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JIP DNA2Explore: Gas Exploration in the North Sea made Greener and Cheaper

Report for TKI

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PUBLIC SUMMARY

This report summarizes the results on the JIP 'Gas Exploration in the North Sea Made Greener and Cheaper' (DNA2Explore). The goal of the project is to estimate prospectivity using DNA fingerprints of the microbial ecosystem of cuttings and seabed samples. The used causal relationship is the presence of vertical micro-seepage of hydrocarbons above fields under pressure. This micro-seepage influences the presence of microbes that feed on or are being poisoned by the hydrocarbons. The influence is found by comparing DNA fingerprints of samples of two different locations either with or without a gas/oil field in the subsurface. This comparison is done with the help of machine learning. To train the machine learning algorithm, stored cuttings of successful and dry wells are used, originating from the entire Dutch North Sea. First cuttings are used to predict other cuttings. Second to try and see if cuttings samples, widely available in core houses, could predict seabed samples.

This project was performed within the Topsector Energy's Program Line on Geo Energy, research theme Geological Characterization, via a consortium of participants consisting of Dana Petroleum, EBN, TNO, Wintershall Dea and Biodentify. If successful, the outcome of this project provides an effective and cheap method to estimate hydrocarbon presence based on (shallow) seabed analysis, which might aid in future prospect portfolio ranking, drilling decisions and possibly limit the chance of drilling dry wells. Furthermore, the methodology can potentially be used to monitor leakage of future wells, also ones drilled for sustainable geothermal energy. There is also a full publications available of this report; a digital version can be ordered at no charge by mailing a request to info@biodentify.ai.

Results:

Samples from 1080 cuttings were gathered from the TNO core store, together with 89 blinded seabed samples from Dana Petroleum and 80 Danish seabed samples from Wintershall. 60% of cuttings samples and 6% of seabed samples did not have the minimum required amount of extracted DNA of 1000 fg/µl. Therefore, DNA fingerprints of 437 cuttings and 159 seabed samples were available for machine learning.

When predicting cuttings from other cuttings (model 1) we were able to predict oil/gas vs dry locations with 82% accuracy. Presence of either source rock, thick salt formations of shallow gas did not influence predictions of these samples. The main factor influencing the quality of the model is the amount of extracted DNA. A lower amount of extracted DNA from the cuttings results in less samples that can be used for modelling. Furthermore, it also results in a small overlap in DNA fingerprints between the cuttings and the seabed samples and therefore effects the prediction accuracy of seabed samples.

Statistics on accuracy of the estimations of seabed samples were: an accuracy of 74% for 58 labeled Dutch North Sea samples from Wintershall (model 2) and 62% for 50 labeled Dutch North Sea samples from Dana (model 3). The Dana seabed predictions of model 3 are skewed as the accuracy above oil/gas fields is 83% whereas samples outside fields/prospects are only 50% accurate. The samples outside fields/prospects are possibly not labelled with 100% certainty as in most cases no well is drilled. The drop in accuracy from model 1 (82%) to model 2/3 (74%/62%) is most likely explained through the above-mentioned small overlap in DNA fingerprints of cuttings and seabed samples because of low extraction rates of the first. For unlabelled Danish seabed samples (from Wintershall), the results were inconclusive, and we were unable at this point to predict hydrocarbon accumulations.

To improve the results described above we recommend improving on the DNA extraction (see below). Furthermore, as there are two different environments (older cuttings vs fresh seabed) they could be too different from each other. Therefore, we propose a seabed project with more seabed samples with a 100% known label. This will increase the likelihood of successfully predicting at unknown seabed locations.

Project execution and dissimination:

After the first DNA analysis, March 2019, a contamination problem in the lab was discovered. In the DNA fingerprints microbes from another lab project on gut samples were found. This delayed the project for about a year (the cause and the solution to prevent the contamination problem had to be found/implemented and the administrative/financial settlement had to be agreed and the new sampling/DNA analysis had to be executed). Because of this, the new DNA fingerprints were available in March 2020 and the final project results were available August 2020. Despite this delay it was possible to reduce lab costs considerable compared to the budgeted costs and the project is executed with lower costs than planned. The project consortium and the TKI management were informed regularly about the status and there have been four half day sessions with the consortium to discuss and explain the gained knowledge. Furthermore, on request of five companies there have been technology sessions with their geoscience teams. Also, knowledge distribution and PR was done via conferences and publications:

- The project was presented in an international seep conference in 2019, in Houston (AAPG Hedberg conference "Hydrocarbon microseepage, recent advances, new applications, and remaining challenges")
- International online presentation in 2020 (EAGE Annual conference "North Sea Prospects: Predicting Hydrocarbon Presence through Seabed Samples, DNA Fingerprinting and AI").
- In the Netherlands, the project was presented at the EBN Exploration day, 2019 ("Using bacterial DNA from well cuttings to predict oil and gas with surface samples").
- A printed article was published in the journal Petrochem, 2020, vol 2 ("Innovatie in olie- en gasexploratie blijft lonen").

The project has contributed to the goals of " de regeling duurzame energiehuishouding" by improving the knowledge position of the Dutch operators on the North Sea on more sustainable and more cost-effective exploration/prospect derisking by using this technology as a direct hydrocarbon indicator. This is supported by the interest of three new companies outside the TKI project consortium for follow up projects. Furthermore, as stated the technology can be applied as well for the Dutch roadmap on the energy transition, in particular for safety assessment of Geothermal wells and for monitoring CO2/H2 storage.