Machine Learning Assisted Cement Integrity Evaluation During Plugging and Abandonment Operations

Aberdeen, June 6th, 2023
How it started?

“Permanently plugged wells shall be abandoned with an eternal perspective\(^1\) …”

- Casing cement shall be verified to ensure a vertical and horizontal seal;
- If casing cement is **verified by logging**, minimum 30 m cumulative interval with acceptable bonding is required to act as a permanent external barrier.

\(^1\) NORSOK Standard D-010, 2013
How it started?

There is room for improvements in the cement integrity assessment

Current process

Data → Visual investigation → Results

Interpretation relies on the expertise of the specialist and hence subject to variability.

Consequences

- Human Dependent
- Error Prone
- Time Consuming
BACKGROUND: TTiLT

Develop a logging tool for the assessment of cement quality through multiple strings of casing (July, 2019 to June, 2022)
BACKGROUND: TTiLT

MACHINE LEARNING TECHNICS: detecting, classifying & estimating severity of flaws in the cement sheath (based on synthetic data: numerical & experimental)
BACKGROUND: TTiLT

Final outcomes of the Project’s first phase

**Patents**

BR102021018581A2
BR1020220146861

**Publications**

*Geoenergy Science and Engineering*

Available online 8 May 2023, 211852
In Press, Journal Pre-proof

**Awards**

Machine learning-based cement integrity evaluation with a through-tubing logging experimental setup

[Logo] World Oil Awards 2022 Finalist

[Logo] premioanp 2020
WHY?

AI can improve the P&A process beyond the cement integrity evaluation

RISK BASED REGULATIONS

Different approaches on P&A are welcome by regulators

P&A DESIGN DILEMMA

No high quality data enough to change the approach

HUMAN BASED INTERPRETATION

Data interpretation in P&A is complex, biased and human-dependent

“WITHOUT AI TO QUICKLY SIMULATED SCENARIOS, P&A DESIGN WILL ALWAYS BE THE SAME”
How? P&A Software Platform

Machine learning based, software platform to assist analysts in the interpretation of well logging data and the operator to optimize planning and management of P&A campaigns

- **Decision-Support Software**
  - Based on Active Learning, benefiting from a dedicated database and interaction with experts

- **Reliability & Accuracy**
  - Results gain robustness from interaction with an expert and improve continuously as the platform is used

- **Transparency & Verifiability**
  - Based on interpretable machine learning models, results can be cross checked, audited and authenticated

- **Time Saving**
  - Faster interpretation of logging data as well as planning and management of P&A campaigns

- **User-Friendly Interactive Interface**
  - An intuitive graphical interface enabling users to explore different scenarios and select most suitable one
The modular software will provide not only ML-assisted log interpretations but also optimized P&A campaigns.
Final Considerations

Where we are now

• Building database infrastructure;
• Developing the modules that compound the software (Back-end);
• Starting the development of the Front-end;

Challenges

• Gather quality and representative data to compose the dataset;
• Deal with log file formats;
• Deal with data from different tools;
• Balance the expectations of the market, users, and regulators

Next steps

• Add more data to the database;
• Models’ refining;
• Search for partners for validating and/or testing the product;
• Search for partners for collaborations;
we are on it!