RESERVOIR PROPERTIES REVISITED
Results of data mining in the Dutch Oil & Gas portal www.nlog.nl
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OVERVIEW

- Data mining from the Dutch Oil & Gas portal: [www.nlog.nl](http://www.nlog.nl)

- Results from data mining: reservoir properties of the Lower Volpriehausen Sandstone
  - Porosity-permeability relation
  - Porosity-depth relation (2 methods):
    1. Based on well data
    2. Based on grain density
       - Method repeatability and applicability

- Conclusions
WWW.NLOG.NL  THE ULTIMATE PUBLIC DOMAIN PLAYGROUND FOR GEOLOGICAL DATA MINING

Some examples:

- > 200,000 routine core measurements.
- Litho-stratigraphic subdivision for almost all wells.
- Reservoir properties from petrophysical analyses.
- Petrographical data and reports.
- Regional reports on the Dutch geology.
- Etc…

Usage:

- Gather and evaluate large data sets.
- Revealing well-known reservoir property trends on regional to sub-regional scale.

   Solid reference framework for local reservoir quality analysis
EXAMPLE: LOWER VOLPRIEHAUSEN SANDSTONE (RBMVL)

- Age: Scythian (252 – 247 Ma), Early Triassic
- Oldest member of the Main Buntsandstein Subgroup
- Fine to medium grained, light-coloured arkosic sandstone.
- Often highly cemented base.
- Fluviatile sediments in the South, aeolian in the North.

(Geluk, 2005)
Porosity - Permeability Relation

Lower Volpriehausen Sandstone Member

- > 5000 core plugs from 75 Dutch wells.

- Coloured background shows contoured density of data points (with Isatis).

- Note the curved nature of the data cloud.

- Often exponential poro-perm relations on log-normal plot are used. These do not honour the data adequately.

- Better to use curved or bilinear relation on log-normal plot.
POROSITY - DEPTH RELATION

Lower Volpriehausen Sandstone Member

- Data collecting:
  - 80 wells
  - ± 7000 porosity core measurements

- Exclusion of data:
  - Wells with restricted sample selection (<10 samples)
  - Wells with restricted reservoir coverage (<25%)

- Remaining data set:
  - 59 wells
  - ± 5500 core measurements
Data points show high degree of scatter.

Variation in porosity due to facies differences and diagenesis.

High porosity envelope visible, caused by burial of sediments.

Be aware: some data from wells in inverted basins present
  Conversion to maximum burial depth required.
BURIAL HISTORY STUDIES

- Maximum burial depth of core measurements determined using the maximum burial map on the right:
  - Maximum burial map based on results of Nelskamp & Verwey (2012):
    - Maximum burial depth of the RBMVL calculated using basin modelling.

- Several studies on Dutch burial history:
  - Nelskamp & Verwey (2012)
  - Luijendijk et al. (2011)
  - Van Dalfsen et al. (2005)
1. Based on well data

- Collecting well data:
  - Composite well logs, digital logs, core reports/descriptions, petrography/sedimentology/petrophysics reports etc.

- Quick look petrophysical analysis:
  - Clay volume & porosity calculations

- Combine data to determine effects on porosity other than burial and assign attributes:
  - Diagenesis (mineral type)
  - Facies type (clay volume, grain size etc.)
1. Based on well data

- P10 – P90 distributions, as well as average porosity of “reservoir quality” data plotted per well.

- Trend line through averages gives poro-depth relation for intervals with reservoir quality.

- Interesting how poro-depth relation develops with increasing clay volume and diagenesis.
2. Based on grain density

- Grain density (GD) is a good porosity indicator:
  - Clay often has higher GD than quartz.
  - Common pore cements have high GD like:
    - Dolomite: 2.85 g/cm$^3$
    - Anhydrite: 2.98 g/cm$^3$
  - Halite has low GD

- Poro-depth trend clear in GD range: 2.625 – 2.675 g/cm$^3$

Note: quartz cement is problematic for this analysis.

Quartz cementation?
Similar porosity-depth trend derived from two different methods.

1. Based on well data

2. Based on grain density
Methodology

› GD classes defined (colour scale).
› Upscaling: average porosity per 50m depth interval, for each GD class.
› Averages plotted versus mid of depth interval.

Results

› Gradual increase in porosity with decreasing GD.
› Decreasing porosity with depth visible in each class.
› But, slope of porosity-depth trend varies per class.
Method is repeatable for other lithological units

Hardegsen & Detfurth Sst. (Triassic)

Upper Slochteren Sst. (Permian)

Lower Slochteren Sst. (Permian)
EXAMPLE OF APPLICABILITY

› Resulting porosity-depth relations used for generation of regional property maps (porosity, permeability, etc.) of important reservoir units in the Netherlands.

› Maps are based on well data. Relations are used for the interpolation process.
CONCLUSIONS

- Data mining and analysis of large data sets support generally known trends and provide an excellent reference framework for more detailed reservoir property analyses.

- Porosity-permeability relations are often defined by straight lines. However, the data proves in most cases that the relation is better described by curved functions on a log-normal plot.

- Porosity-depth relations in core data are revealed when correcting for maximum burial depth and other factors like cementation and facies differences.

- Porosity-depth relations in core data can be defined per grain density class. A decrease in porosity reduction with depth, with increasing grain density, is shown in the data.
REFERENCES


THANK YOU FOR YOUR ATTENTION