MATURE OIL FIELD REVALUATION DRIVEN BY ROCK TYPING APPROACH

A CASE STUDY FROM HUNGARY

István Szabó
Petrophysicist Expert

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‘G-FIELD’

ONE OF THE BEST CURRENT OIL PRODUCER FIELDS IN HUNGARY

- Three segments (faulted compartments)
  - **G-Central** – Karstified and fractured Triassic limestone overlaid by Eocene conglomerate
  - **G-South and G-North** – Highly heterogeneous Eocene conglomerate

G-SOUTH (AREA OF INTEREST)
ORIGINS

- TRIASSIC CENTRAL UPLIFT
  - Subsurface karstic system
  - Major reservoir

- EOCENE CONGLOMERATE (CENTRAL)
  - Fracture supported flowing paths from Triassic basement
  - Poorly developed
  - Negligible matrix contribution / Tight
  - ‘Auxiliary’ reservoir

- EOCENE CONGLOMERATE (NORTH & SOUTH)
  - Matrix plays
  - Possibly charged from Central (via conductive faults, fractures)
  - Development target
MODEL UPDATE

▶ ROCK TYPING STUDY
  ▶ New PP workflow
  ▶ Eocene in focus
  ▶ 7 wells
  ▶ Followed by new CPI-s

▶ UPGRADED RESERVOIR MODEL
  ▶ Facies specific property distribution
  ▶ Mapping Conglomerate subdivisions (Markers)
  ▶ Reliable production forecast
  ▶ Identify new development locations
WORKFLOW

GROUNDWORK
- QC/Select/Prepare Input Data
- Completeness, Consistency & Representativeness

ROCK TYPING
- Learning/Indexation/Validation (core-log domain)
- Model Application (log domain)

CPI
- Matrix parameters per RT Facies (PG-s)
- Petrophysical (Re-)Interpretation

FUNCTIONS
- Facies-specific SHM / Permeability (core to log)
- To Be Delivered to Geo-Modeller
ROCK TYPING
WHAT IS BEHIND DATA?

1.95  DEN [g/cc]  2.95
1.95
45  NEU [pu]  .15

1.95  DEN [g/cc]  2.95
.15  NEU [pu]  45
Selection of input data
Wells, input curves, zones

Unsupervised / Supervised

Learning and indexation
Build model

The model is built via two steps:
Self organizing map: Finding trends in the data
Indexation: Division of the trends to groups

Model application
Apply the model
Classification curve

Create a continuous classification curve for the learning data
Apply the model to other wells/_intervals

Select a representative set of data
Verify that there is no data redundancy: each input adds additional information
It is highly recommended to perform a Principal Component Analysis (PCA) before launching the model
ROCK TYPING

IPSOM™ – (RE-)INDEXATION

Example of interactive selection: Coal beds

Input of local knowledge and experience
ROCK TYPING

IPSOM™ – VALIDATION

- SCAL – Pc CURVES (CENTRIFUGE LAB DATA FROM 3 WELLS)
- CORE PERMEABILITY COVERS 3 ORDERS OF MAGNITUDE (COLOUR SCALE)
- HETEROGENEOUS ROCKS ARE WELL REPRESENTED
- VALIDATION CHECK MADE BY FILTERING PER ROCK GROUPS
ROCK TYPING

IPSOM™ – MODEL APPLICATION

- KEY ROCK GROUP IN FIELD (EOCENE M-6)
- EQUIVALENT – SHALY/SILTY SANDSTONE
- D/N X-PILOT INDICATES ITS MIXED NATURE
PP QUANTITATIVE RE-INTERPRETATION – CPI

- Techlog Quanti.Elan™
- Probabilistic (inversion) method for complex/multimineral lithology
PP QUANTITATIVE RE-INTERPRETATION – SW?

- Formation resistivity depends on:
  - Presence of formation water / hydrocarbons
  - Salinity/temperature of formation water
  - Volume of water-saturated pore space
  - Texture (tortuosity, geometry of pores and coating fluid)
  - Morphology and species of clay minerals
  - Rock matrix components

\[ R_{\text{formation}} = f(R_w, \Phi, Sw, a-m-n, Vsh, R_{\text{matrix}}) \]

- Alternative, resistivity independent saturation estimation
  - Special logs (NMR, Dielectric, PNL, C/O,...)
  - Dean-Stark (OBM)
  - Saturation Height Modelling (SCAL – Pc data)
FUNCTIONS – FACIES-SPECIFIC PERMEABILITY

- PORO-PERM RELATIONS DERIVED FOR EACH ROCK GROUP
- INPUT TO MODEL AND SATURATION HEIGHT FUNCTIONS
- PROPAGATION OF CORE DATA TO LOG DOMAIN
FUNCTIONS – FACIES-SPECIFIC SATURATION - SHM
RESULT SAMPLES

- G-4
- G-S-1
CONCLUSION

- Eocene conglomerate level was found to be a dual-porosity system with complex, heterogeneous lithological composition
- Conventional PP interpretation methods failed to describe contradictions
- New approach for characterisation takes closer to understand the behaviour of so called ‘conglomerate’ dividing it into rock groups with different quality and highlights promising reservoir rock types
- Delivered facies specific K/Sw input to static/dynamic reservoir models
- There are still ambiguities (Uncertainty estimation demanded)
  - Weak core data support
  - Point information from wells – High lateral variations of rocks – Seismic-PP link is essential
- Conventional logs ‘do not see’ small or micro-fractures – secondary porosity unrevealed
  - Other options to manage dual-porosity system
    - Fracture analysis of Borehole Images, cross-checked with core CT data, seismic, etc.
    - Integrate dual-porosity nature into reserves estimation
CREDITS

- G-Field Development Subsurface Team
  - Ágnes Bárány (Senior Geophysicist)
  - Tibor Báródi (Senior Specialist Reservoir Engineer)
  - Mátyás Sanocki (Senior Reservoir Geologist)
  - + me 😊

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- Q & A