Well Data Analysis with EarthNET

Summary

- EarthNET enables prospect level accuracy at basin scale by automatically analysing data based on previous discoveries.

- Through our platform your geoscientists are able to create consistent data driven studies from all your data at a fraction of the cost of traditional workflows.

- In 2019 Earth Science analytics analysed 5000 wells from the Northern North Sea and successfully identified over 200 opportunities from over 30,000 kilometres of log data in 4 months.

- Traditional workflows consume up to 20 times the resources to complete the same work compared to using EarthNET

Well Data Analysis

A database containing more than 70 different data types and 90 million depth indexes was turned into a cloud native exploration project using our data management tools in EarthBank.

From here we were able to use our quality control tools and semi-automated workflow to clean and edit the data on log by log and multi-well scale. This screening process gave us a basin wide view of data coverage, quality and exploration patterns.

Machine learning algorithms then "learn" hidden relationships in the measured data which allows us to predict missing log data, rock and fluid properties and exploration targets.

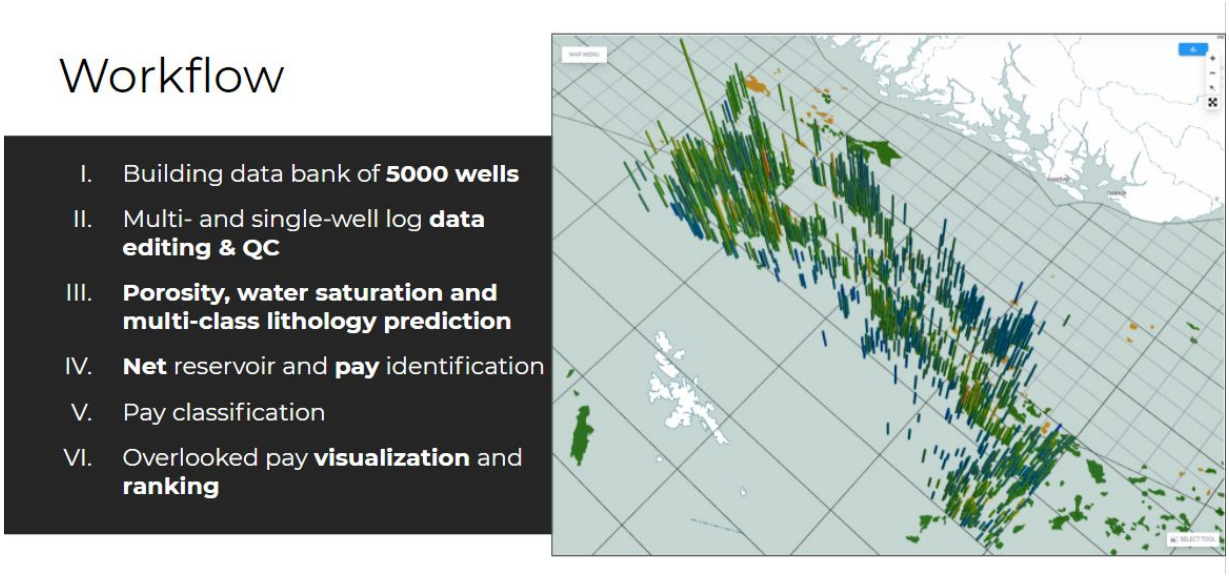
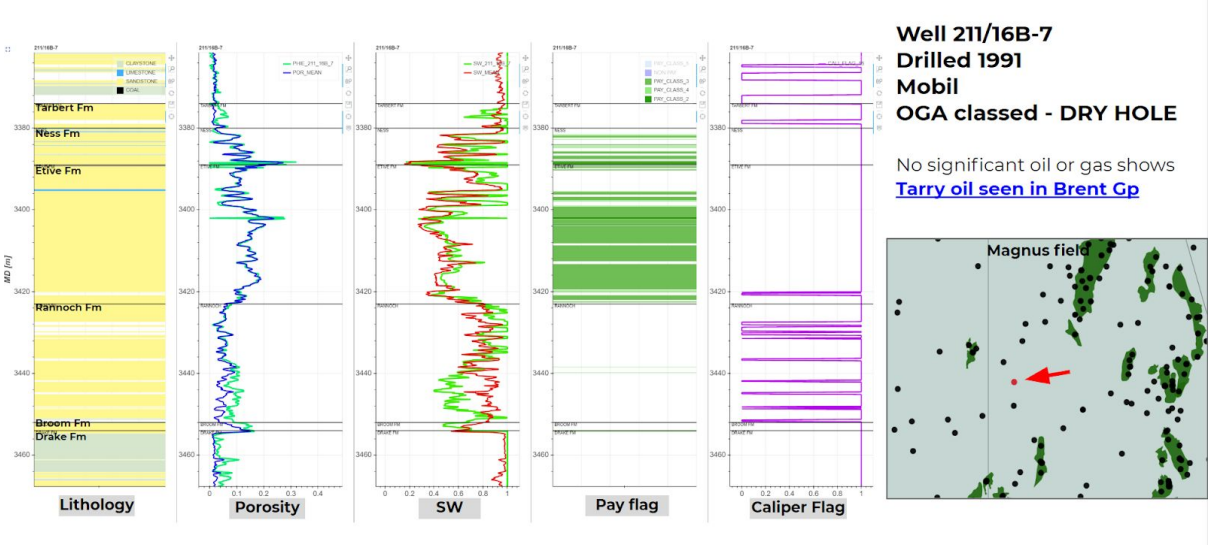


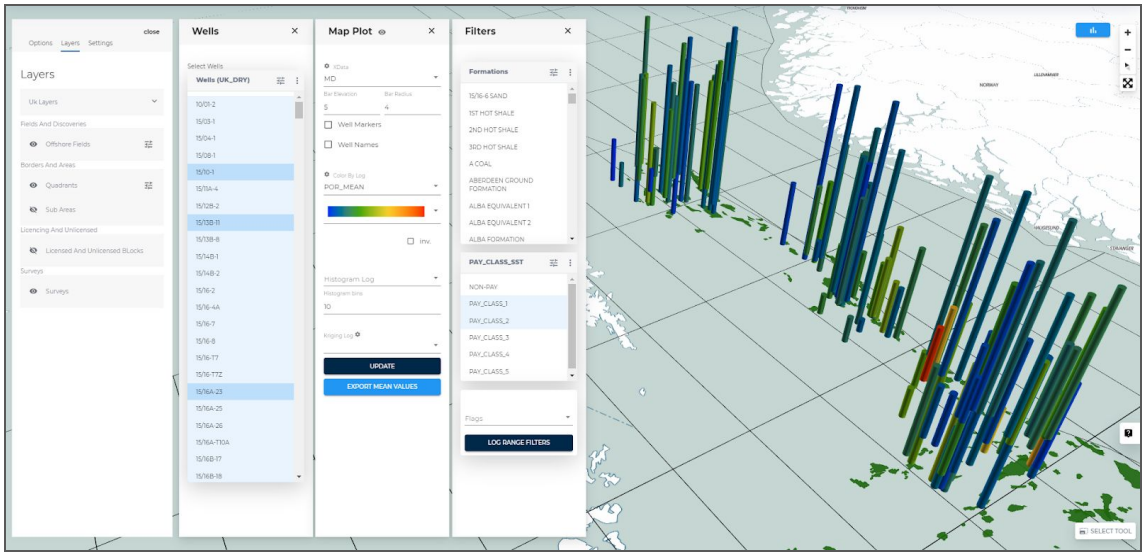
Figure 1: A high level workflow for missed pay prediction in Northern North Sea. An example map view of a subset of wells is shown on the right.

Each model was reviewed locally to see how the machine learning performed as well as globally to see how the predictions match the wider geological context.



The end result of was a suite of highly controlled CPI logs produced from an ensemble of models that can be traced back to original wellbores and an overall increase in data richness by up to 300%

Predicted mean Sw and porosity curves were then used to identify oil/gas pay intervals.



Advantages

Unlike conventional techniques we utilize large amounts of data to predict reservoir properties at significantly shorter turnaround leading to huge cost savings:

- 2 Senior petrophysicists can work 2.5 wells per day
- It will take them a **minimum of 2000 days to analyse 5000 wells**
- Completing the same work with a single EarthNET licence will take one geoscientist **a maximum 100 days to analyse 5000 wells**
- EarthNet increases efficiency by at least 20 times
- Utilising ML saves significant money **less than $10 to analyse 100's of wells**

By running this workflow in EarthNET we were able to complete the entire process within a standard budget cycle, while our team was able to move between projects freely and contribute as needed.

EarthNET therefore provides an extra layer of insight that is otherwise unavailable to the industry.

The EarthNET result is also evergreen and self improving as the models you train will be available for use on other projects while your EarthBank project stays live and can be updated with new data, additional models or transferred into a different area.

The EarthNET well study can then be combined with seismic to produce 3D volumes in the application.

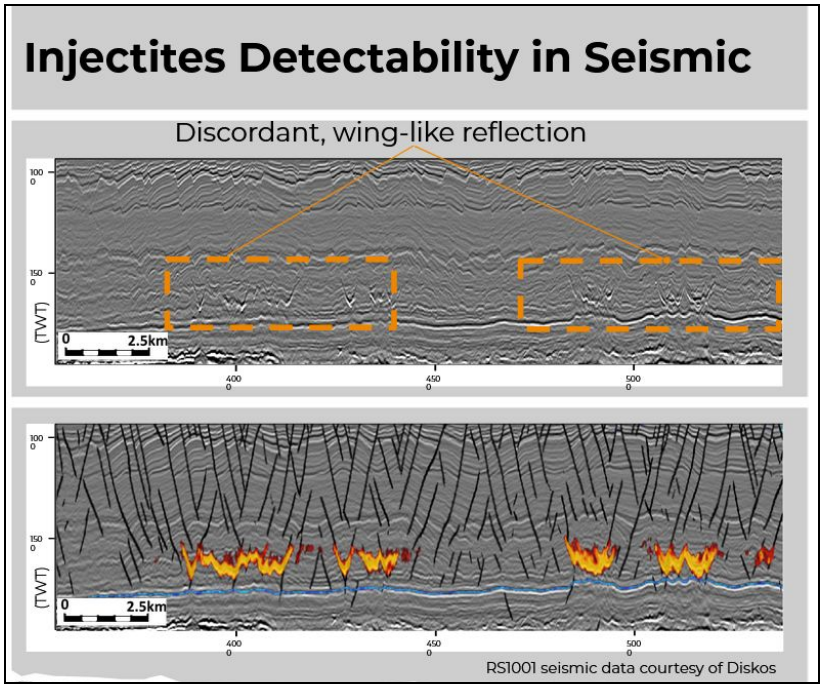
Seismic Data Analysis With EarthNET

Summary

- EarthNET can help identify and map many types of geobodies within the subsurface by using artificial intelligence
- A popular use case in the North Sea is to map injected sandstones, a task which is very difficult to do using traditional methods
- Geoscientists can kick start interpretation with pre-trained models and then optimise using their local survey and geological context
- EarthNET's models are self improving as they learn over time from your interpretations and data
- Automated seismic interpretation is orders of magnitude faster and identify geobodies in hours instead of weeks
- Alongside geological interpretations the model also measures the consistency of the data and model performance

Automated Seismic Interpretation

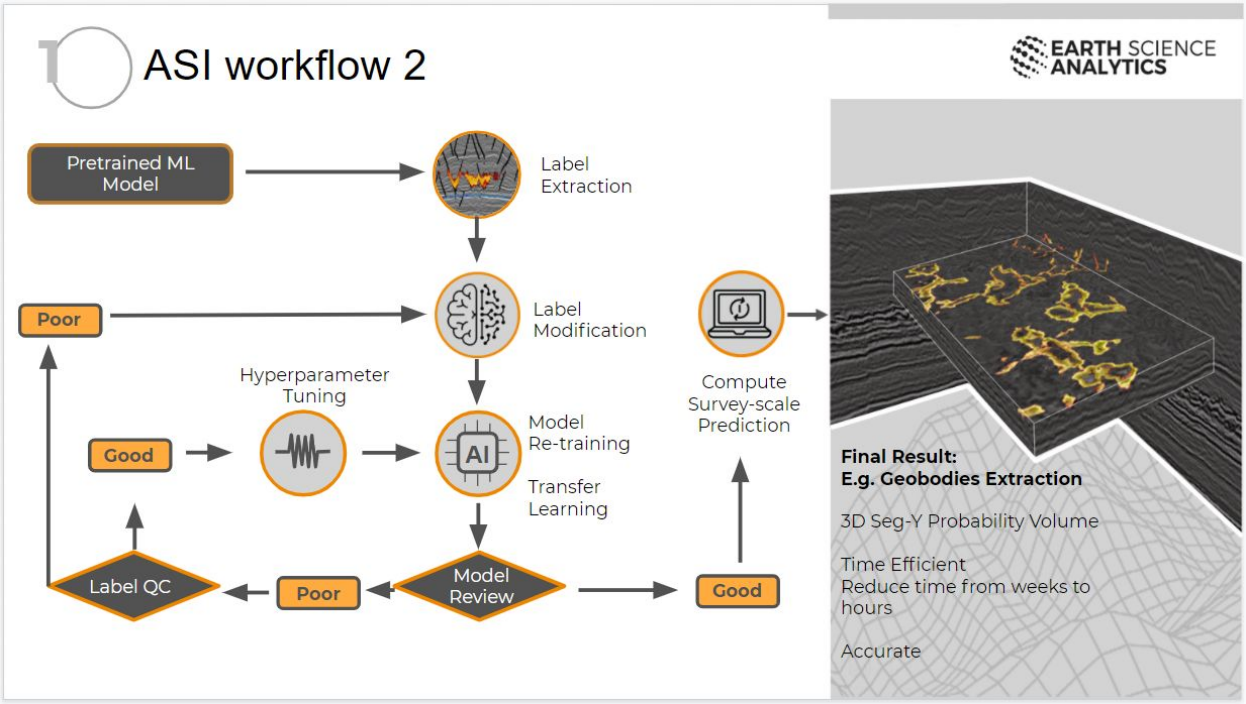
Injected sandstones are a major component of several petroleum systems in Norway and are the subject of significant exploration interest.



The problem with identifying these targets is that their convoluted shapes are not easily isolated by conventional auto trackers.

In some cases they are invisible seismic due to the seismic quality and overlap in acoustic impedance therefore requiring an experienced interpreter and lots of time.

In EarthNET we can use big data to our advantage by starting with pretrained models and combining information from wells, seismic and other domains to better understand the injectites.



Our pretrained network has seen millions of different examples of injectites and will quickly identify potential targets in the seismic cube which we can then review using our regional understanding combined with model and data scores.

This interactive loop can be completed any number of times allowing you to refine and redefine targets on the fly.

Once we lock in the targeted injectites a local model can be quickly trained and deployed to identify injectites across the entire survey.

The end result is not just a fully interpreted survey- we have also produced models that can be deployed on other surveys, captured our geological knowledge as high quality labels and improved the seismic workflow by several orders of magnitude.

Advantages

Compared to conventional methods EarthNET offers significant reductions in cost and time to project completion while also elevating the quality of results:

- **Produce repeatable and highly detailed** structural/stratigraphic interpretations with integrated uncertainty.
- **Extract subsurface elements based on geological knowledge** of the interpreters through the supervised and active learning process.
- **On demand** applications based on synthetic training, provides an excellent solution to save time/money.
- **Simply exceeds the capabilities of any traditional seismic attributes-based workflows** by orders of magnitude.

By producing data driven results we can quickly assess productivity and the role of our geobodies in the area of interest. Our interpretations can be connected to ground truth data such as cuttings, core samples or biostratigraphic markers.

By running this workflow in EarthNET we were able to complete the entire process within a standard budget cycle, while our team was able to move between projects freely and contribute as needed.

We can then combine our geobodies with well properties to produce 3D property models within EarthNET

3D Property Prediction With EarthNET

Summary

- EarthNET uses deep learning to directly predict acoustic, elastic and reservoir properties from 3D seismic partial stack data, velocity and well data.

- In this case study from the Sleipner area in Norway we created 3D volumes from 11 wells, partial stacks and a velocity cube in a matter of weeks

- This approach is significantly faster and can be carried out in-house by your asset teams

- No intermediate products or external contractors required

- Create multiple 3D studies in time to support licence decisions

Property Prediction From Core Samples to 3D Volumes

Normal seismic inversion methods are time consuming, resource intensive and limited by their underlying assumptions. To carry out this work accurately lots of highly specialized knowledge and software is needed which puts it out of reach of many exploration teams

EarthNET uses deep learning to help geoscientists overcome these barriers and deliver accurate volumetric results with minimal overhead and a short turnaround time

In this study, we focus on using neural networks to directly predict both elastic and rock properties from 3D seismic partial stack data, velocity and a combination measured and modelled property data at wells.

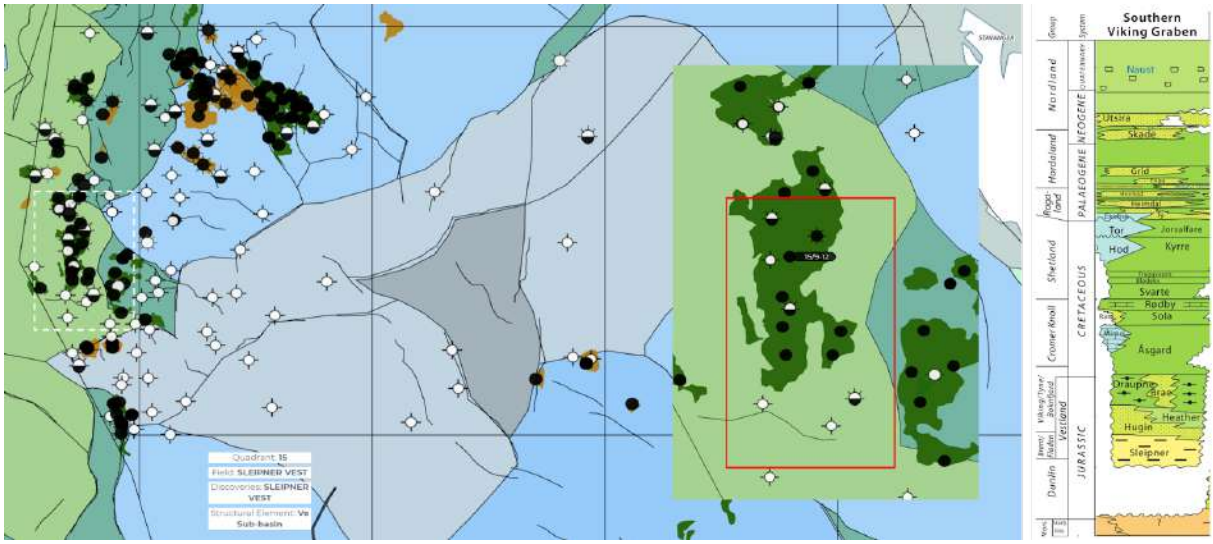
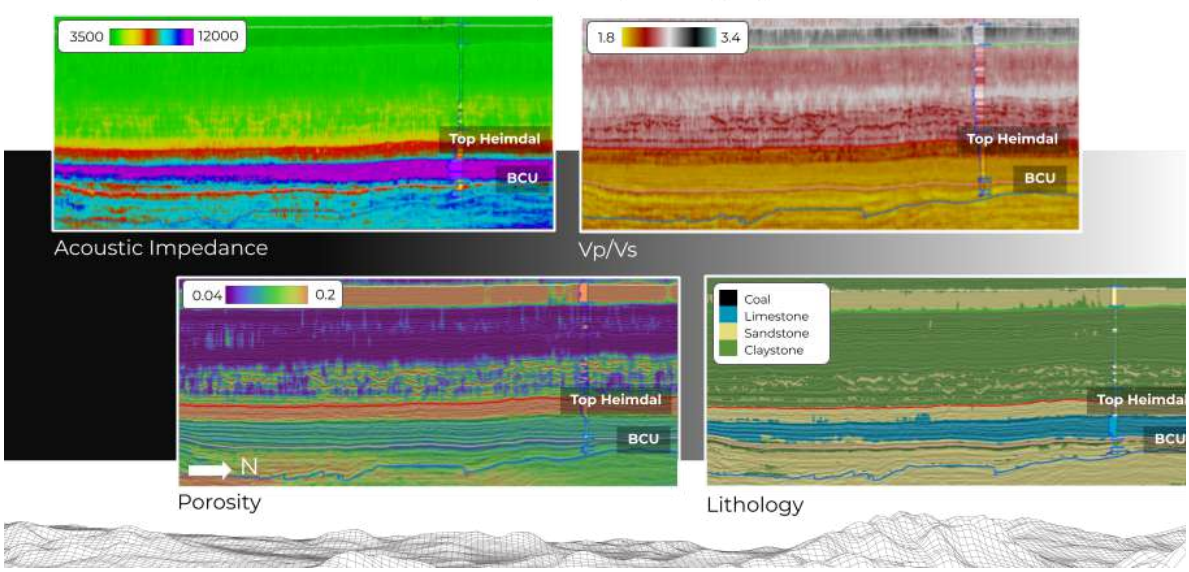


Figure 1 *Study Area. (background map) The structural setting and distribution of 230 wells used for modelling at well scale are shown. The Sleipner Vest field lies west (white box). (inset map) Sleipner Vest field outline with the extents of the ST0804D14 PSTM seismic survey shown in red. Of the 13 wells within the survey area, 11 were used in training models at seismic scale. (right) stratigraphic column in the basin*

By deriving our properties from the well data, we can use supervised learning to predict across our entire survey. To make sure that the results are robust data were cross validated spatially, by geological features and using hold out methods.

This means you can explore whether there are any outliers in the data such as bad wells, avoid overfitting and assess generalisation during the training stage.



The model ensemble with the lowest average mean square error and highest average explained variance was then selected for prediction.

Advantages

EarthNET's property prediction enables fast inversion for key reservoir rock properties, increasing the speed of quantitative interpretation by up to 10 times. EarthNET also provides a much more robust and well defined result.

- **Typical Inversion product will take up to 9 months** for an intermediate result
- With EarthNET your team can **complete the same work in 1 month**
- EarthNET **works in any domain and requires no special data conditioning**

By using our state of the art models and web based platform your exploration teams can create full data driven regional models that capture the ground truth.

EarthNet can help generalists overcome the limitations of traditional workflows by eliminating the need for wavelets ,1d convolution and specialized data conditioning.

These flexible and robust networks can be trained to predict any property in time or depth and the whole workflow takes only a few weeks.