Th H 06

Unleashing Hydrocarbon Show Data in Exploration and Well Planning

G. Hoetz* (EBN), S. Korevaar (Utrecht University)

Summary

A key enabler to successful exploration is the way how multiple data types can be integrated efficiently. One of the data types often being underutilized is Hydrocarbon Shows (HCS) observed during the drilling and testing phase. This is related to the fact that HCS data are provided in various and often non-standard data formats. Hence capturing HCS data in a database is not trivial and therefore this information is rarely accessible via integrated interpretation platforms.
The workflow presented here offers a powerful method to obtain insight in the distribution of hydrocarbons in the subsurface. It allows to analyze any observation on hydrocarbons from well data and seismic data via 2D and 3D visualization. Additional benefits include better understanding geo drilling hazards and planning well trajectories for petroleum as well as geothermal projects.

Introduction

A key enabler to successful exploration is the way how several data types can be integrated efficiently. One of the data types often being underutilized is Hydrocarbon Shows (HCS) observed during the drilling and testing phase. This is related to the fact that HCS data are provided in various and often non-standard data formats. Sometimes this information is provided just as text statement in the well completion log. Hence capturing HCS data in a database is not trivial and therefore this information is rarely comprehensively accessible via integrated interpretation platforms.
In the drilling phase, typically three data types referring directly to the presence of Hydrocarbons can be observed:
1) Mudlog shows i.e. gas (oil) shows while drilling using gas chromatography.
2) Core shows: i.e. hydrocarbon indications from cores (e.g. oil stains, fluorescence, gas bubbles).
3) Test shows: i.e. hydrocarbons from RFT, DST and well test data.

Ideally this geo-spatial information is also made available to the seismic interpreter while evaluating the seismic. We have developed a workflow that allows to capture the different types of shows into a single database. This database contains all relevant HCS observations from those three data types using a semi-quantitative classification tool. The classification is based on rules that translate parameters like maximum gas show, background gas show level, and lithology into one of the following HCS quality labels: *good*, *medium*, *poor*, *no show* or *no data*.
Thus quantified HCS attributes are created for every formation encountered in every borehole.
In this way, the nature and the importance of any show observation can be assessed, quantified and made available to explorers including the seismic interpreters. Because these attributes are depth referenced they can be plotted in well log panels and displayed together with seismic data: x-sections and seismic maps. Subsequently, the presence (or absence) and the quality of shows can be evaluated in the context of geological structure and seismic attributes.
The co-rendering of HCS attributes together with seismic data is a valuable tool in play analysis and prospect evaluation. This paper explains the workflow being developed, addresses some of the pitfalls and gives examples on how this data integration can help to explain specific well results.

Method

An important element of this approach is the classification scheme that was developed in order to translate miscellaneous observations from the wells into data suitable for a database. For the observations from the gas chromatograph, the classification was based on maximum gas reading, background gas reading (average gas reading over a longer interval) and the ratio of both: *peak gas to background gas ratio* (PtBR). For example, in case the maximum gas reading for a particular stratigraphic interval is above 1000 ppm and the PtBR is larger than 5, this gas show classification is "*good*". For this procedure, all gas readings have been quality controlled in order to take out signals which are not representative e.g. *trip gas or connection gas*. Also the lithology at the depth of the gas peak plays an important role in the interpretation of the gas chromatographic signals. In this way for every stratigraphic level where mudlog data is available, a HCS quality label could be determined.
Hydrocarbon observations from cores (oil stains, fluorescence and gas-bubbling) have been quantified and classified too and constitute a separate component of the database.
Well test data (DST and RFT (samples)) have also been quantified using maximum rates being tested and predetermined test classification criteria (e.g. net HC gas flow of > 50,000 m3/d result is labeled as "*good*"*)*. The classification criteria are designed to make the different observations comparable to a certain degree. In those intervals where multiple observations were available, cross plotting the classifications from different sources helped to define the cut-off criteria for the classifications. In this way it was possible to combine different observations into a single classification scheme.

Subsequently, a rule-based integration method where test data takes priority over mudlog data and where "*good*" shows take priority over "*fair/poor*" shows yield a single, concatenated HC Shows label per stratigraphic interval per borehole. The diagram (figure 1) summarizes the workflow.
The database allows to visualize the separate HC shows types (also oil and gas separately) or the concatenated HC Shows which combines all the available show information.

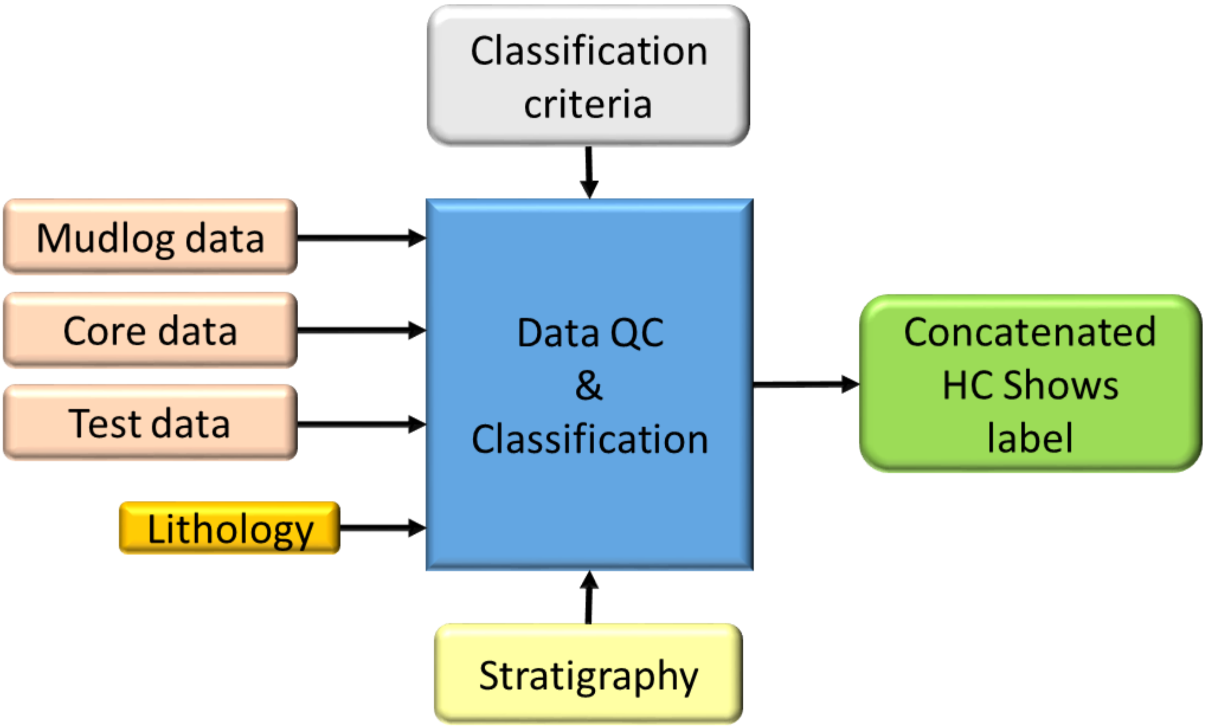

Figure 1. Dataflow in HCS classification (simplified)

Examples

The HC Shows database allows to systematically analyze observed occurrences of hydrocarbons in the Dutch subsurface. Figure 2 illustrates how hydrocarbons are distributed over the stratigraphic groups. The graph illustrates, not surprisingly, that the Rotliegend, being by far the most mature play in the Southern North Sea Basin, is rich in HCS. More interestingly is the observation that the Carboniferous play is very comparable in terms of HCS abundance. As the Carboniferous counts relatively few developed gas fields, this might point towards missed opportunities in this play.

HCS from the Chalk in the Northern Offshore are displayed in figure 3. Specially designed labels allow to plot multiple attributes from the HCS database at their true spatial position. The map indicates that the Chalk play is only attractive in certain fairways, possibly related to charge availability.

An emerging play in the offshore Netherlands is Shallow Gas. Seismic amplitude anomalies are important clues for these Cenozoic gas accumulations. By plotting HC Shows against seismic data it is possible to study the relation between actually recorded hydrocarbons and seismic amplitudes. In figure 4 the HC Shows derived from well tests are plotted. Whilst there is generally a good agreement between HC Shows and amplitude anomalies, there are exceptions too. This can be explained by the fact that also low gas saturation can give rise to significant amplitude effects.

In the Netherlands currently significant drilling takes place for geothermal projects. With target depths of 2 - 4 km here also accurate well planning and understanding geo-drilling hazards including hydrocarbons is of paramount importance. The HCS database allows to assess the hydrocarbon risks in projects where aquifers are the target.

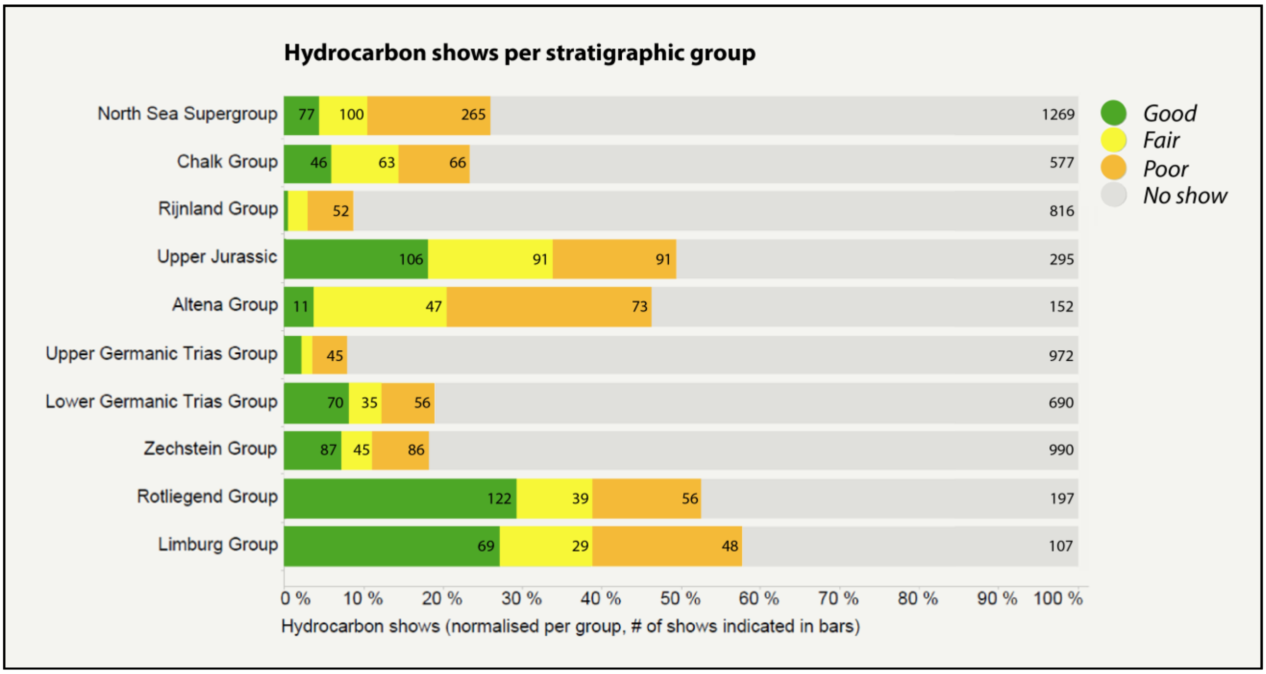

Figure 2. HCS distribution and breakdown per stratigraphic group in the Netherlands.

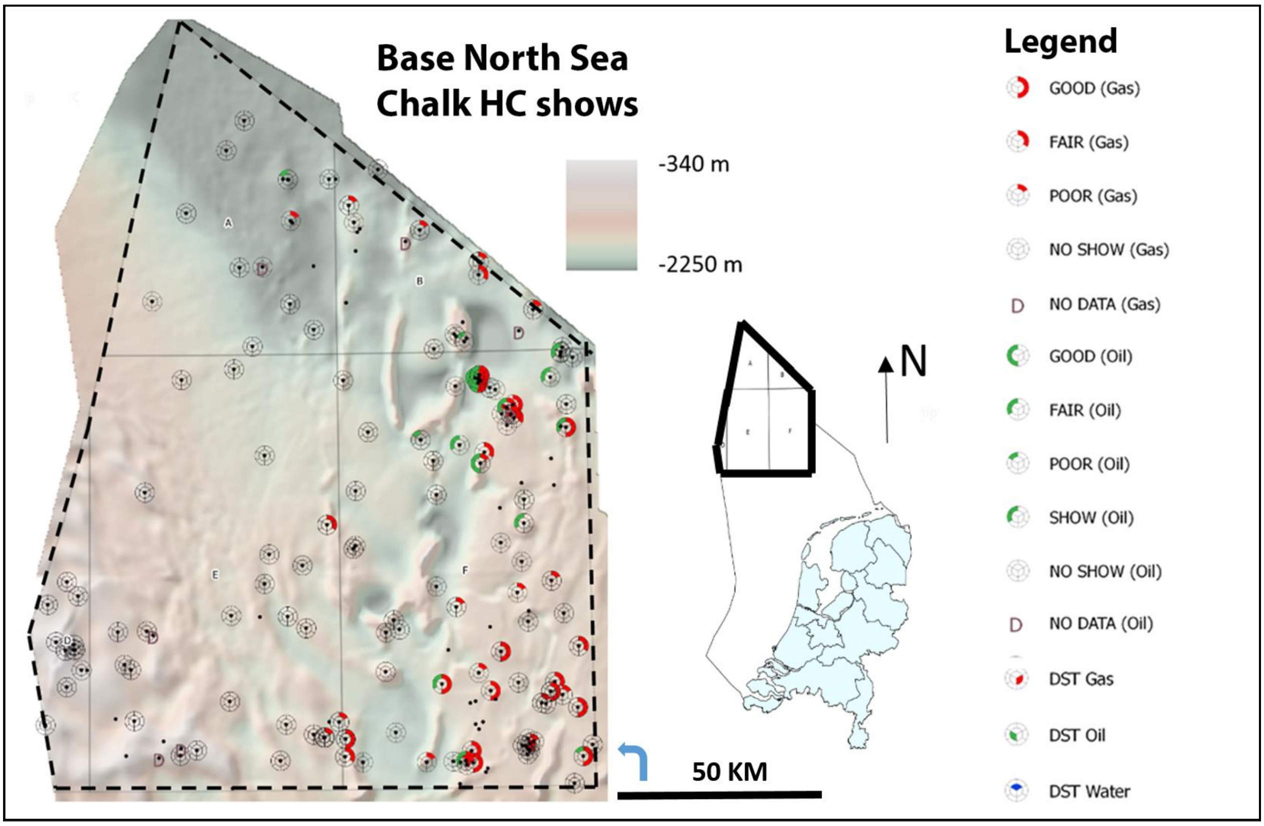

Figure 3. Example of visualization of Chalk HCS's with the Top Chalk seismic structure map.

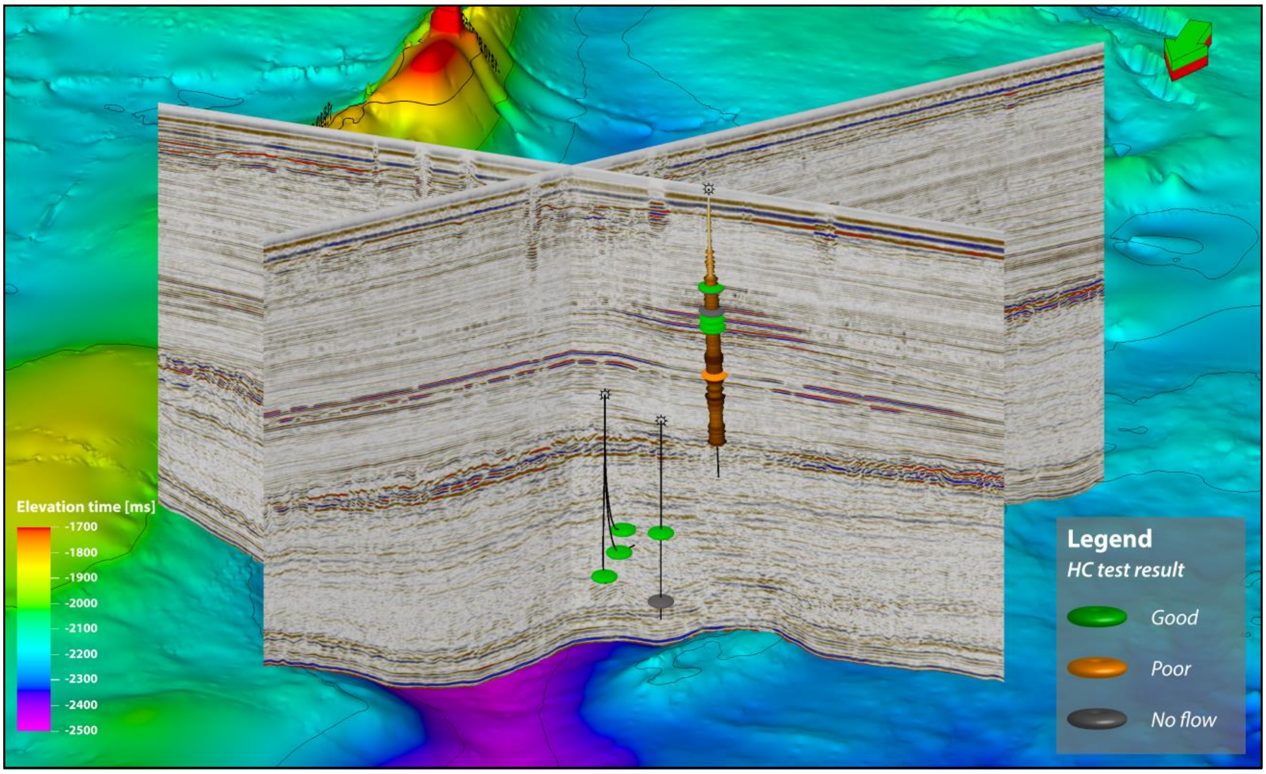

Figure 4. Integration of HCS test data with seismic- and well log data (gamma ray). Displayed surface is the Base North Sea Group. (Block A15, Perspective view)

Acknowledgements

Special thanks to Petrogas (Shallow Gas operator in NL), Jan Westerweel, Youri Kickken, Claudia Haindl, Constantijn Blom and Chris Heerema for their contributions to the HCS DB project.

References

Doornenbal, Hans; Stevenson, Alan, eds. 2010 Petroleum geological atlas of the Southern Permian Basin area. Houten, the Netherlands, EAGE.

Boogaard, van den M. & Hoetz H.L.J.G (2012). Shallow Gas Play in the Netherlands Takes Off. Extended abstract 74th EAGE Conference and Exhibition.

Westerweel, J. 2017 Hydrocarbon Show Database: The benefits of a well-defined methodology MSc internship Earth Structure and Dynamics thesis Utrecht University (available via www.ebn.nl)