EARTH SCIENCE ANALYTICS

AI-DRIVEN GEOSCIENCE

A PARADIGM SHIFT PROMISING INCREASED EFFICIENCY, REDUCED COSTS, AND ACCELERATION OF THE ENERGY TRANSITION

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ABOUT THE AUTHOR

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He has held various technical and managerial roles in E&P energy companies, where he has worked with exploration, field development, production and research.

INTRODUCTION

How do you make the right business decisions? You base it on the available data. But what do you do when the datasets are so large and complex that a human being could never go through it all - even in a lifetime?

In 2021, the total amount of data created, captured, copied and consumed world wide was around 79 zettabytes. How big is this? 1 zetabyte is 1 billion terrabytes, which equals all the grains of sand on all the world's beaches. 10 years ago, this number was *just* 2 zettabytes.

The energy industry has enormous amounts of data - and it's increasing exponentially. A single seismic volume of full-stack seismic data from a North Sea survey covering 40 000 km² can now be 1.5TB of data.

This multiplies when we take into account the angle stacks, and even more so when adding in the seismic gathers. The net area of the North Sea is 575 000 km², and though far from being fully explored, much of this area is covered by multiple overlapping seismic surveys.

So back to the question, what do you do when the datasets are so large and complex that a human being could never go through it all - even in a lifetime? You make assumptions when selecting what to process and how it is processed - and this is how opportunities get missed.

Big data analytics is not only a question of the analysis process, which itself faces challenges of lacking integration between disciplines. It is just as much a matter of integrating, contextualising and cleaning the data being analysed.

An example of missed opportunities is the Johan Sverdrup oil field, which was overlooked for over 40 years. Upon further inspections, it turned out to be one of the biggest oil reserves in the North Sea! Nothing is more expensive than a missed opportunity.

In this e-book we will look beyond the exciting methods and technology of AI analytics workflows and rather go in-depth of what Geoscience analytics is today, why it is important, the friction points of legacy methods and how to rethink our approach.

THE ROLE OF AI IN GEOSCIENCE

The challenge before us, both as a society and as industry professionals, is reducing carbon emissions and combating climate change, while also addressing fuel poverty and the increasing energy demands of a growing global population.

The field of geoscience is intrinsically woven into the UN Sustainability Goals and will play a crucial role in delivering on these commitments.

As we stand at the forefront of a new era in the energy industry, we recognise the untapped potential that lies within our subsurface data.

Hindered by outdated technologies and limited resources, the wealth of this data remains largely unexplored. Unlocking subsurface insights has traditionally been hampered by data accessibility and inefficient interpretation methods.

By leveraging digital technologies, we can liberate data from legacy silos, make it readily accessible for large-scale analytics, and utilise AI to automate interpretation workflows.

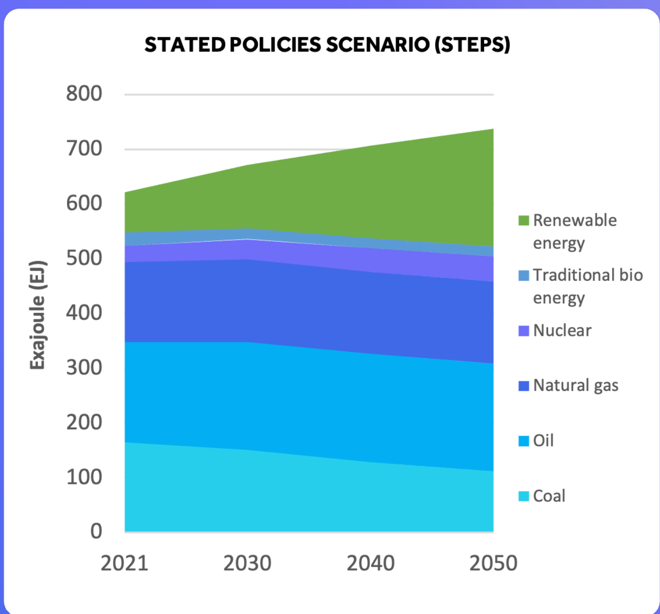
OPTIMISING EXPLORATION AND PRODUCTION PROCESSES TO MEET ENERGY DEMAND

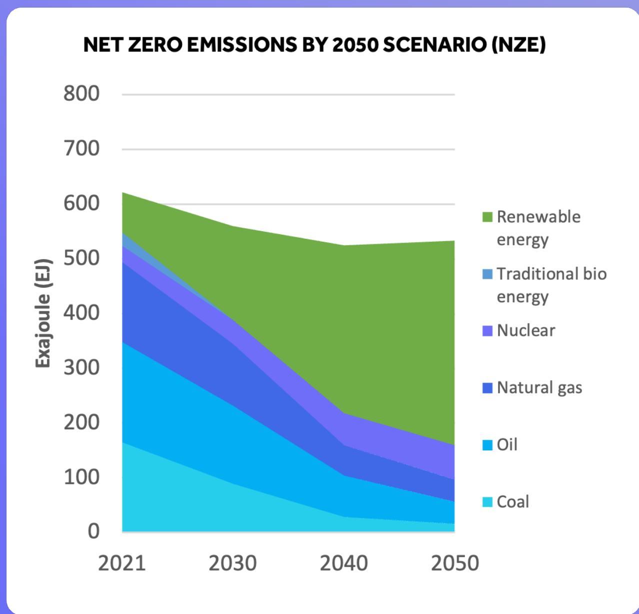
Despite the growing shift toward renewable energy, the world still requires oil and gas, and will continue to do so for the foreseeable future.

The energy industry is at a dual crossroads: it's not just about being greener but also about staying profitable. To stay profitable and cut costs, the industry needs to lean into the latest in data science and technologies, enhancing subsurface imaging and improving oil and gas recovery.

The massive growth in data, coupled with improvements in computational power, has highlighted the limitations of traditional physics-driven and statistical models. This has set the stage for a new modeling approach: artificial intelligence (AI). The benefits of AI - its ability to scale, capacity for recognising patterns in massive datasets, and versatility - offer great potential in speeding up discoveries and increasing accuracy of predictions.

FORECASTED WORLD ENERGY SUPPLY FOR DIFFERENT SCENARIOS





Source: IEA (2021), Net Zero by 2050 Data Explorer, IEA, Paris
https://www.iea.org/data-and-statistics/data-tools/net-zero-by-2050-data-explorer

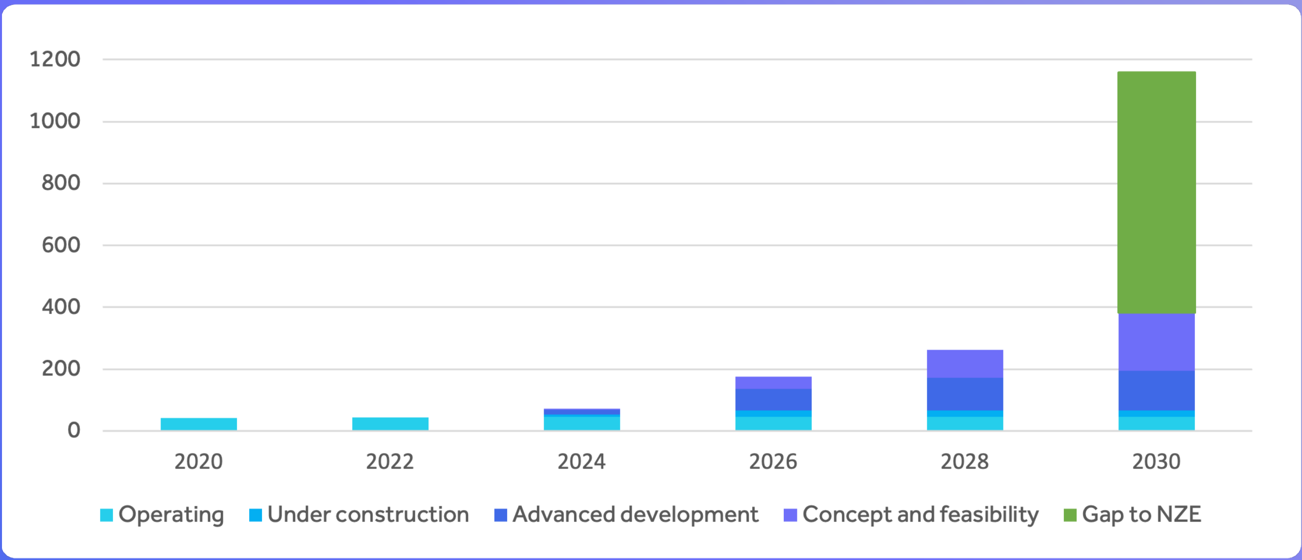
SCREENING, DE-RISKING AND MONITORING CO2 STORAGE SITES TO TACKLE EMISSIONS

To achieve net-zero emissions by 2050, capturing and storing vast quantities of CO2 is essential. However, there is currently a large a gap between the expected demand for CO2 storage and the rate at which

In 2021, approximately 40 commercial capture facilities were operational worldwide, with a total annual capture capacity exceeding 45 million tonnes (Mt) of CO2. While more than 50 new capture facilities targeting operation by 2030 have been announced since January 2022, the pipeline of current projects is only just around a third of the 1.2 gigatonnes (Gt) CO2 per year target stipulated in the Net Zero Emissions by 2050 (NZE) Scenario.

Utilising AI instead of traditional methods will be crucial to accelerate and streamline the process of screening, characterising, de-risking, and monitoring CO2 storage sites.

CAPACITY OF CURRENT AND PLANNED LARGE-SCALE CO2 CAPTURE PROJECTS VS THE NET ZERO SCENARIO



Source: IEA (2021) Capacity of current and planned large-scale CO2 capture projects vs. the Net Zero Scenario, 2020-2030, IEA, Paris https://www.iea.org/data-and-statistics/charts/capacity-of-current-and-planned-large-scale-co2-capture-projects-vs-the-net-zero-scenario-2020-2030

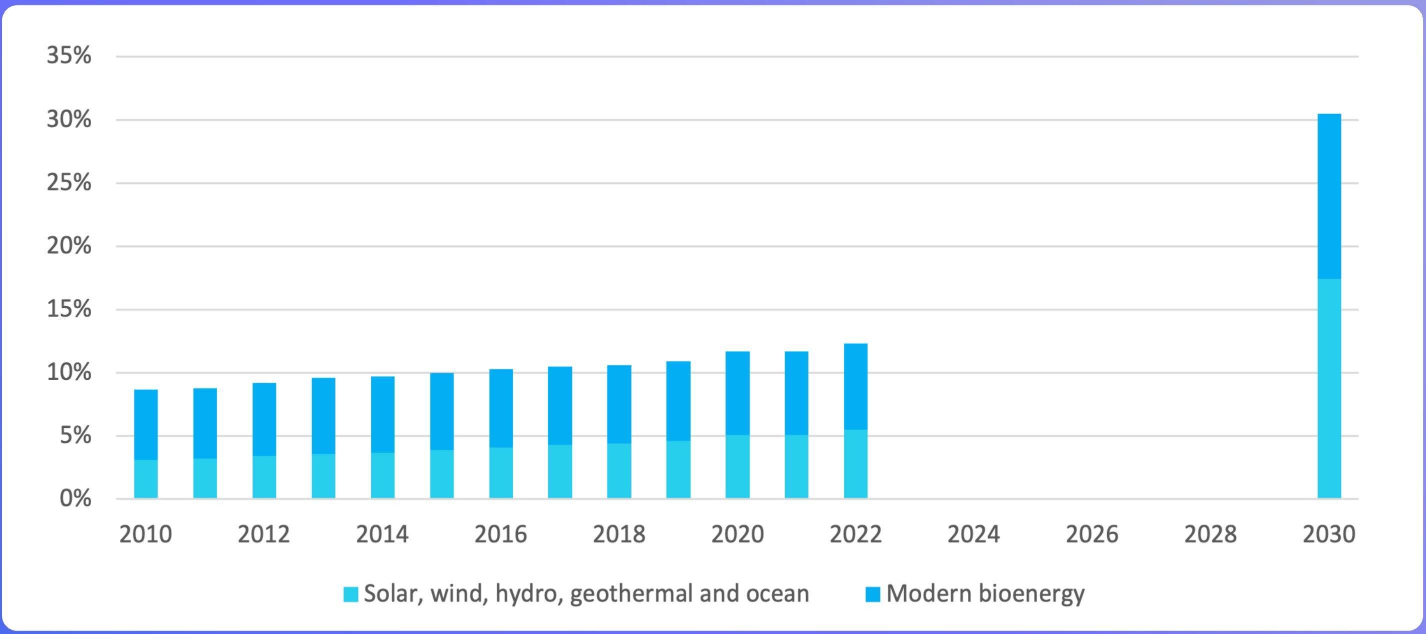
ACCELERATING THE TRANSITION TO RENEWABLE ENERGY SOURCES

The expansion of renewables share of the energy mix is crucial for reducing CO2 emissions in line with the NZE Scenario.

The goal is to increase the non-bioenergy renewables' share of the total energy supply from roughly 5% today to about 17% by 2030. This calls for a yearly increase in renewable energy use of around 13% from 2023 to 2030, a pace double that of the previous five years. To achieve this goal, there's a pressing need for a significant acceleration in the use of wind, hydro, geothermal, solar thermal, and ocean energy.

Determining areas and locations for installing power-producing wind turbines at sea is a labour-intensive, time-consuming, and expensive process that can be revolutionised by AI. By automating seismic interpretation for boulder detection and streamlining 3D mapping of geotechnical properties, AI makes these processes more efficient and cost-effective.

RENEWABLES SHARE OF TOTAL ENERGY SUPPLY IN THE NET ZERO SCENARIO



Source: IEA (2021) Renewables share of total energy supply in the Net Zero Scenario, 2010-2030, IEA, Paris
https://www.iea.org/data-and-statistics/charts/renewables-share-of-total-energy-supply-in-the-net-zero-scenario-2010-2030-2

THE STATE OF GEOSCIENCE ANALYTICS WORKFLOWS

Any scientist analysing data knows that it can consist of much tedious and manual work. A large degree of that consists of simply tracking down and organising your data, to make it analytics ready.

In order to extract the information needed to support business decisions, multi-disciplinary workflows are executed since a single group of subject-matter experts is not able to carry out all the necessary tasks.

Traditional geoscience software tools have seen positive developments the last 20 years, but one could argue that this is on the wrong premise, with focus on innovations that optimise for a paradigm that is now being replaced by emerging AI, data science and cloud technology.

Being the industry standard, these traditional tools are certainly competently made software, but lack a lot of automation features that can take efficiency, data utilisation, and prediction accuracy to another level.

DATA MANAGEMENT

Traditionally, geoscience data is organised in folder structures without metadata stored across multiple data stores connected to specific software products. As a result, geoscientists spend more than half of their time searching for data.

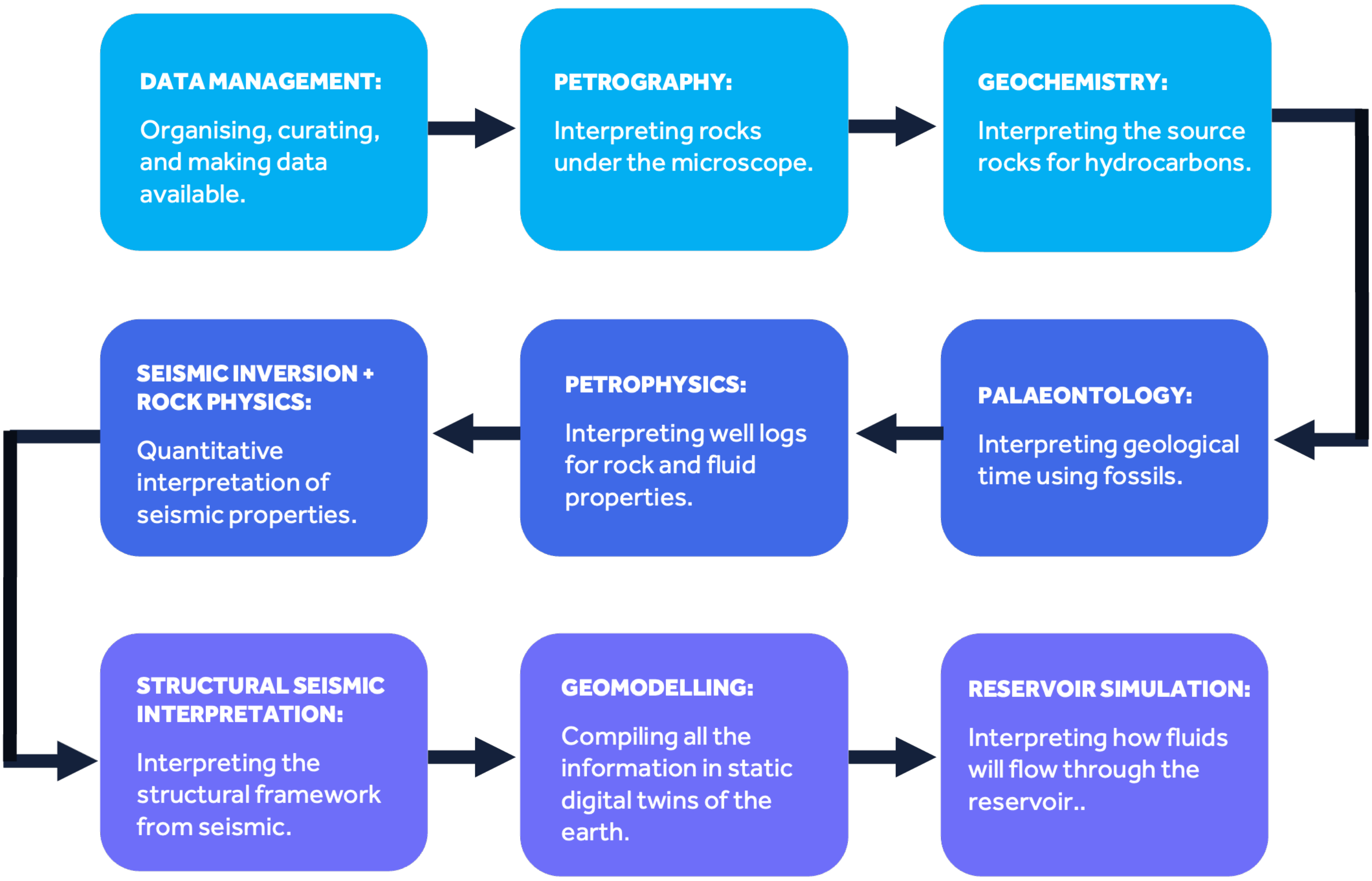
THE CHALLENGES WITH TRADITIONAL DATA MANAGEMENT

- Every application has its own data storage, with different versions of the data.
- Duplication of files leads to unnecessarily high storage costs.
- Results of work is saved in geoscientists personal projects within different applications making it hard find, and to leverage previous work in new projects.
- Subsurface workflows use multiple, poorly connected, applications to create the basis for investment decisions.
- Geoscientists work in discipline silos with little collaboration between experts in different domains.
- The multi-discipline workflow relay suffers from information and knowledge loss at handovers.
- Lack of version control and traceability makes it difficult to build on top of previous work.

TRADITIONAL WORKFLOWS

In multidisciplinary studies, like that of subsurface geoscience, the traditional workflows are heavily reliant on experts in multiple fields. This drives cost up, while information will always be lost in the transfer between the discipline-specific steps.

All these disciplines require a deep understanding and specialisation, and solving integrated geoscience problems requires collaboration between experts in these disciplines.



However, due to the complexity of the problems being solved, an expert in a single discipline has limited competence in the adjacent discipline. Like in a relay race, the baton is handed over from one specialist to the next specialist, with non-optimal integration between disciplines, and loss of important information at each handover.

THE HUMAN ELEMENT

In our discussion of multi-discipline workflows and the inherent inefficiencies of the "relay race" approach, it is vital to acknowledge the unavoidable human element.

We have immense respect for the value and significance of human scientific resources, and firmly believe they can be better applied and utilised, to the advantage of both the energy industry and the scientific community.

With the sheer volume of data that must be processed for any given project, we identify three aspects of friction where AI workflows offer immense promise:

1. **Bias**
2. **Efficiency**
3. **Expertise**

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HUMAN BIAS: THE UNCONSCIOUS INFLUENCER

Bias is an undercurrent of subjectivity that subtly colors human decision-making. It's rarely a deliberate distortion, but it's a topic we must address in the context of human data selection and analysis.

Even with the cleanest data, most thorough methodologies, and rigorous approaches, human predictions and interpretations will always carry some level of bias. There is too much data to manually interpret all of it, so we rely on educated best-guesses. These assumptions are susceptible to both outside influences, as well as personal preference and opinion.

A 2016-2017 study, conducted by The Norwegian Petroleum Directorate, had some revealing results. It looked at the predictions of potential pay offshore versus actual resources. **It showed a 2,5 times overestimation.**

The vast empirical knowledge and experience possessed by individual scientists and the scientific community will always carry socio-economic considerations that tint its conclusions.

The scientific method counters bias through peer review, seeking to establish truth from consensus. But gaps persist.

AI software solutions offer a complementary tool to mitigate, though never entirely eradicate, this vulnerability.

EFFICIENCY: THE HUMAN LIMITATIONS

Time's constraints bind us all. Unlike machines, humans need rest, nourishment, and meaningful experiences for sustained productivity.

Our physical capabilities are bounded; we can only type and click at a certain speed, and our minds, as remarkable as they are, don't interface directly with data storage. This puts limitations on what a single scientist or researcher can achieve in a day, month, year or even lifetime.

«AI will not replace today´s geoscientists, but geoscientists leveraging AI tools will replace those who don´t.»

EXPERTISE: DEPTH AT THE COST OF BREADTH

An expert is often someone who knows a great deal about very little. Solving complex problems invariably requires input from multiple fields, with each discipline contributing a piece of the puzzle before passing it on.

A geologist interprets data from a petrophysicist, whose findings are then relayed to a data scientist or geomodeller for further calculations. This cyclical process is reiterated with contributions from other experts and sensors.

Such linear progress in problem-solving still has its place. However, we need to reconsider its application given the exponentially growing volumes of data we are accumulating. Parallel processing, with interconnected nodes of expertise, is the only viable way to handle this data within a reasonable timeframe.

LIBERATING DATA AND INNOVATING GEOSCIENCE WORKFLOWS WITH AI

Unlocking subsurface insights has traditionally been hampered by data accessibility and inefficient interpretation methods. The future of geologic interpretation involves a split between routine tasks driven by AI and complex, creative work led by subject matter experts.

This fusion of AI automation with human expertise will revolutionise the field, delivering data-driven insights at a speed and pace previously unimaginable while also fostering an environment for innovation and discovery.

DATA ORCHESTRATION

Your data is potentially the most valuable asset that you have, but its value is determined by how accessible it is for decision making.

Traditionally, data has been kept in silos, designed specifically for certain tasks, often only capturing a portion of the whole picture. A common challenge in geoscience analytics is the lack of ready-to-use data. In fact, getting data prepared for analysis can take up a whopping 80% of a scientist's time.

Since AI is so reliant on the data, a part of its implementation is solid data governance, which will lead to "data liberation" if properly planned and implemented.

OSDU: A STEP TOWARDS CENTRALISED DATA

The OSDU initiative is a good foundation of centralising your data. It is not locked to proprietary technologies, allowing you an application-neutral data layer accessed through APIs. With a solid community and documentation, OSDU and Open Data Layer is accessible, and already adopted by many key industry actors. But this is only the beginning - data lake is the continuation.

While OSDU makes sure that data is discoverable through search and filtering using metadata, you need further cleaning and contextualization to have a solid foundation for large scale integrated analytics.

DATA LAKES: DIVING DEEPER

A Data Lake refers to a pool of data that is structured, organised and accessible at high speed.

It's not the data itself that's groundbreaking, but the way it allows a higher level of contextualisation. This contextualisation elevates the concept of metadata, letting you ask questions directly to the data, not just the metadata. Every asset, along with its history of analysis, becomes easy to access.

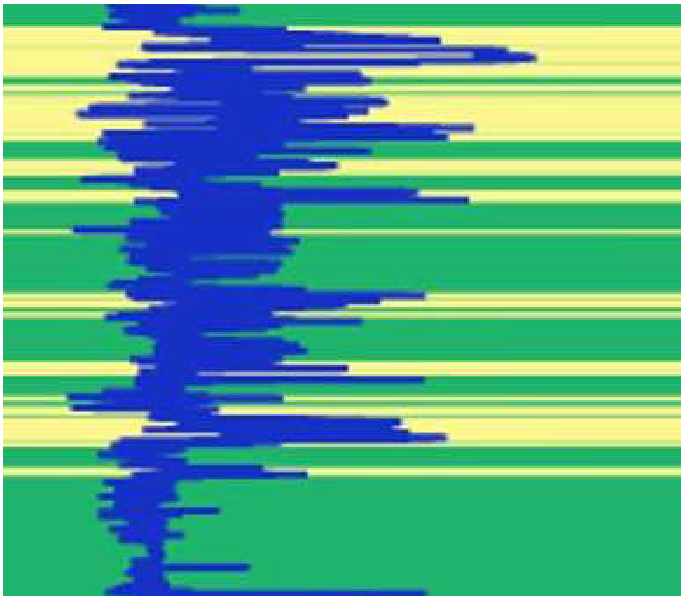
Using meta-data alone for indexing and contextualisation is insufficient when you want to scale modern collaborative and integrated workflows. For collaborative workflows considering posterity, you must be able to query the data itself, not only its meta-data. This requires a deeper level of contextualisation than what OSDU provides.

Getting your data aligned, contextualised, and cleaned, and building consistent subsurface data is crucial for Machine Learning (ML) applications.

Once this is done, you can access any data point within entire datasets instantly. Although there's some human effort needed in this process, it's a one-time investment. You can now integrate all data types and propagate information from the ground truth sources, to every log sample in every well, and to every seismic sample in all your surveys. This opens the door to new opportunities that has until now been unobtainable.

WELL INTERPRETATION

Traditional well logs measure physical properties, but we're interested in the lithology, porosity, permeability, and water saturation of rocks. Accurately quantifying these properties is crucial to understanding hydrocarbon accumulations and CO2 storage capacity. It is, however, very time-consuming, and it can take a petrophysicist 1-2 days to interpret one single well.



AI-driven geoscience software revolutionises your petrophysics by enabling you to predict rock- and fluid properties with AI - faster, better, and cheaper than traditional

In 2021, NPD commissioned a study revisiting 1250 exploration wells drilled in the North Sea. Utilising an AI software solution, a full analysis was completed in 6 months.

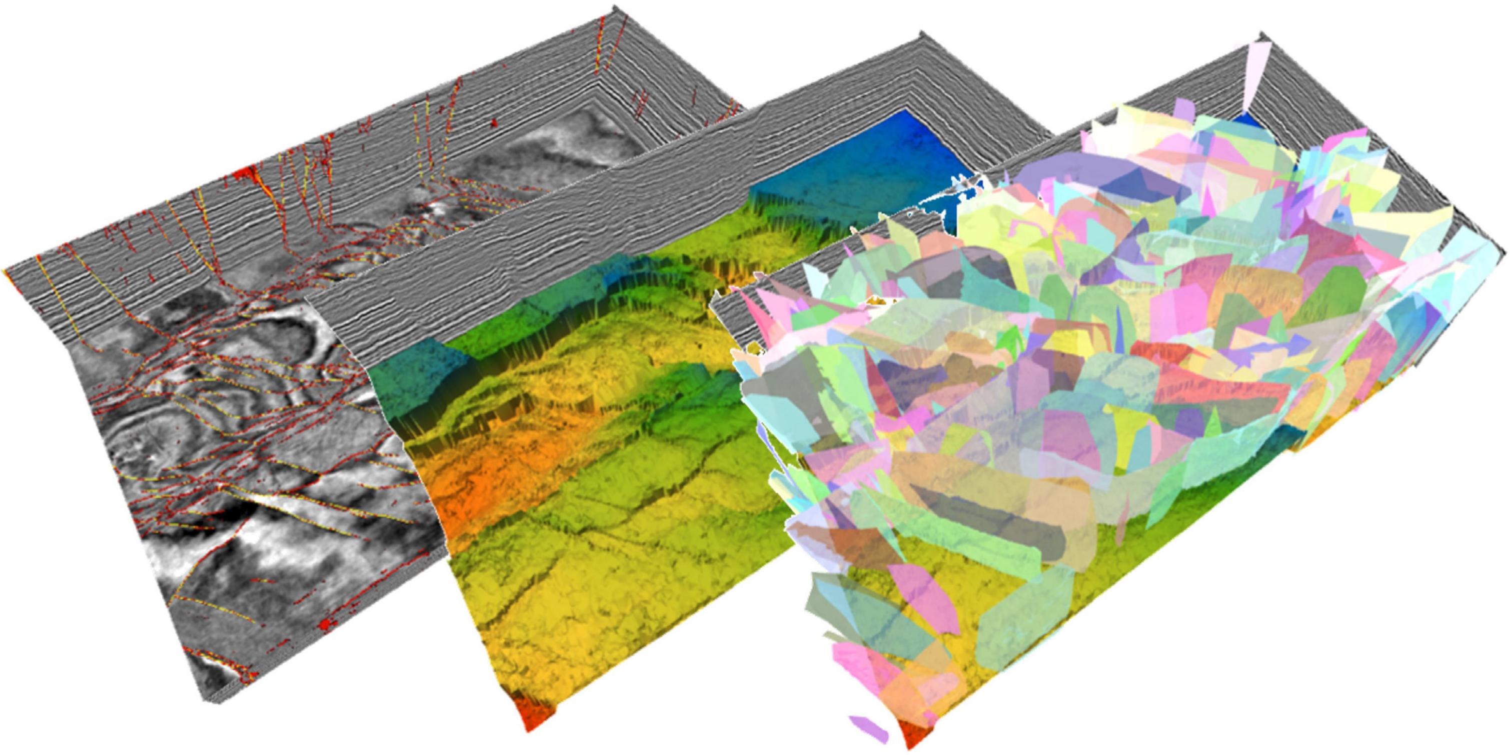
This was accomplished by intelligent and efficient integration, contextualisation and cleaning of the data, which was then processed using multiple workflows. The AI driven study discovered the potential for missed opportunities in over 300 of these wells.

This project would take over 10 years to complete using traditional methods.

SEISMIC INTERPRETATION

Interpreting seismic data to map the reservoir's geometry, structure, and layering is crucial for understanding the volume of hydrocarbon accumulations, the capacity of CO2 storage sites, and the sealing capacity for both hydrocarbon and CO2 reservoirs. However, traditional seismic interpretation processes are highly subjective, repetitive, and time-consuming, often leading to inconsistent results.

AI can dramatically increase the efficiency of seismic interpretation. By applying AI models, you can reduce your workflows from weeks and months to days while simultaneously improving the quality of interpretation.



3D PROPERTY PREDICTION

Quantifying the reservoir's properties is essential for populating geocellular models for volumetric calculations and flow simulation studies, and for identifying exploration opportunities and potential carbon storage sites. Traditionally, predicting reservoir properties is done by geophysicists through seismic inversion and rock physics. This multi-step process is both time-consuming and costly, and demands the expertise of highly skilled individuals.

The seismic property prediction process can be revolutionised into one seamless workflow using AI. This enables you to create a 3D property cube in a matter of weeks, which would be impossible using the traditional seismic inversion workflow.

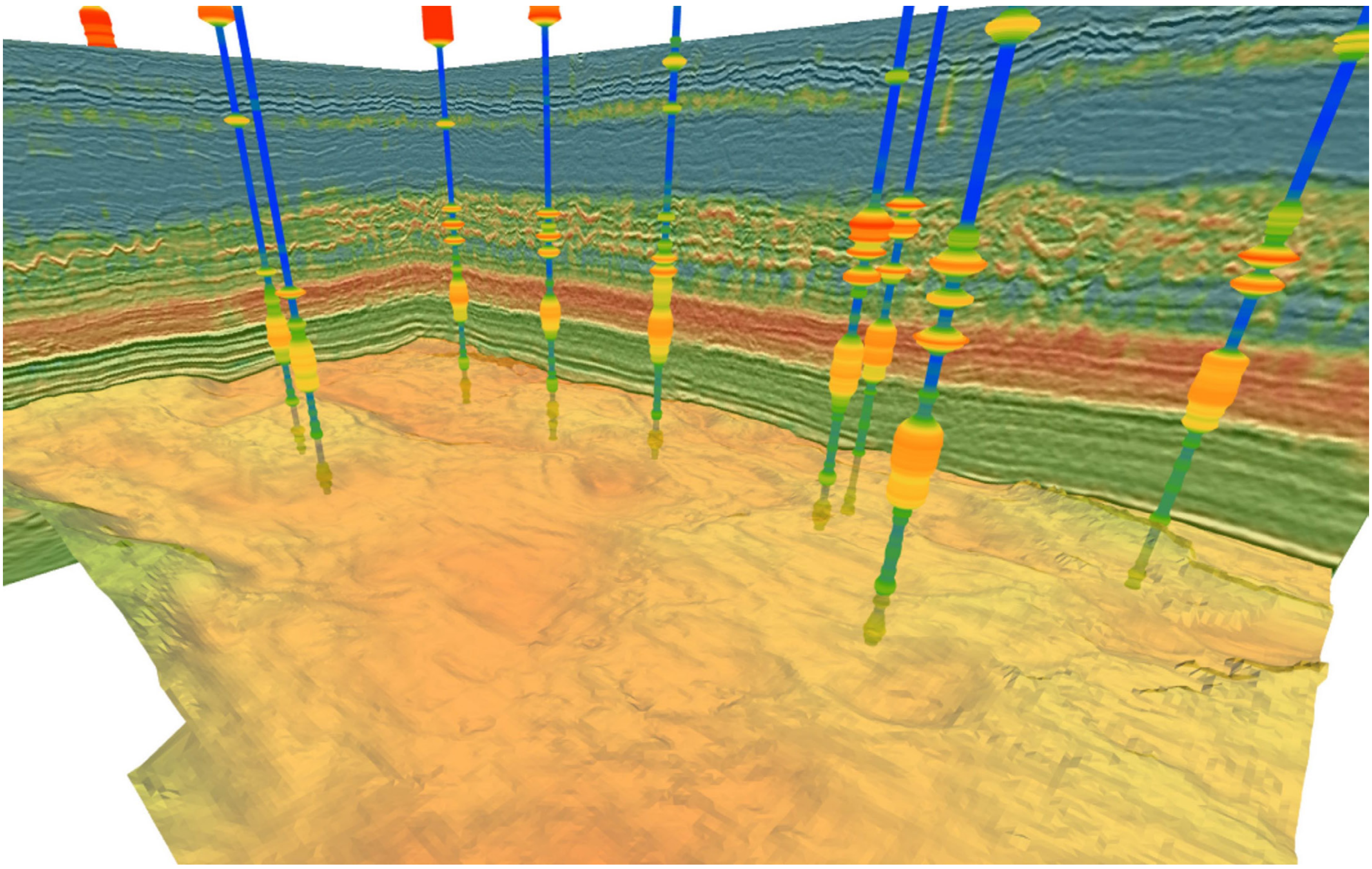
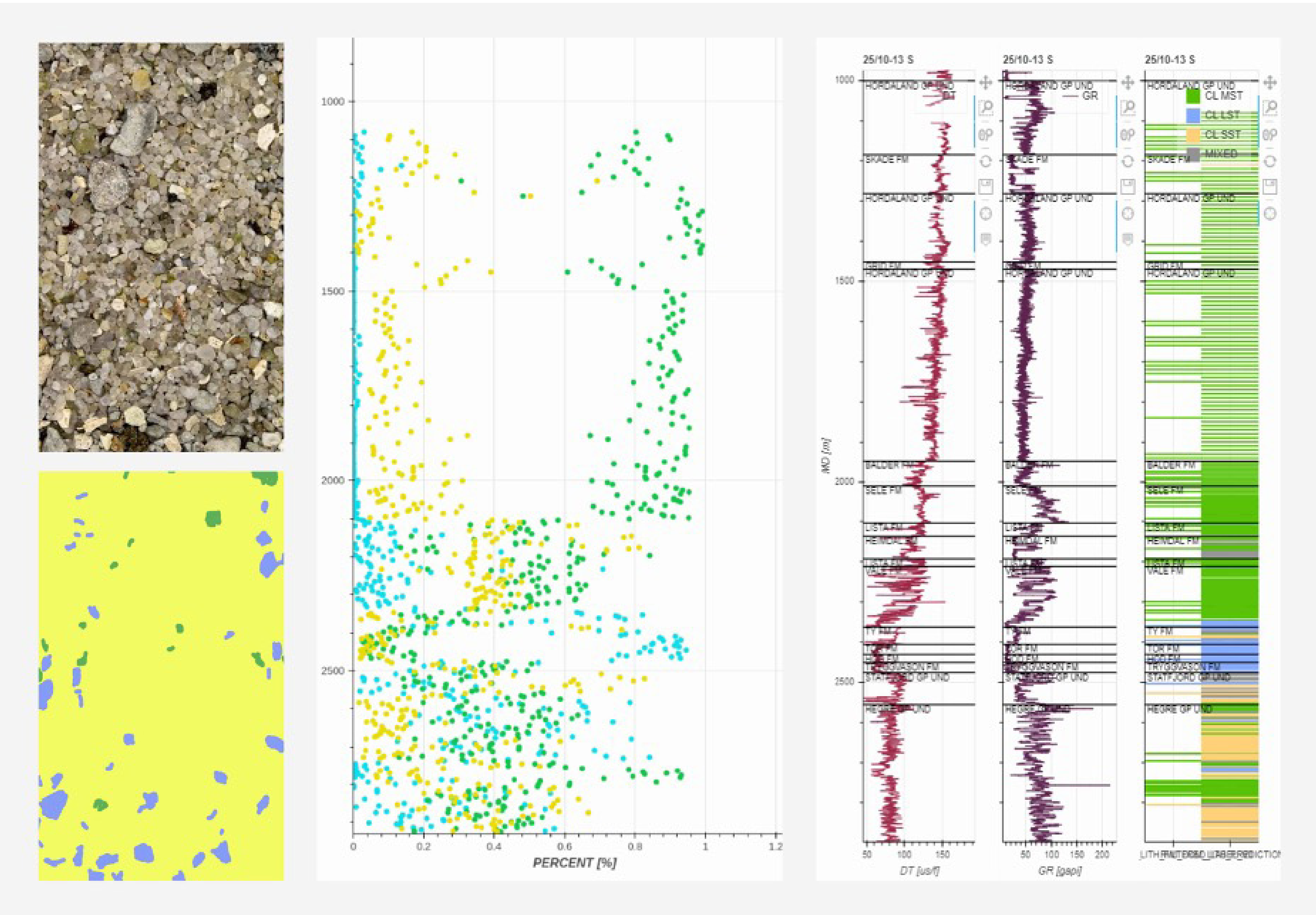


IMAGE DATA INTERPRETATION

Interpreting rock samples is a crucial aspect of geoscience as they provide the closest representation of the ground truth. Usually this process is done manually under suboptimal conditions, leading to errors and inefficiencies. Since the interpretation is time-consuming and expensive, it is often limited to few samples despite vast amounts of data available.

By using computer vision, you can interpret rock samples with speed and accuracy. Incorporating these interpreted rock samples into your workflows increases your understanding of reservoir formations and improves well planning, petrophysics, and sedimentology studies.



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SUMMARY

There are some serious friction points in the traditional methods of geoscience analytics, which is an obstacle for it scaling sufficiently to meet future demands.

Integrated AI solutions represent a paradigmshift in that contextualisation and analysis can be efficiently done to unlock the value hidden in the large and ever-growing sub-surface datasets. It is simply the only way of utilising the available data in an economically viable fashion.

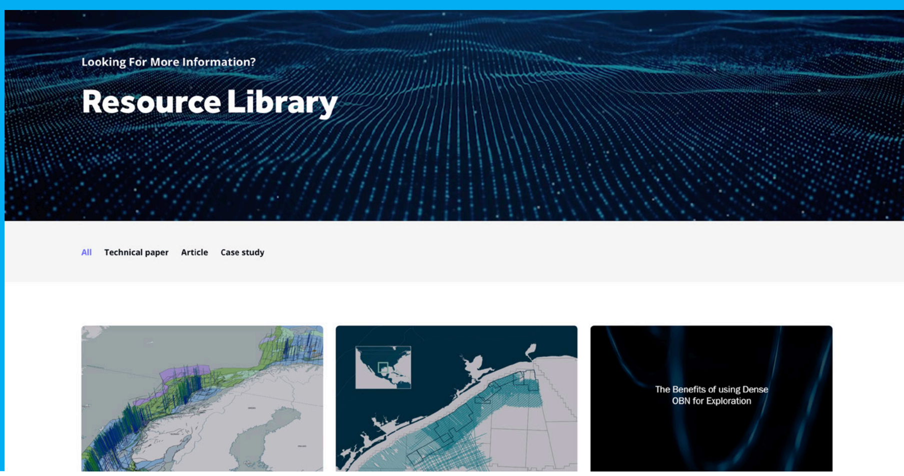
It also relieves subject matter experts of manual repetitive tasks, allowing them to spend more of their time on new questions, possibilities and ideas.

Applying AI driven solutions to geoscience analytics, not only improves the economics of this important field, but allows results to be less influenced by human bias.

Do you want to explore and learn more?

Hopefully you have discovered some new opportunities for your business or organisation. We recommend to see our resource centre, where we aim to educate and share our knowledge on AI technology in the field of geoscience analytics.

Go to Resource Center



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