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Newsletter of the German Section of the Society of Petroleum Engineers | Volume **33** | Issue **2** | Oct **2023**

REGIONAL SECTION OFFICER MEETING

SPE International
German Section

Content

COVER

IMPRESSUM

Group picture from the SPE Regional Section Officer Meeting

PUBLISHER

Deutsche Sektion der Society of Petroleum Engineers e.V.

An der Quelle 2
30539 Hannover

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Event Calendar

For latest information and details on SPE Germany events visit our website.

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Date	Type	Event	Location
Nov 2023 09-10	SPE Congress	Student Technical Congress	Clausthal-Zellerfeld, Germany
Dec 2023 07	SPE	Get together and presentation (details to follow)	Berlin
Jan 2024 11	DL Event	Rock Chalaturnyk - CO2 Geological Storage from 8 Years of Dynamic Injection at the Aquistore CO2 Storage Site	TBA

German Section SPE Chairman Letter

SVEN HABERER, GSSPE CHAIR & BAKER HUGHES

Dear SPE German Section Members,

Welcome back from hopefully relaxing summer holidays and welcome to our new 2023-2024 season!

Last season closed with our annual membership meeting, a very well attended in-person event. It included nominated students receiving their GSSPE Student award and presenting their research. The meeting concluded with a BBQ, which was a great opportunity to meet old friends and forge new connections.

As every year during our annual meeting, a new board was elected. This regular renewal of our board allows for fresh ideas, experience, and of course, energy - ensuring our section stays relevant for our members. Therefore, I would like to seize this opportunity to express my gratitude to both our outgoing and continuing board members and volunteers for their dedicated service! Also, I want to warmly welcome our new board members, including Julia Möller (Membership), David Fischer (Secretary), Maxim Boreiko (Student Liaison), Joshua Siewert (YP), and Wolfgang Weinzierl (Communications).

Please see the last page of this newsletter for our current board-members and officers, as well some of our volunteers. If you are interested in volunteering or otherwise support our section, please contact me.

We take immense pride in the fact that five of our German Section members have received the prestigious SPE regional award, which proves that our members are very engaged, and that their efforts were appreciated by SPE during the 2023 Regional Section Officers meeting in The Hague (see title picture).

Please join me in congratulating these outstanding individuals:

- Prihandono Aditama (Wintershall DEA) - SPE Regional Production and Operations Award
- Hans Uwe Brackel (Baker Hughes) - SPE Regional Drilling Engineering Award
- Matteo Loizzo - SPE Regional Service Award
- Oliver Obenaus (Wintershall DEA) - SPE Regional Management Award
- Holger Thern (Baker Hughes) - SPE Regional Formation Evaluation Award

This week, the 2023 Student Technical Congress will take place in Clausthal. This will be a great opportunity for students to present their own research, stay informed about the latest technical advancements, and of course network with other international students and industry representatives.

Enjoy this newsletter!

Sincerely yours,

Sven Haberer, SPE German Section Chair

The Language Model of GeoBERT for Named Entity Recognition (NER) and Geoscientific Text Contextualization

By Ryan Bobby Andika, RWTH

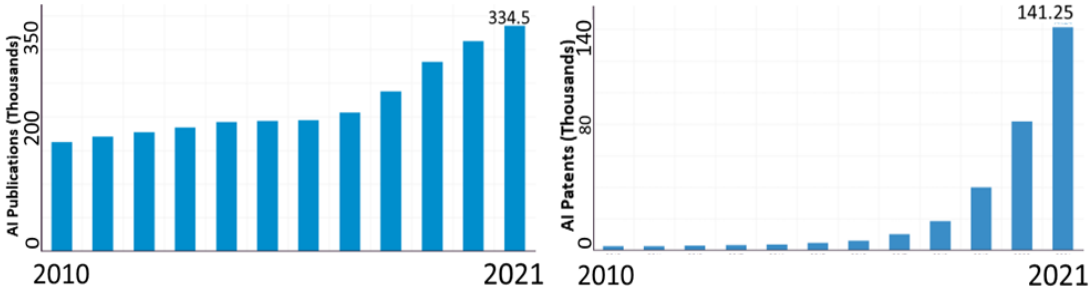

*Figure 1: (**a**) Number of publications and (**b**) Patent Filings related to AI in the world in 2010 – 2021 (Modified after Zhang et al., 2022)*

The global impact of Artificial Intelligence (AI) work has been felt across various fields. The proliferation of AI is evident in the significant increase in AI-related publications or patents since 2010 and the rise in total investments in numerous disciplines since 2017. It is undeniable that AI has permeated different aspects of human society, leading individuals in sectors such as Education, Organizations, Companies, Government, and others to rely on AI advancements, often unknowingly, due to the vast amount of data being generated. AI and data, working hand in hand, form a symbiotic relationship. Data requires AI for efficient analysis, while AI relies on data to enhance its analytical capabilities. Notably, text data, a byproduct of human language used for communication through various mediums such as books, scientific publications, and the internet (news articles, social media, e-commerce, etc.), has experienced exponential growth. Consequently, the abundance of textual data has captured the interest of AI enthusiasts, who seek to process it computationally into valuable outputs. This processing technique is commonly known as Natural Language Processing (NLP).

Figure 2: Geoscientist collecting data

The development of the Geoscience Language Model marks a crucial advancement in the field of Geoscience, leveraging cutting-edge Artificial Intelligence technology, specifically Natural Language Processing (NLP), to process and understand human language context. NLP, a significant aspect of modern Computational Linguistics, revolutionizes the way linguistic data (e.g., corpus, audio, video) is computationally processed as numerical data, enabling both machines and humans to benefit from it for various purposes. Considering the vast amount of linguistic data generated by Geoscientists, such as geological interpretations in scientific papers, fieldwork notes, audio-video recordings, and more, exploring NLP in Geoscience becomes an important emerging topic. The comprehensive research in this area encompasses Data Extraction (Preparation), Data Processing, and Evaluation stages. Utilizing Artificial Intelligence to tap into this data abundance produced by Geoscientists on a daily basis can significantly support their core work in the field of Geoscience.

This research primarily focused on developing a Named Entity Recognizer (NER) machine for Geoscience in the architecture of the $BERT_{BASE}$ model and with the Transfer Learning scheme from the pre-trained Language Model of SciBERT. Then, most importantly, the development of the NER machine in this study also subsequently built a Fine-Tuned Language Model called GeoBERT. The success and novelty of this Thesis come from multiple products and results in a wide range of research areas in conducting Language Model training for NLP jobs, mentioning Data Extraction, Data Processing, and Evaluation.

In Data Extraction, as part of the data preparation, a well-preserved semantical corpus from approximately 200 thousand corpora (publications) has been successfully extracted and processed into the form of million sentences after being processed in the "relaxed" Pre-Processing 1 pipeline that developed in this study. The combination of various techniques in text data scraping, mentioning PDF Scraping – Web Scraping – API Scraping – Regex Scraping, has made the job in Data Extraction (as the input for the deep neural training) able to provide good quality and quantity of data that is even can be re-useable for further NLP training. As training in this study focuses on the framework of NER, a novel approach of the combined Self-Supervised and Ruled-Based labeling method algorithm (along with the self-developed software) was designed for the newly extracted text dataset. This new approach had to be made to promote a mountain production of the labeled dataset from either newly dataset from this study or another study (BGS-NER dataset by Heaven et al., 2020) to enhance the performance of the GeoBERT- NER machine and the Language Model of GeoBERT in contextualizing the Geoscientific corpus.

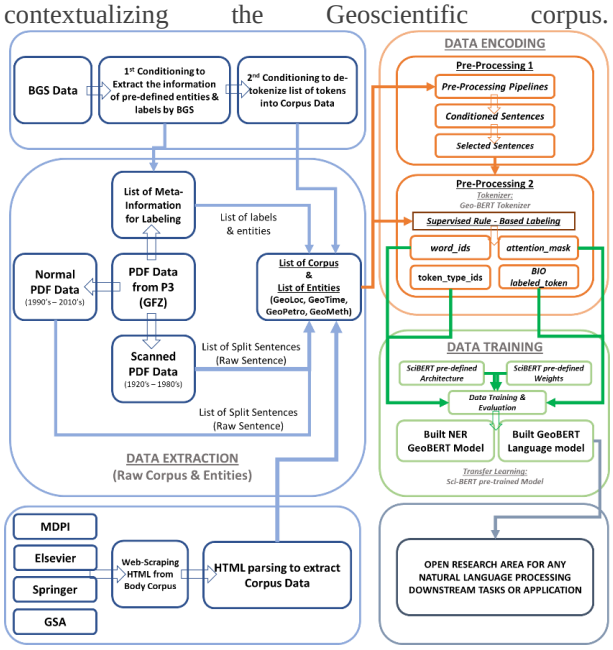

Figure 3: General Workflow of Data Extraction – Data Encoding – Data Training

In Data Processing, the novelty is contributed by the simplicity of the $BERT_{BASE}$ model deployment to create the NER machine and Language Model of GeoBERT with the Transfer Learning scheme from the Language Model of SciBERT. The Transfer Learning scheme has statistically advanced the contextualization performances of the products with the Geoscientific corpus by the inherited richness of "experience." In detail, the richness of "experience" comes from the Language Model SciBERT that has been pre-trained by a mountain of scientific text corpora of Semantic Scholar (Beltagy et al., 2019), with the scheme of Transfer Learning from the $BERT_{BASE}$ Uncased Model built by Google that has priorly pre-trained as well by million corpora from BookCorpus and English Wikipedia (Devlin et al., 2019). Therefore, the development of the GeoBERT can be algorithmically titled as the Fine-Tuned Language Model that is built upon the downstream task of the NER framework with the Geoscientific corpus. Additionally, not forget to mention that this study also made a new Tokenizer called GeoBERT that could perform a better text data encoding job for Geosicentitific Corpus.

In the Evaluation of this study, both of the products' performances (the NER machine and the Language Model) from the development of the GeoBERT-NER were assessed in a rigorous combination of qualitative literature research and quantitative statistical approach. From the qualitative research analysis and the pre-study quantitative analysis from the dataset of P3 publication, numerous published Language Model architectures that proposed a better text contextualization job have been summarized. The decision that regards the statistical approach and efficiency of the training led to assigning the BERT model as the prominent architecture for this study. Then for the strict quantitative analysis, the performance assessment for the NER machine was conducted with statistical metrics of the Confusion Matrix (that served value of F1-Score, Precision, and Recall), and the statistical analysis from the several token vector representations value (Word Embeddings) from the last encoder layer in GeoBERT model with the help of Principal Component Analysis (PCA) method.

A different approach to assessing the Language Model of GeoBERT (which was simultaneously created with the NER machine training) has been taken in this study. As the Language Model GeoBERT evaluation aims to give a performance overview for further application of NLP tasks in Geoscience, the model was first trained for the Text Classification job, with the specific task of differentiating the Geoscience and Non-Geoscience Corpus. Then, the novelty in this evaluation is promoted from the approach called as two-level statistical assessment by PCA: the word entity-level and sequence-level assessment (to the vector representations value from the last encoder layer of GeoBERT). This approach could assess both the entity recognizer functionality from the inherited knowledge of GeoBERT-NER inside the model, and the ability of the Language Model GeoBERT model to contextualize the Geoscientific text to distinguish the Geoscience corpus. The Confusion Matrix also supplements the Language Model GeoBERT assessment.

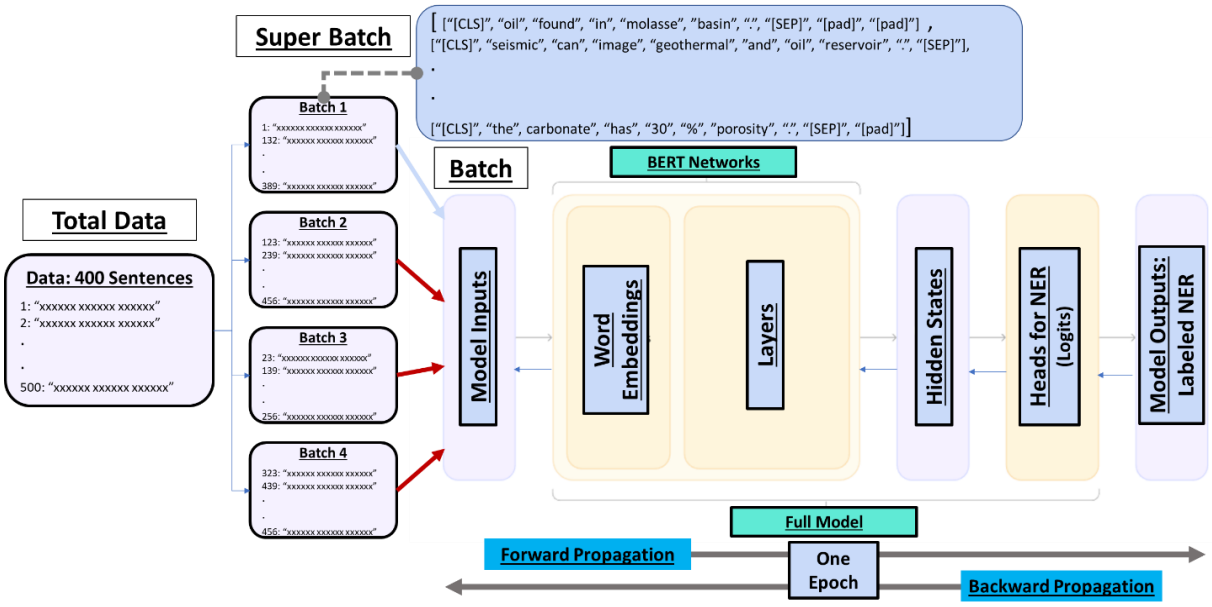

Figure 4: The general training procedure to produce GeoBERT- NER with multiple sentences (modified after Huggingface, 2022)

Finally, this research success in delivering:

1. The newly built GeoBERT Tokenizer is success to be used for the Geoscientific corpus.
2. The developed software and algorithm of Self-Supervised – Ruled-Based auto-labeling
3. The GeoBERT-NER machine is statistically and objectively able to perform excellently in distinguishing four groups of entities: GeoLoc, GeoMeth, GeoPetro, and GeoTime.
4. The Language Model GeoBERT is proven ready to be used for any further NLP task in Geoscience as the ability to contextualize the Geoscience corpus is evaluated as remarkable.

The development of GeoBERT-NER and its Language Model offers numerous opportunities for further Natural Language Processing (NLP) tasks in Geoscience. The GeoBERT Language Model equips Geoscientists with a powerful tool to create machines capable of learning and processing unstructured Geoscientific text data to support various specialized tasks in Geoscience. Future research aims to utilize GeoBERT to assist in a geothermal energy exploration campaign in Germany by training the model with relevant unstructured text data. Potential applications include risk assessment analysis based on historical geothermal drilling publications, Named Entity Recognition for crucial information extraction, detection of flaws in Geological interpretations, and other tasks to support geological businesses. Therefore, continuous feeding of text data for NLP training will further enhance GeoBERT's ability to contextualize Geoscientific text which hopefully can help many crucial jobs in Geoscience.

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The impact of brine salinity and ion type on the wettability of calcite in the presence of acid oil compounds

By Mats Wolter, Clausthal University of Technology

Introduction

Wettability alteration is one of the most crucial aspects when it comes to enhancing oil recovery in modern waterflooding projects. Especially in carbonate reservoirs wettability is of particular importance as these reservoirs tend to be originally neutral- or oil-wet with a high residual oil saturation [1]. Wettability alteration can already be induced during water injection. To control, or at least steer the wettability alteration into a certain direction, the ion concentration and the type can be selected accordingly. While already known for a while, the so-called smart water flooding is still a relatively new technique, and it entails “designing” the composition and concentration of the injected water in accordance with the targeted reservoir conditions.

Many publications give credit to the wettability alteration as the main mechanism for enhancing oil recovery in carbonates when the carbonate surface is altered from oil-wet towards more water-wet.

Despite the general agreement that careful selection of the ion composition in the injection water can improve the oil recovery, the precise mechanisms of how and to which degree the wettability alteration occurs are not yet completely understood. For a better understanding, it is essential to analyze factors like brine salinity, ion type and oil composition for their impact on the wettability in more detail.

This paper summarizes the results of a research in which different factors of influence on wettability were methodically investigated in the laboratory on pure calcite which is a mineral representation of carbonate rocks. A high pressure drop shape analysis system was used to measure the contact angles in brine-oil-calcite systems at 15MPa and 60°C. The impact of brine salinity, ion type and the concentration of acidic compounds in the oleic phase was investigated. Brines composed of monovalent and divalent ions were investigated at concentration of 3% and 10%. Wettability was investigated using a model oil with no acids. Then, the impact of acid on calcite wettability was investigated by raising the concentration of cyclohaxanepentanoic acid in the model oil from 0 to 1 and 5wt%.

Materials and Methods

To investigate the effect the ion type on the wettability experiments with brines containing NaCl, CaCl2, MgCl2x6H2O andNa2SO4 salts with a salinity of 3 and 10 wt%. Further on to investigate the impact of the oil composition on the wetting, wettability measurements using the aforementioned brine composition were also conducted for a model oil containing 1% (MO-1) and 5% (MO-5) cyclohexanepentanoic acid. The wettability was determined quantitively through the measurement of the contact angle in the aqueous phase in a brine-oil-calcite system.

The contact angle measurement was performed using a high pressure drop shape analysis system. The needle for the oil injection into the view cell (Eurotechnica GmbH. Germany) was placed to the bottom of the cell to account for the lower density of the oil compared to the brine. The experiment was started with the placement of the rock sample on a holder above the needle inside the view cell. Then the cell was closed, and the brine was injected. The view cell was heated up to 60°C and then pressurized with the aqueous phase to 15MPa. After the testing conditions were reached, oil was injected creating a drop at the tip of the needle. The drop was placed on the calcite surface. A charge coupled device camera records images that are fed to a software (ADVANCE-Kruss, Germany). The software detects the contour of the drop and determines the contact angle and the drop size simultaneously. Drop volumes were kept constant around 25µl³. Measurements were conducted in duplicates.

Experiments

To investigate the effect of the different combinations of oil composition, ion type and brine concentration several experiments were performed including different preparation and cleaning steps for the rock sample.

Experiment 1: The contact angle was measured for the first model oil without acid compounds (MO-0) in combination with the distilled water and each brine at concentration of 3wt% and 10wt%. Between the experiments the calcite sample was cleaned with acetone.

Experiment 2: Second model oil (MO-1) was tested with distilled water and all eight brines at both concentrations. Like in experiment 1 the calcite sample was cleaned with acetone in between the measurements.

Experiment 3: In experiment 3, the procedure from experiment 2 was repeated for the 10% CaCl2 brine with the second rock sample to investigate the effect of alteration during the experiments on the calcite surface.

Experiment 4: Rock sample 1 was altered in dodecane with 1% cyclohaxanepentanoic acid compounds added for 64h before the experiments were continued. Then the procedure was like in Experiment 2, where the rock sample was cleaned with acetone before the next measurement.

Experiment 5: Rock sample 1 was altered like in experiment 4 but this time not cleaned with acetone in between the measurements. Instead, it was dried and placed again in dodecane with 1% cyclohaxanepentanoic acid compounds for 15min in before the next contact angle measurement was conducted.

Experiment 6: In a last step rock sample 1 was altered like before but this time for 42h. Then the contact angle of the third model oil containing 5% cyclohaxanepentanoic (MO-5) was measured with the calcium chloride and the sodium sulfate at 3wt% and 10wt% concentration

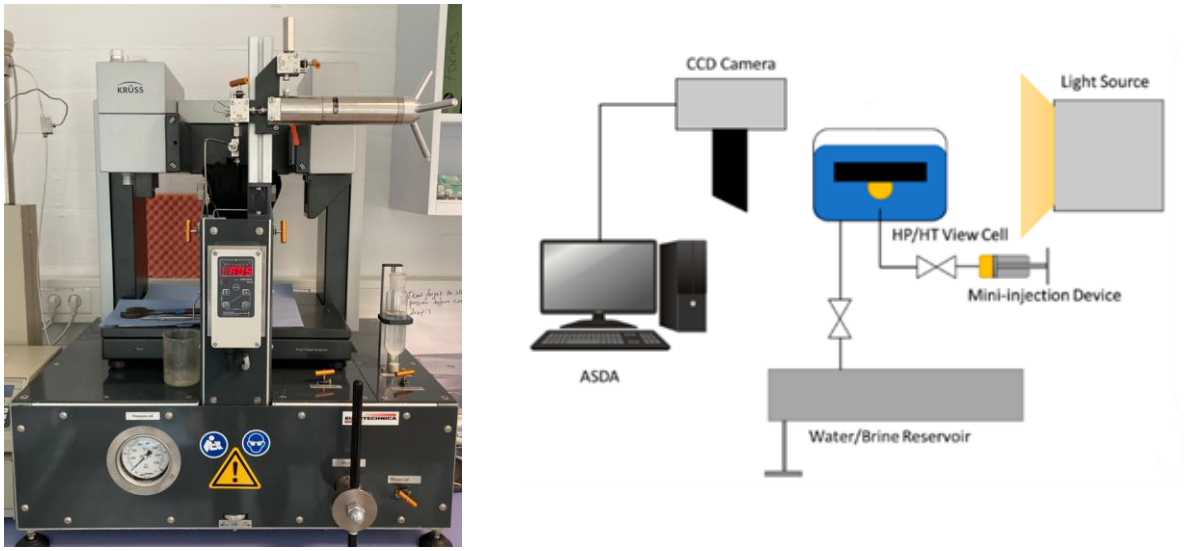

Figure 1: High pressure drop shape analysis system [2]

Results

The measured contact angles revealed in table 1 show that the ion type is the most crucial parameter for the wettability, even more than the overall concentration. This result is in line with the literature. Among the ions, the potential determining ions (Mg2+, Ca2+, SO42-) show more influence on the wettability than the non-potential determining ion (Na+). The comparison of the two divalent ions Mg^{2+} and Ca^{2+} and its effect on a calcite sample. There the calcium reveals a much stronger effect of calcium than magnesium. It is assumed that this is caused by a stronger interaction of the calcite with calcium than with magnesium as calcite primarily consists of calcium. Unexpectedly, a change towards more water wettability was observed as acid compounds were added to the model oil. This phenomenon is opposite to most published experiments. Further experiments were conducted to investigate this effect. These experiments showed that repeatedly flushing the calcite sample with brine during the measurements is likely to cause a stronger tendency for the sample to become water wet and by that not allowing significant interactions with the oil components. Overall, it can be stated that the way of pretreatment or ageing of the sample prior to the measurement is of crucial importance to the resulting contact angle.

concentration	ion	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6
3%	NaCl	58°	37°		50°	37°	
	CaCl2	79°	35°		50°	37°	71°
	MgCl2	57°	42°		41°	33°	
	Na2SO4	86°	36°		35°	31°	42°
10%	NaCl	92°	37°		40°	39°	
	CaCl2	88°	76°	124°	57°	44°	73°
	MgCl2	103°	33°		33°	40°	
	Na2SO4	118°	29°		44°	39°	41°
0%	Distilled water	49°	35°		40°	29°	

Table 1: Contact angle results

Conclusions

Effect of ion type

In the first experiment with the model oil without acid compounds it could be seen that the contact angle for the distilled water is smaller than for all brines at 3% concentration showing a stronger water wettability. The tendency towards neutral-wet increased further with increasing the brine concentration to 10%. The decreasing water wettability with increasing salt concentration is supporting publications in the literature that determine higher oil wettability with higher salt concentrations [4, 6].

Comparing the effect of the salt concentration to the effect of the ion type it is also confirmed that the ion type has a stronger influence on the wettability with oil containing acids than the concentration. During the measurement differences between 3% and 10% where smaller than among the ions themselves. Most distinguished where the PDI´s calcium and sulfate while the non PDI sodium and the PDI magnesium showed less effects during the experiments.

Effect of salt concentration

Undesired conditioning effects like reuse and exposure showed a high impact on the measurements. From the first experiment to experiment 2 the contact angles measured decreased for all brines. This is opposite of the expected effect of acid in the solution. That it is not only caused by interactions between the negatively charged acid and the positively charges ions in the brine. Also conditioning effects are probable as the contact angle with the distilled water decreased by 14° towards more water wet.

A reason could be the reusage of a single calcite sample. It is assumed that there is an effect of the saturation history of the calcite sample on the contact angle measurement. The first sample which was used (exp. 1 & 2) was exposed to air for a long time and never exposed to oil. In the experiments conducted the calcite sample was always first exposed to the surrounding brine before a small oil drop is created and placed on the calcite surface. The repeatedly flushing of the calcite sample with brine during the experiments influences the results [7]. The hydration of the rock sample during the measurements seem to alter the wettability towards stronger water-wet. With ongoing experiments, the water film on the rock surface becomes more stable does not allowing significant interactions with the model oil [8]. This thesis is emphasized the results of experiment 3. In this the same model oil with 1% acid compounds was used but this time the second calcite sample was used for the first time and thus not exposed to water. The measured contact angle with 10% CaCl2 brine increased from 76° (exp. 2) to 124° (exp. 3). Changing the rock sample to the second, virgin sample significantly changed the wettability from more water-wet to more oil-wet. This indicates that in the different measurements with the first calcite sample reactions happened during the exposure to water which cause a higher tendency to water wetting.

If the theory with the alteration of the rock sample is true, the contact angles of the first experiment are the

only where the absolute value can be taken, which emphasizes expectations of scientists that calcite in general is more likely neutral- to oil-wet [1]. For the experiments 2-6 the relative difference between the contact angles for the brines should be used and the absolute value must be considered with precaution.

Cation bridging effect

Some publications discuss a cation bridging effect of calcium. Hereby the calcium with its two positive charges acts as a bridge and connects one negative charge at the mineral surface with one negative charge at the oil surface. The effect in sandstone is thereby similar to what is seen during this experiments, wherefor the cation bridging effect should be outlined and discussed if this is also possible with the calcite rock [6, 9]. For this a negative surface charge of the calcite is needed but if one assumption with the permanent thin water film one the calcite surface is correct, this might create a less positively charged surface making water bridging a potential explanation for the weaker water wetting seen in the measurement with calcium.

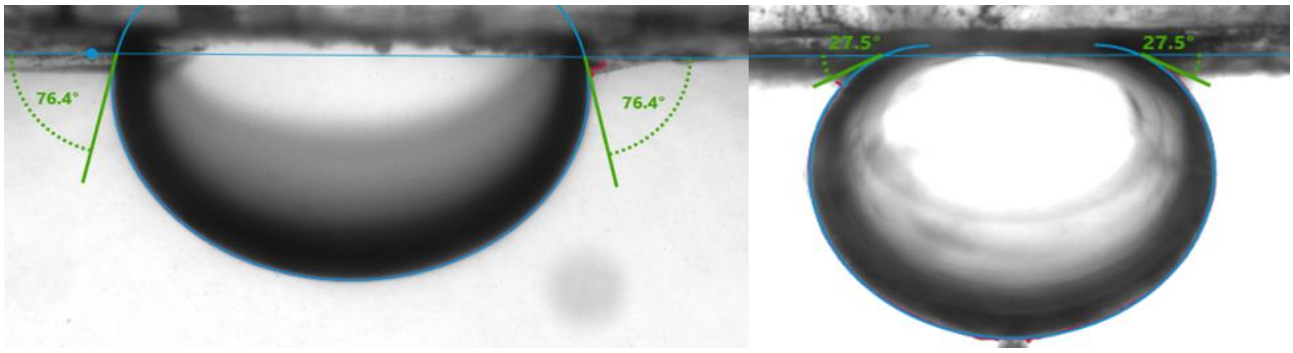

Figure 2: Captive bubble of model oil with 1wt% cyclohaxanepentanoic acid on calcite sample at 15MPa and 60°C in 10% CaCl2 brine (l) and 10% Na2SO4 brine (r)

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Neural Networks facilitate precise at-Bit Formation Detection and post-COVID travelling

BY Lucas Katzmann, BAKER HUGHES, CELLE

The Bahrain MEOS GEO 2023 is an annual international conference that focuses on the latest advancements in geosciences and oil and gas exploration. The event brings together industry experts, researchers, and academics from around the world to discuss new technologies and innovative approaches to the challenges facing the industry.

While Artificial Intelligence (AI) may not have played a central role in Bahrain MEOS GEO 2023 specifically, its impact on society cannot be overstated. AI has become a household name, and its capabilities are increasingly utilized across a wide range of industries, including oil and gas (O&G).

This industry is one that requires accurate and efficient predictions to be made to minimize technical and commercial risks. AI has the potential to greatly improve these predictions, allowing companies to make better decisions and operate more efficiently. By using AI, companies can process vast amounts of data and identify patterns that would be difficult, if not impossible, for humans to detect.

Accordingly, I am glad that I had the opportunity to present my approach to predicting formation changes in the subsurface using neural networks at this year's conference. It describes how a Convolutional Neural Network (CNN) can be used for at-Bit formation detection. The detection itself is based on the prediction of the bulk density subsurface.

The underlying data set comes from 90500 drilled meters and contains 189 different signals, i.e., features. Before passing the data to the CNN, it is preprocessed. In a first iteration outlier and ambiguous features are removed from the data set. Since Logging While Drilling (LWD) tools are mounted behind the bit, the bulk density, as the prediction target, of a certain depth is measured later with respect to time. However, transitions between formations can only be recognized when the BHA moves in space. Since density will be the target, this must be corrected. If a bulk density was recorded in a depth of 1000 m, then it must get the timestamp from the bit when it hit 1000 m.

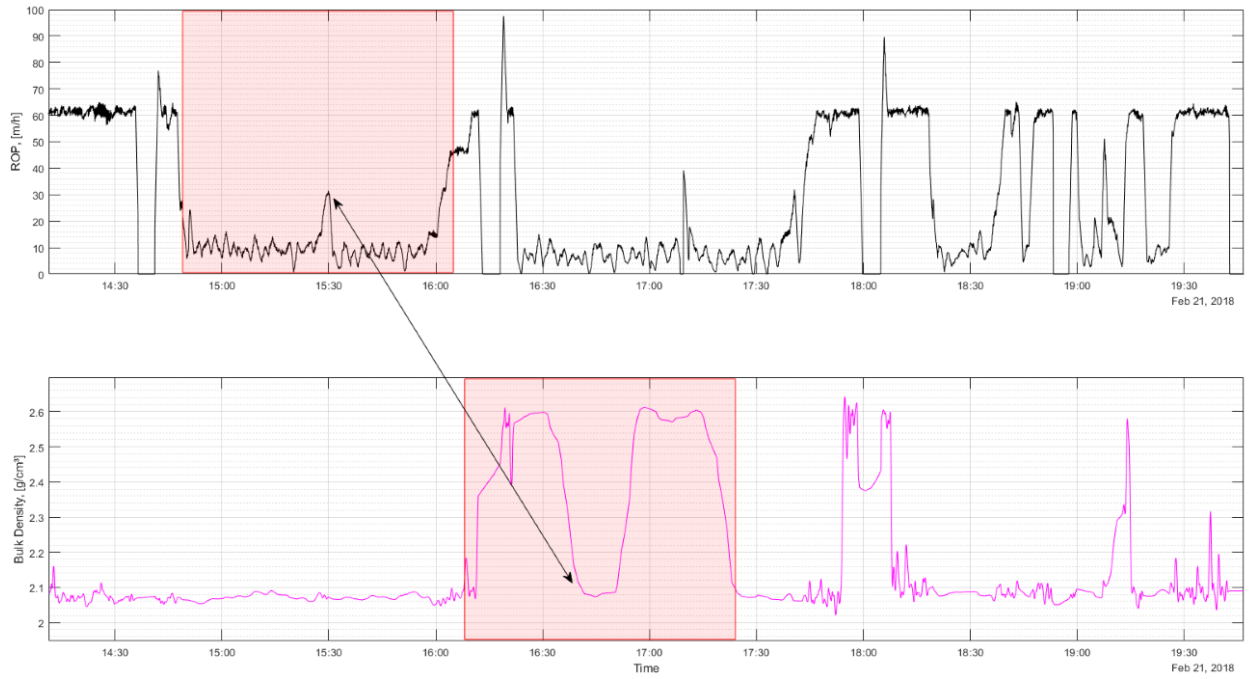

Figure 1: Plot of ROP (black) and rock density (pink) versus time. ROP show the reaction the change in density, which is recorded later, when the measuring tool crosses the formation.

Figure 1 shows the ROP signal and the downhole bulk density signal. The ROP usually reacts quite sensitive to formation changes, and it is recognizable, that the bulk density shows the exact inverted behavior. Without the correction of the density signal, it is not possible to find such correlations using algorithms.

A CNN is commonly used for image recognition. However, this approach uses a CNN to predict a scalar value, namely the bulk density at bit. For image recognition, images are represented as matrices containing numerical values indicating how dark or bright a certain pixel is. It is also possible to represent the derived features as a matrix. In this case, each row will contain data from one sensor of a drilling context in meters. Depending on the number of sensors used for prediction, the more rows the matrix will have. With that, a CNN can be applied.

Prior to the testing, a Mean Absolute Error (MAE) of 0.1 g/cm³ was defined as a goal to achieve. Using MAE makes it easy to get a feeling about the performance, since it is calculated in the unit of the target density value.

The results are promising. The CNN achieves a MAE of 0.077 g/cm³ on the test data set. Figure 2 shows the predicted results against the reference, showcasing that CNNs are not only able to provide a good estimate of the rock density, but also maps its qualitative course well. Thus, transitions between formations are also well detected.

The result was well recognized by the audience, and I was able to discuss the approach in details with colleagues from the O&G industry. And it is precisely these encounters that make a conference visit important and valuable.

The opportunity to meet and network with other professionals in the industry is and will be important. The O&G industry is one that relies heavily on collaboration and sharing of information, and events like this provide a valuable platform for people to come together and exchange ideas.

In addition to the professional benefits, attending events like Bahrain MEOS GEO 2023 is also important for the industry in general. The pandemic has disrupted many aspects of business and society, and events like this demonstrate that the industry is still moving forward and innovating despite the challenges it faces. It is important to continue to support these events and the people who organize them as they help to ensure that the industry remains resilient and dynamic.

It's not just the industry that benefits from this, but also us as individuals. Travelling and meeting actual humans from foreign countries and cultures help us to look beyond a more and more remote-controlled world. There must always be a balance between state-of-the-art technology and social, human interaction.

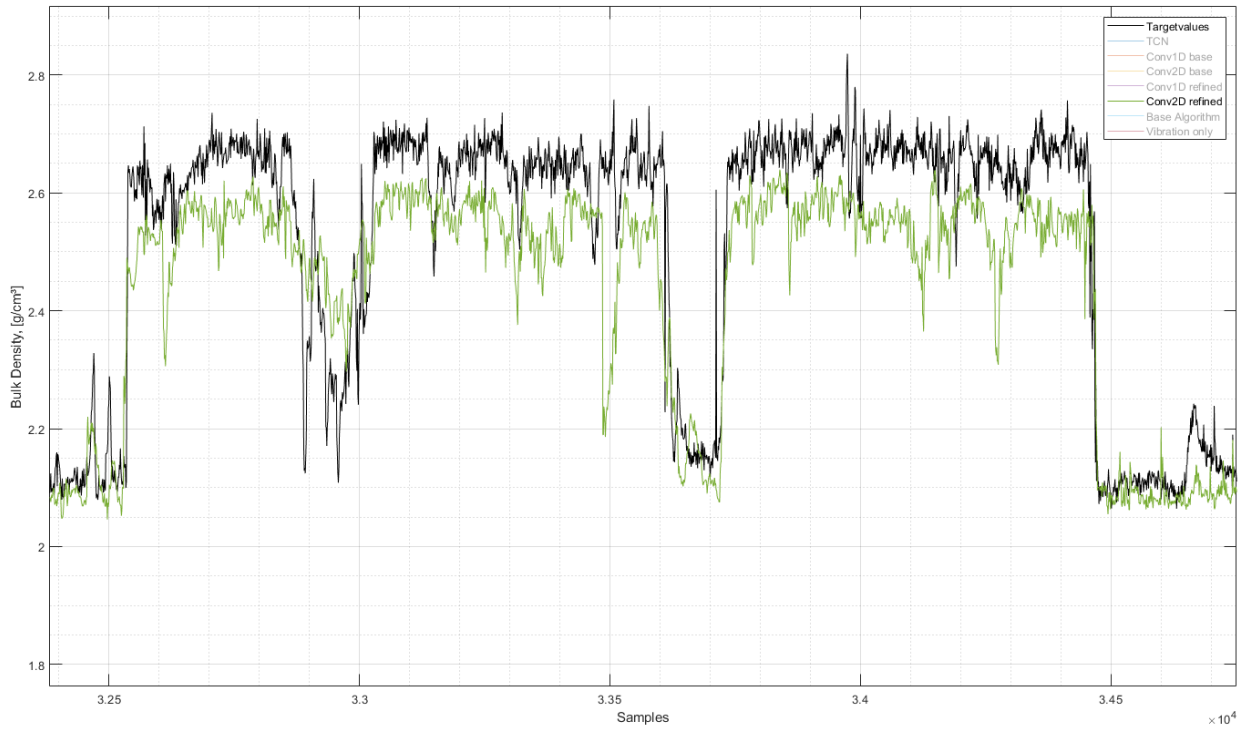

Figure 2: X-axis count of samples/time, y-axis bulk density in g/cm³. Best working 2D CNN with target values (black) and predicted values (green).

Clausthal University of Technology Drillbotics® Team Triumphs in International Competition

BY A. ALKHAWAJA, C. SOILEMEZIDIS, TU CLAUSTHAL

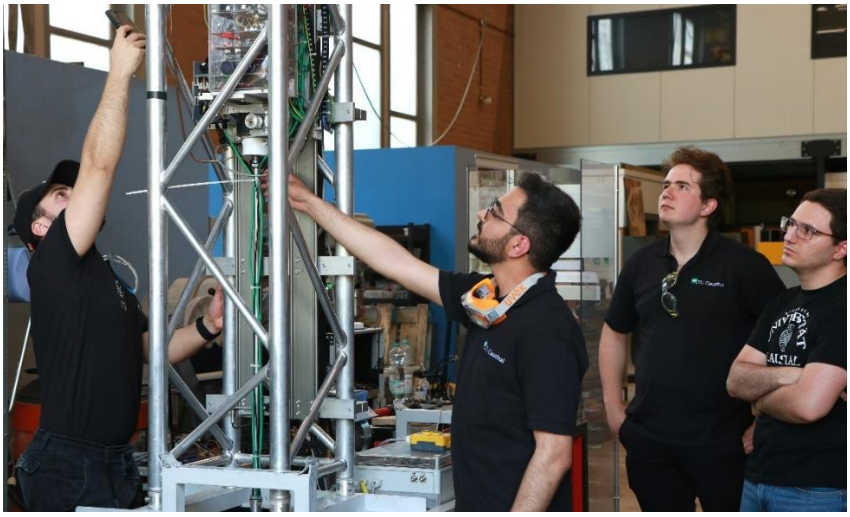

Figure 1: The student team from the left: Charalampos Soilemezidis, Ali Alkhawaja, Farouk Jamali and Kanaan Almaasarani

We are delighted to share the outstanding achievement of the Clausthal University of Technology Drillbotics® Team, who emerged victorious in the 2022/2023 International Drillbotics® Group B (Physical Rig) Competition. The competition, organized by the Society of Petroleum Engineers Drilling Systems Automation Technical Section (DSATS) and hosted this year by the University of Mons, Belgium, witnessed the team's exceptional performance and innovation in the field of autonomous lab-scale directional drilling rigs.

Led by student team members Charalampos Soilemezidis, Kanaan Al Maasarani, Ali Alkhawaja, and Farouk Jamali, the team was under the guidance of Wolfgang Hollstein and Erik Feldmann, and advisory support from Prof. Dr. Philip Jaeger, Dr. Carlos Paz, and Ramez Abdalla.

The TU Clausthal team's rig, which measures 2 x 1 x 3 meters, is capable of operating at speeds up to 3000 RPM and boasts a top rate of penetration of about 1.6mm per second in Sandstone. The rig has an integrated mechanical rotary steerable system (RSS) to enable steering capability in a 1.5" hole, reaching build-rates up to 4°/10cm. A distinctive feature of this rig is its decentralized control, which enables it to be managed from any location worldwide.

Figure 2: The BHA model

Amidst a competitive lineup, the rig garnered attention for its modularity, adaptability, and impressive performance. By integrating an advanced mechanical steerable system, algorithms, and sensors, their rig is able to respond to varying drilling conditions, ensuring optimal drilling speed and stability while executing a directional well.

Day 1: Rig Preparation and Travel

The team efficiently disassembled the rig at the university's digital drilling lab, benefiting from its modular design for easy transportation. Transported via a trailer, the rig safely arrived in Mons, Belgium, setting the stage for the competition.

Day 2: Setup, Calibration, and Testing

Rigging up and station setup was swift, followed by calibration and testing to ensure readiness for the upcoming competition.

Figure 3: Rigging up and calibration of the rig

Day 3: Competition Day

The competition day began with team presentations, followed by the drilling challenge. The team encountered minor issues with their automated algorithm, prompting them to shift to a semi-automated approach. Regardless, the rig demonstrated exceptional performance, achieving remarkable rates of penetration and steering of up to 4 degrees per 10 cm. The team's adaptability and ingenuity were clearly demonstrated as they adjusted the drilling process on demand, leading to a successful drilling of an S-curve trajectory given by four coordinates.

Figure 4: Competition Day - Rig Usage

The competition culminated in interviews and a Q&A session with the judges, who lauded the teams for their efforts. The Clausthal team's impressive results led to their well-deserved Group B (Physical Rig) victory.

The team's victory signifies their pioneering contributions to drilling automation and robotics. It opens new opportunities for their careers and underlines the quality of education at Clausthal University of Technology. Notably, the winning team will collaborate with Group A winners (Virtual Rig) to craft a joint paper for presentation at the 2024 SPE/IADC International Drilling Conference and Exhibition in Galveston, Texas, until then stay tuned for more from the team at Celle Drilling 23, in Celle and at the SPE STC 23 in Clausthal!

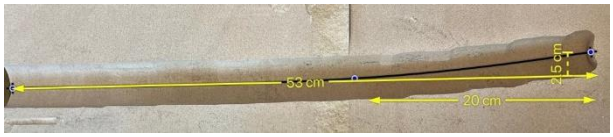

Figure 5: Cross-section of the rock showing a test borehole

The SPE TU Clausthal Student Chapter extends heartfelt congratulations to the victorious team for their remarkable achievement, serving as an inspiration to future engineers worldwide.

The team expresses gratitude to their partners, sponsors, and donors, including KCA Deutag, Baker Hughes, MICON-Drilling GmbH, ITE Engineering GmbH, Institute of Subsurface Energy Systems, TU Clausthal, and TU Clausthal SPE Student Chapter, for their invaluable support.

Figure 6: Group picture of the Drillbotics® team

The team eagerly anticipates embracing industry support for their upcoming ventures in 2024, as they persistently try to enhance drilling automation and robotics, and they look forward to welcoming new team members onboard

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Leoben Collaboration Trip

BY TELMA DA SILVA, CHRISTIAN GLÄSER, LEONEL MACHAVA, TU BERGAKADEMIE FREIBERG

Day 1: Arrival in Vienna, City Tour, and Korean BBQ

We kicked off our exciting Leoben Trip with an early morning arrival in Vienna at 11:00 am. After settling into our rooms and dropping off our bags, we wasted no time delving into the wonders of the city. In the evening, we enjoyed a delicious Korean BBQ feast followed by a captivating city tour, immersing ourselves in Vienna's rich history and culture.

Day 2: OMV at Gänserndorf

Our second day began with an enlightening visit to the ITC (International Training Center) at OMV in Gänserndorf. At 12:00 pm, we arrived and indulged in a hearty lunch at the OMV canteen with our company guide who explained to us how the OMV Gänserndorf facility was operating.

Lunch was followed with a comprehensive Tech Centre and Lab Tour, where we got introduced to cutting-edge technologies and state-of-the-art facilities ranging from materials & corrosion technology, the geology lab with is thousands of core samples, and all the way to the reservoir engineering technologies department.

At the end, we also had the opportunity to take a tour through OMV's Innovative Technology Center which was very interesting. Eventually, we bid farewell to Gänserndorf and returned to Vienna where we concluded the day with a delightful dinner at a local restaurant, creating memories and strengthening bonds amongst SPE Student Chapter Leoben and our Student Chapter.

Day 3: Welcome to Leoben

The third day marked our much-anticipated arrival in Leoben. At 11:30 am, we were warmly welcomed and guided through the esteemed Montan University of Leoben and its impressive laboratories. After the University Tour, we got invited to the Department of Petroleum Engineering where both Chapters had the opportunity to present their chapter, as well as having talks on how to increase collaboration efforts between our two chapters.

All in all, we had a very interesting conversation about further collaborations in technical talks, field trips, and

how to increase the overall satisfaction for SPE Student Chapter Members. The tour ended at 5:00 PM, leaving us with a sense of accomplishment and camaraderie, having established connections with the SPE Student Chapter Leoben at Montanuniversität Leoben.

A Memorable Collaboration Experience

Throughout the trip, we had the opportunity to present our SPE Student Chapter, to the SPE Student Chapter Leoben. This led to meaningful discussions and a better understanding of our collaborative efforts, vision, mission, and achievements. A major highlight of the trip was our visit to OMV in Gänserndorf, where we were greeted with warmth and enthusiasm. The intensive tour of various labs and technology centers left us in awe of the company's dedication to innovation and research. We extend our heartfelt gratitude to Fahmi Al Salmi and the incredible team at SPE Student Chapter Leoben for organizing and hosting us with such warmth and hospitality. Special thanks go to SPE Vienna Basin Section, OMV, the Department of Petroleum Engineering at Montanuniversität Leoben and of course to the SPE German Section for their unwavering support and warm invitation. This trip has strengthened the collaboration between both chapters and universities, fostering a stronger foundation for future endeavors.

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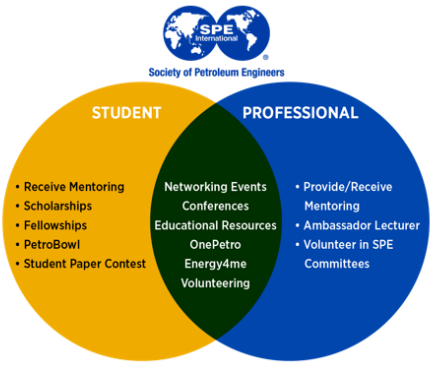

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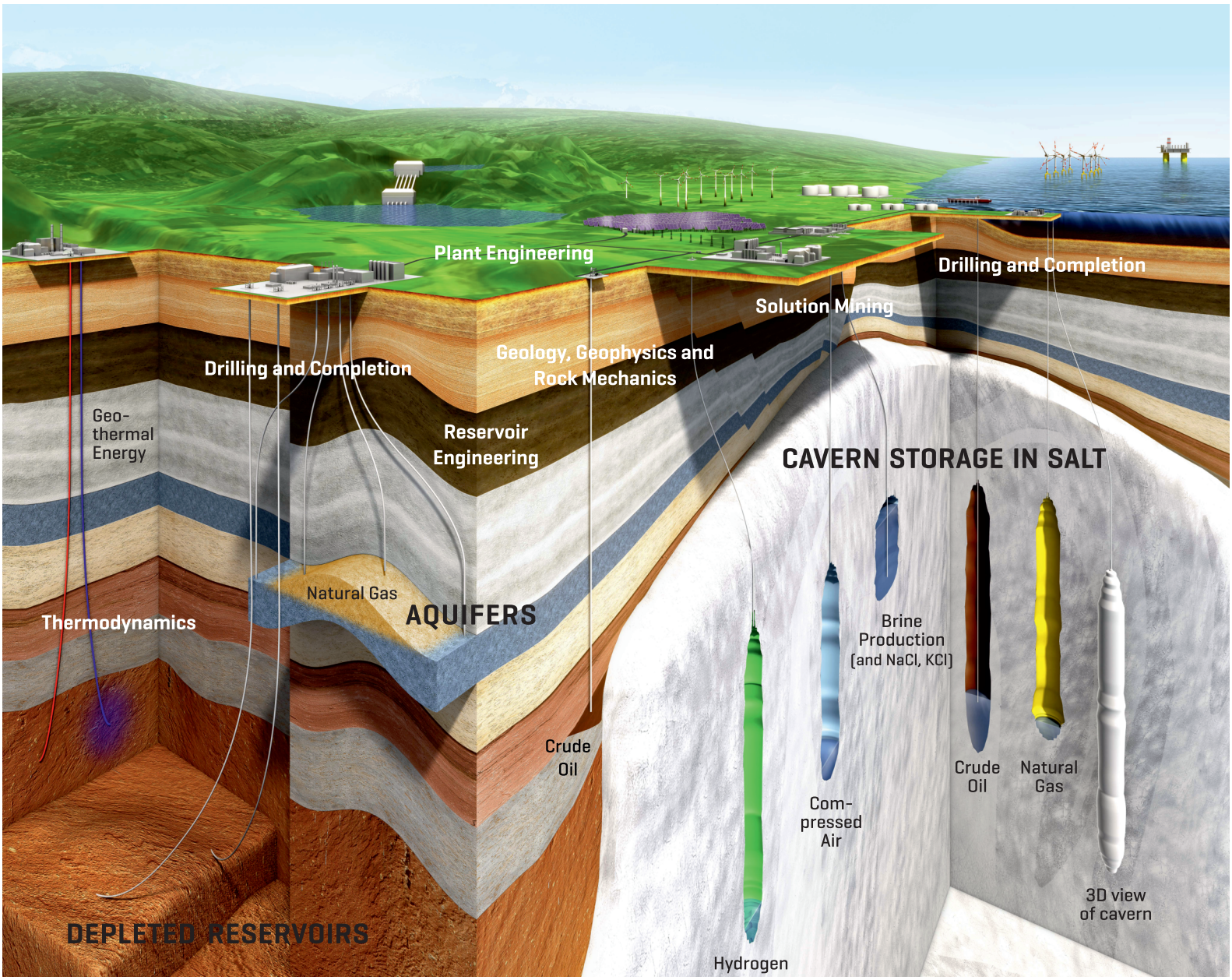

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Geothermal News

By Valentin Goldberg, Karlsruhe Institute of Technology

Geothermal Energy for the Heat Transition – The Ministry for Economic Affairs and Climate Action sends a strong signal for Geothermal Roll Out

Editor's note: Adapted from original text in German Language, 11.11.2022.

Geothermal Energy has a high potential for tackling the challenges of the energy transition. It can derive weather- and season-independent baseload energy and is especially in terms of heat production highly efficient. Yet the large potential in Germany is just minorly tapped. This shall now be changed, as stated by the German Government most recently.

The German Ministry for Economic Affairs and Climate (Bundesministerium für Wirtschaft und Klimaschutz) Action released a benchmark paper stating that to secure the prosperity and security of supply they want to make greater use of the potential of geothermal energy. The goal is to exploit until 2030 a potential of 10 TWh by middle-deep and deep geothermal energy and with this tenfold feed into heating grids. To achieve this goal 100 additional geothermal projects shall be initiated to give a pulse for even more projects, further develop the technology, and prepare the market.

To achieve these goals, eight measures were defined:

1. **Exchange with stakeholders** - dialog process on necessary measures.
2. **Data campaign** - Systematic provision of existing data to enable the basis for successful projects.
3. **Exploration campaign** - Exploration partially financed by the federal government in areas that offer a high probability of success for specific projects.
4. **Planning acceleration** - Identify and leverage optimization potential in approval processes.
5. **Support programs** - Provide impetus for market preparation and competitiveness.
6. **Risk mitigation** - Examine risk hedging instruments.
7. **Securing skilled labor** - Developing strategies for attracting young talent.
8. **Acceptance** - Information events and acceptance programs should become an integral part of any project.

Sources

Bundesministerium für Wirtschaft und Klimaschutz - Geothermie für die Wärmewende , dated 11.11.2022.

Hottest Well in Germany - Plant in Graben-Neudorf produces thermal water for the first time

Editor's note: Adapted from original text in German Language, 22.08.2023.

15 Months after the start of drilling geothermal water flows for the first time at the Graben-Neudorf site near Karlsruhe in August 2023.

The company Deutsche ErdWärme concludes the first testing phase of the Graben-Neudorf-1 well. The well reaches a depth of 4000 m and sets a new German record in terms of temperature. Reaching over 200 °C the well exceeds significantly the expectations of the operator and is with this value the hottest well in Germany. After analyzing the first fluid samples taken from the geothermal brine the next step is the conduction of injection tests. In the end, the Geothermal power plant Graben Neudorf shall supply 40 MW geothermal capacity for up to 20,000 households. Yet the high temperatures pose high challenges to the equipment and will require detailed planning for the 2nd well. After the successful drilling of the 2nd well and the construction of the plant itself, the plan foresees to go on the grid in two years.

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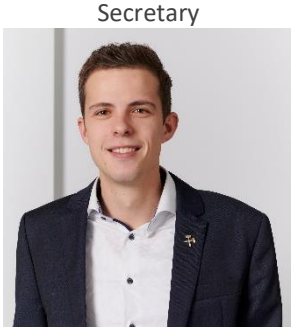

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