hour. So the well intervention with leak detection is planned if the input parameters exceed the above-mentioned criteria. The logging is started with a shut-in or build up mode. The last one should have close to maximum (flat) sustained annulus. In such logging conditions, the undisturbed baseline temperature and background noise is measured. The next stage is induced leak survey when the differential pressure is applied across the leak zones. The High Precision Temperature and Spectral Noise Logging are acquired and compared to the baseline logs. The difference between the logs is caused by the induced leak, and allows identification of the pressure source and tracks the flow path to the surface.

Applications: Spectral noise logging for Pre-& Post Abandonment assessment.

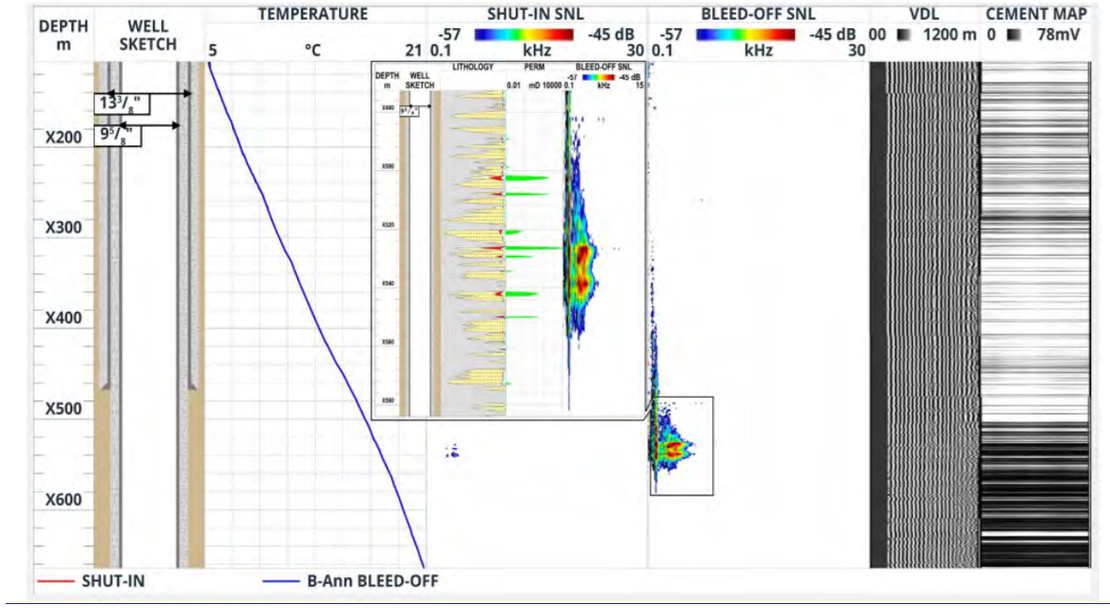
Well #1 was part of an abandonment campaign. The sustained annuli pressure was observed with a rate of 0.1 bar a day in C-annulus and 5 bars a day in B-annulus. The maximum pressure in B-annulus was 35 bars whilst in C-annulus only 3.2 bars. Multiple log and plug/section milling stages were executed in order to abandon the well. Each time, the Spectral Noise Logging and High Precision Temperature logging data analysis aided in determining the plug intervals and verifying the integrity of the plug. After the third stage, the sustained annulus pressure was eliminated in both annuli.

Well #2, a water injector, started experiencing the B-annulus pressure of 5 bars. The build-up rate did not exceed 1 bar a day. A conducted Cement Bond Log survey indicated a good cement bonding below X500 while above the cement was poor quality. A leak detection survey utilizing Spectral Noise Logging and High Precision Temperature analysis was conducted under shut-in and the bleed-off survey indicated the activity in the reservoir and channeling up in the good cement bonding area. The frequency noise pattern was in good correlation with saturation and permeability profiles suggesting the gas was produced from these formations.

The perf and cement squeeze job restored the isolation in the B-annulus and eliminated the sustained annulus pressure.



Well #1 Channelling noise and upward gas migration identified by Spectral Noise Logging and High Precision Temperature logging.



Well #2 Channelling in the good cement bonding area identified by Spectral Noise Logging and High Precision Temperature logging.

Conclusion

Today with 60$ oil price the oil and gas industry dictate the need for the Operators to reduce costs and operate in an efficient manner during the life of a producing well and abandonment phase. While conventional spinners and production logging temperature can assess first barrier leakages only, the Spectral Noise Logging enables tracking the leaks at very early stages occurring behind multiple barriers with a minor rates enabling intervention and prolonging the well life.

APPLICATION ROUNDS & LICENSES SERVICE

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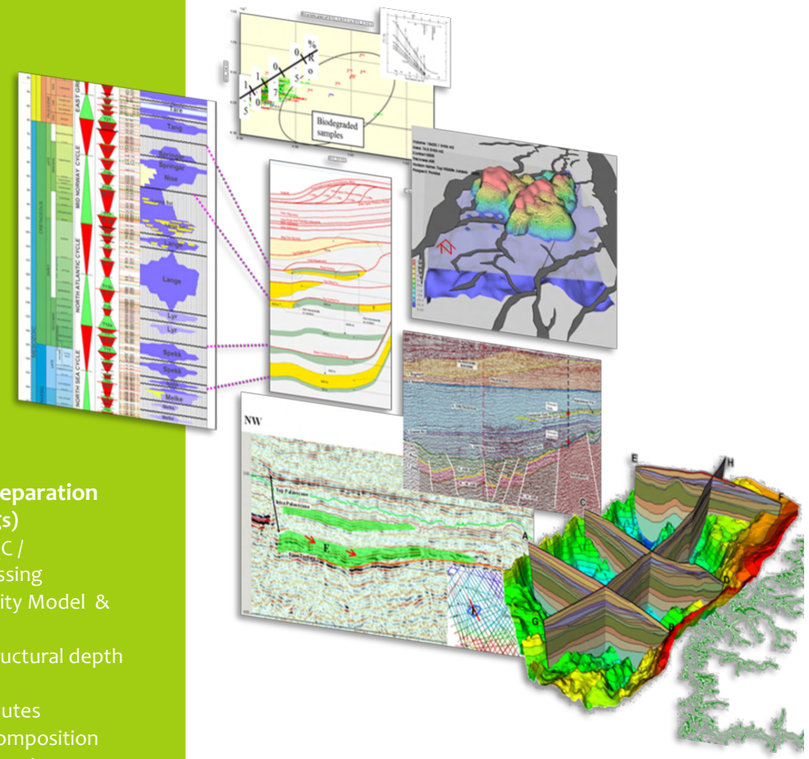
Services
APA Application
License rounds
Prospect Evaluations
Farm-in Estimation



License Application Preparation

Data (Seismic & EM, well logs)
- Survey planning / Data QC / Conditioning /Processing
- Clarification of the Velocity Model & Velocity Model Building
- Depth conversion for structural depth and thickness maps
- AVO volumes and Attributes
- Spectral and Phase Decomposition
- Geological time cubes / sections
- Petrophysical analysis

Geological Interpretation
- Structural Interpretation
- Seismic Facies Analysis
- Structural time Maps Preparation
- Preparation of Seismic amplitude maps
- Reconstruction of tectonic evaluation
- Sedimentological/Depositional model
- Basin Modelling
- Biostratigraphy

Geophysical Interpretation
- Rock Physics Modelling/ Fluid substitution and Synthetic Gathers Modelling
- All types of Inversions (necessary one)
- Seismic Attribute analysis
- Dynamic / AVO Analysis
- Quantitative interpretation

Identification of promising prospects

Field Development concept
- Reservoir Engineering / Prepare production profiles

Administration
- Assessment of geological risks and resource potential
- Prepare Capex and Opex profiles
- Prepare economical analysis
- Application report delivery

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We use latest techniques!
We use fastest simulations!
We make decisions taking 20 years of experience into account!

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