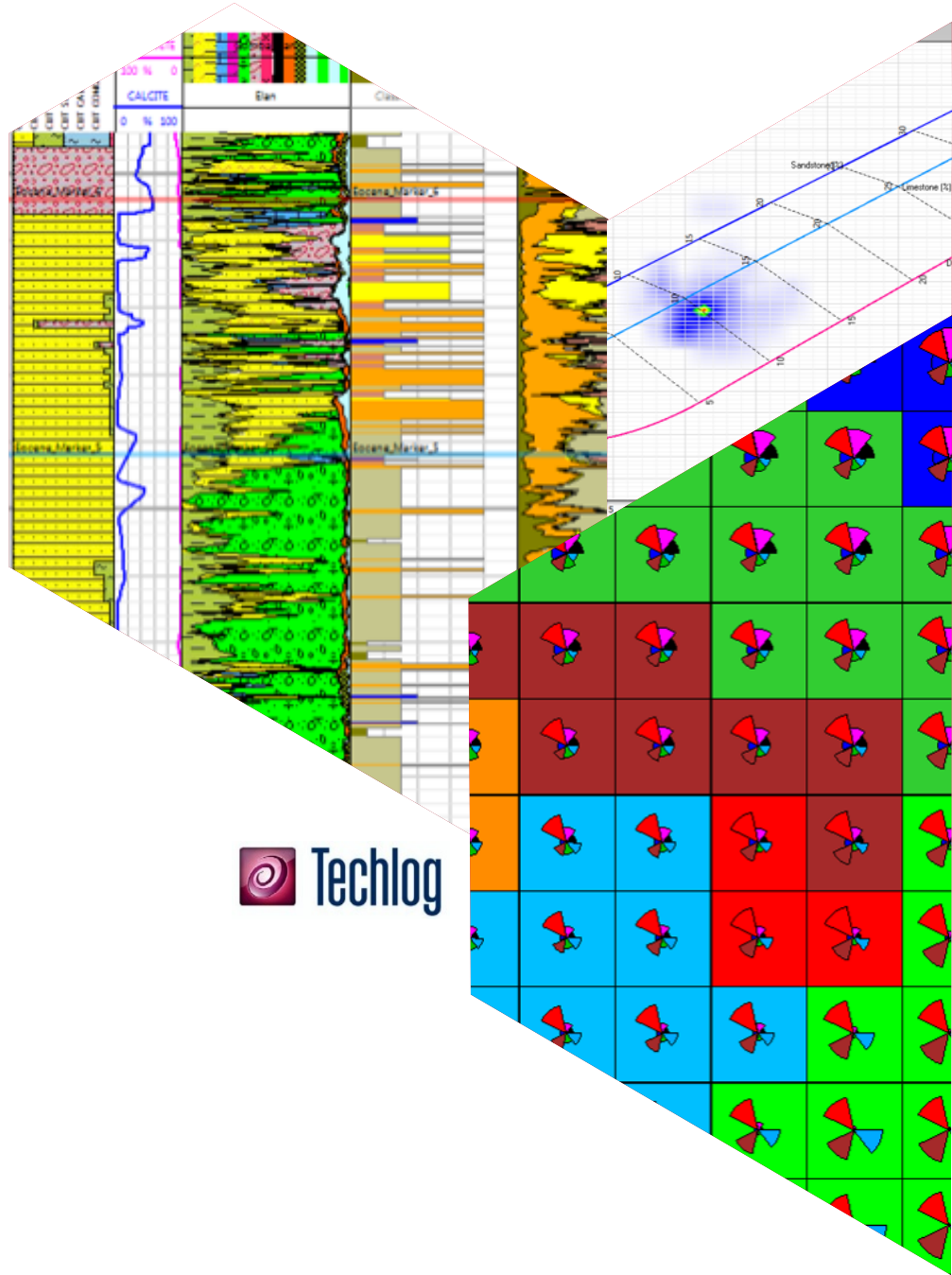
MATURE OIL FIELD REVALUATION DRIVEN BY ROCK TYPING APPROACH

A CASE STUDY FROM HUNGARY

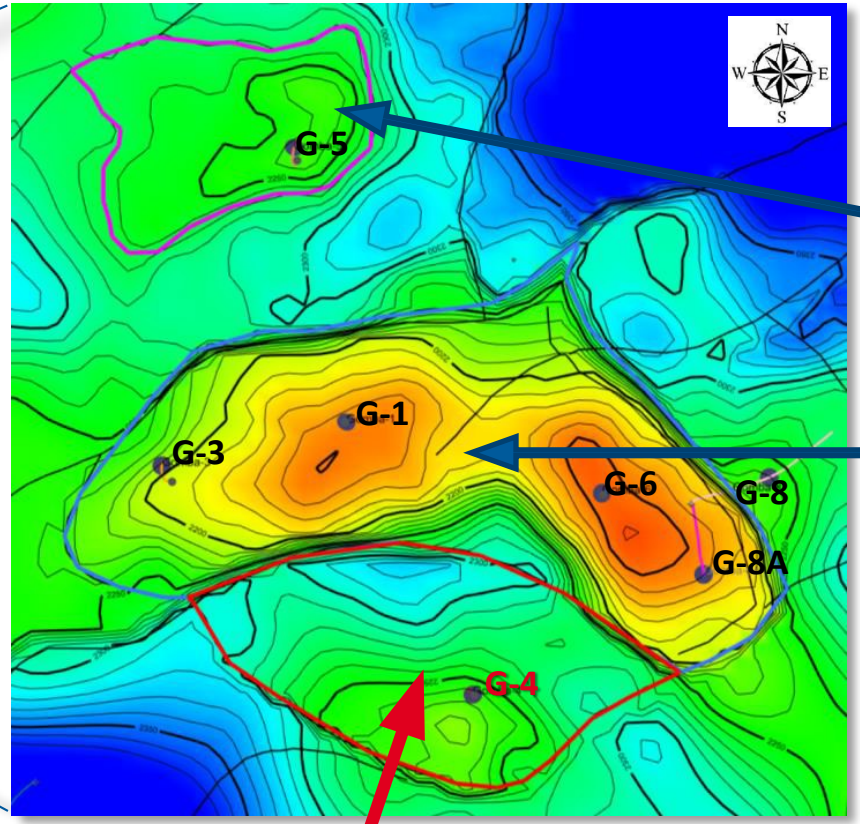


István Szabó
Petrophysicist Expert

19 Sep 2019 – Monaco – SIS Global Forum 2019

MOLGROUP

’G-FIELD’

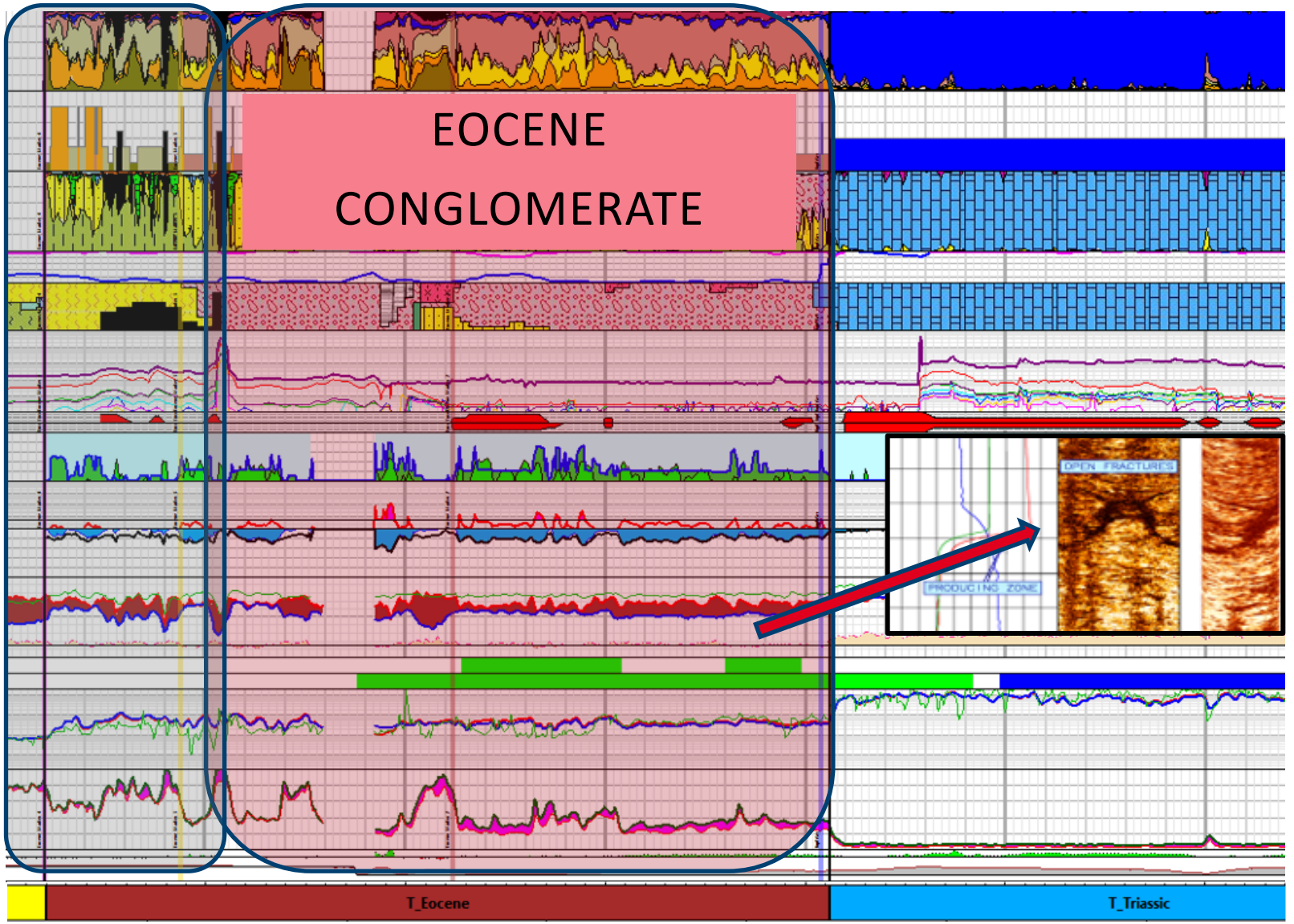


- G-NORTH
- G-CENTRAL
- G-SOUTH (AREA OF INTEREST)

- 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

ORIGINS

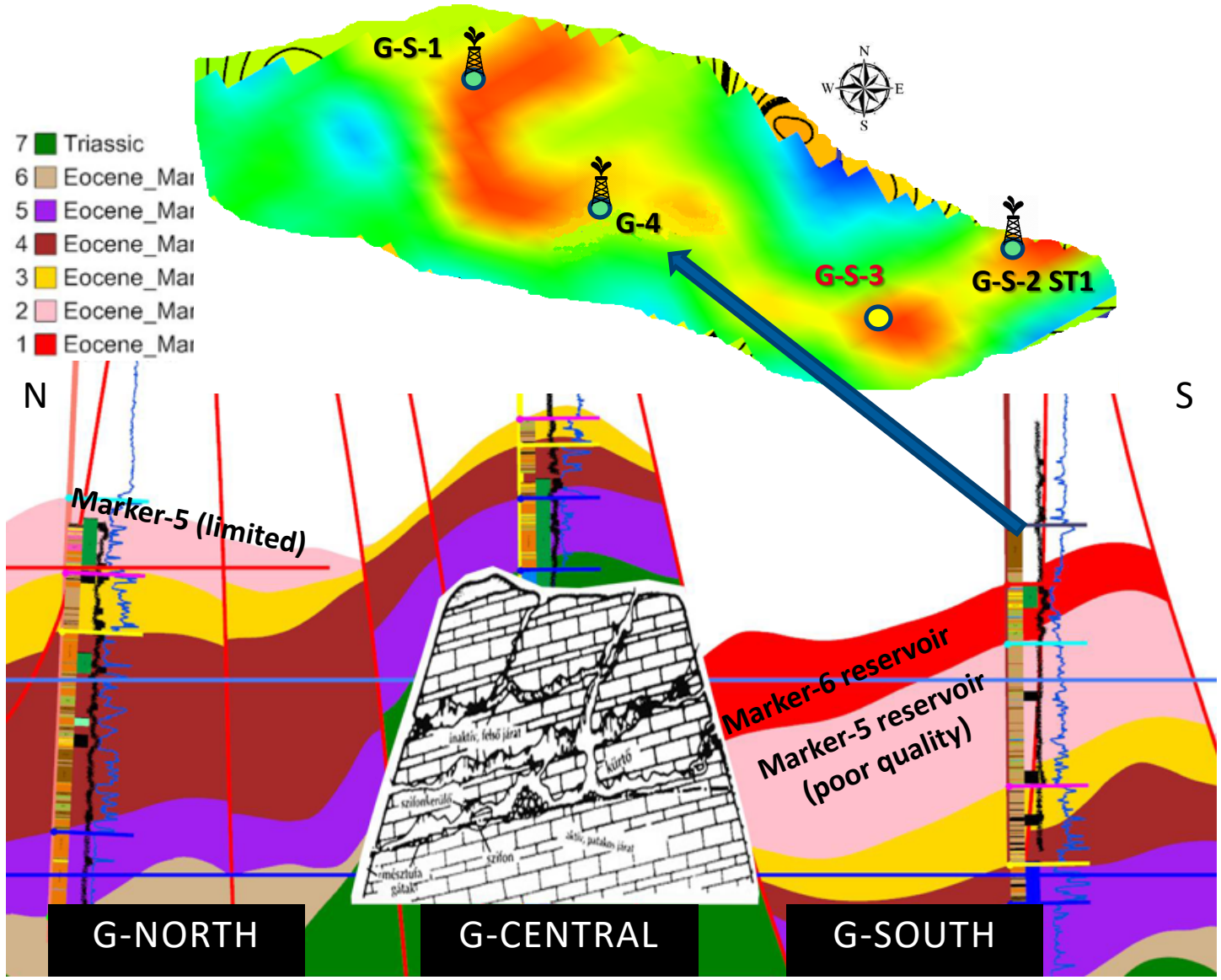
- TRIASSIC CENTRAL UPLIFT
  - Subsurface karstic system
  - Major reservoir
- EOCENE CONGLOMERATE (CENTRAL)
  - Fracture supported flowing paths from Triassic basement
  - Poorly developed
  - Negligible matrix contribution / Tight
  - ’Auxiliary’ reservoir
- EOCENE CONGLOMERATE (NORTH & SOUTH)
  - Matrix plays
  - Possibly charged from Central (via conductive faults, fractures)
  - Development target



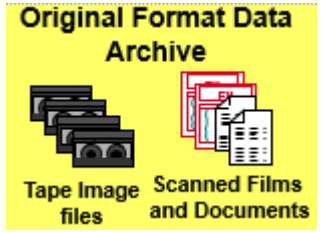
MODEL UPDATE

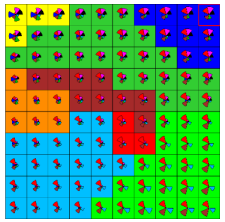
- ROCK TYPING STUDY
  - New PP workflow
  - Eocene in focus
  - 7 wells
  - Followed by new CPI-s

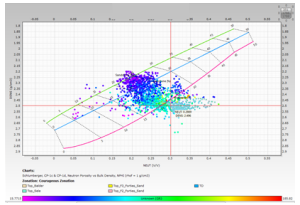
- UPGRADED RESERVOIR MODEL
  - Facies specific property distribution
  - Mapping Conglomerate subdivisions (Markers)
  - Reliable production forecast
  - Identify new development locations

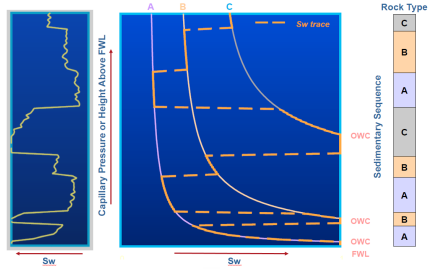


WORKFLOW







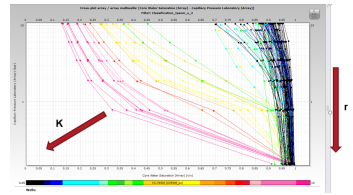


GROUND-WORK

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

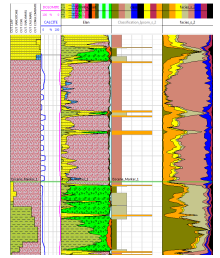
ROCK TYPING

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



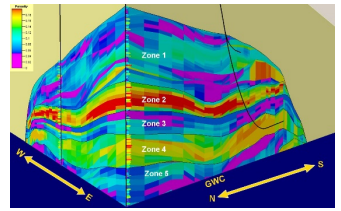
CPI

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



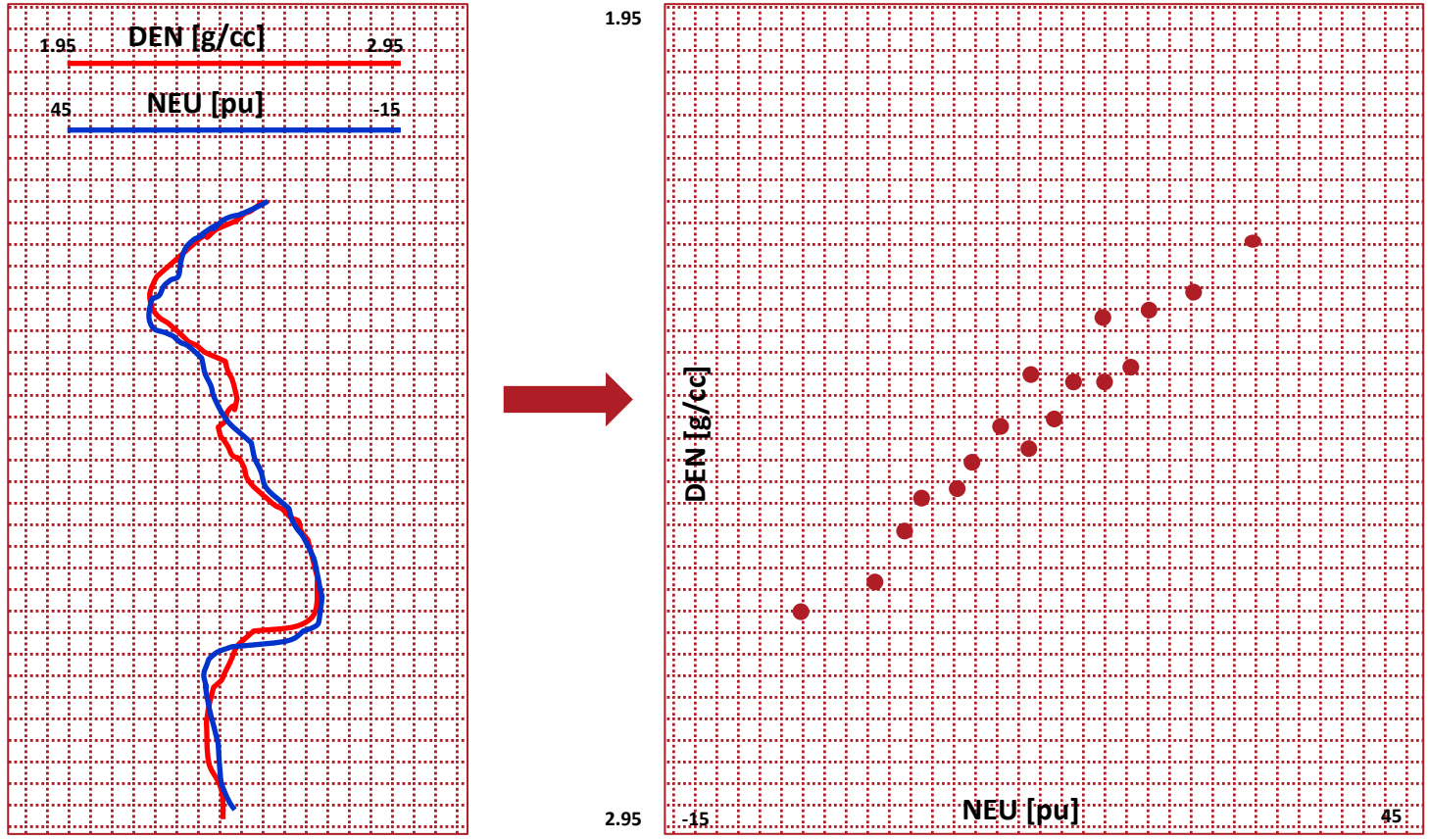
FUNCTIONS

- Facies-specific SHM / Permeability ***(core to log)***
- To Be Delivered to Geo-Modeller



ROCK TYPING

WHAT IS BEHIND DATA?



ROCK TYPING

IPSOM™ – WORKFLOW

Unsupervised / Supervised

Selection of input data

Wells, input curves, zones

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

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

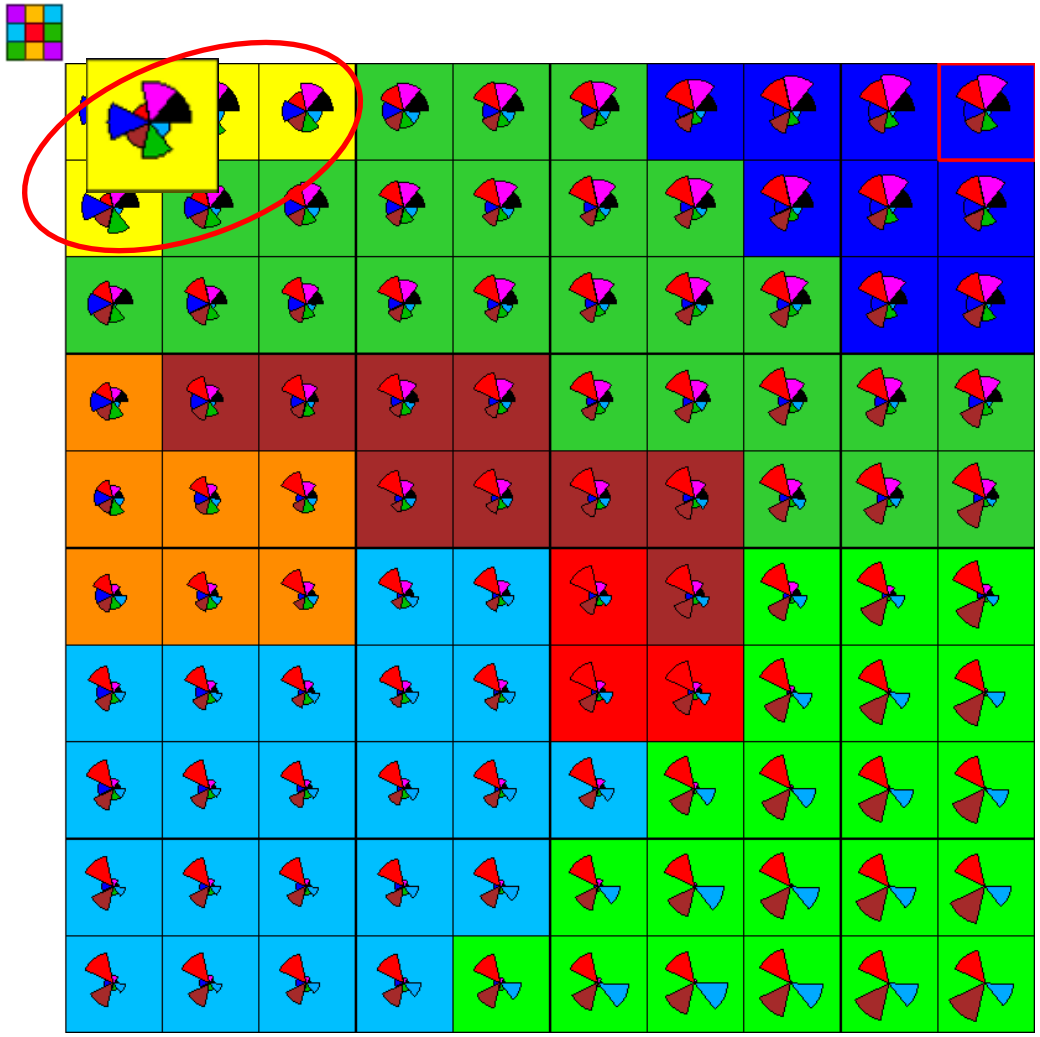
Apply the model
Classification curve

Create a continuous classification curve for the learning data

Apply the model to other wells/intervals

ROCK TYPING

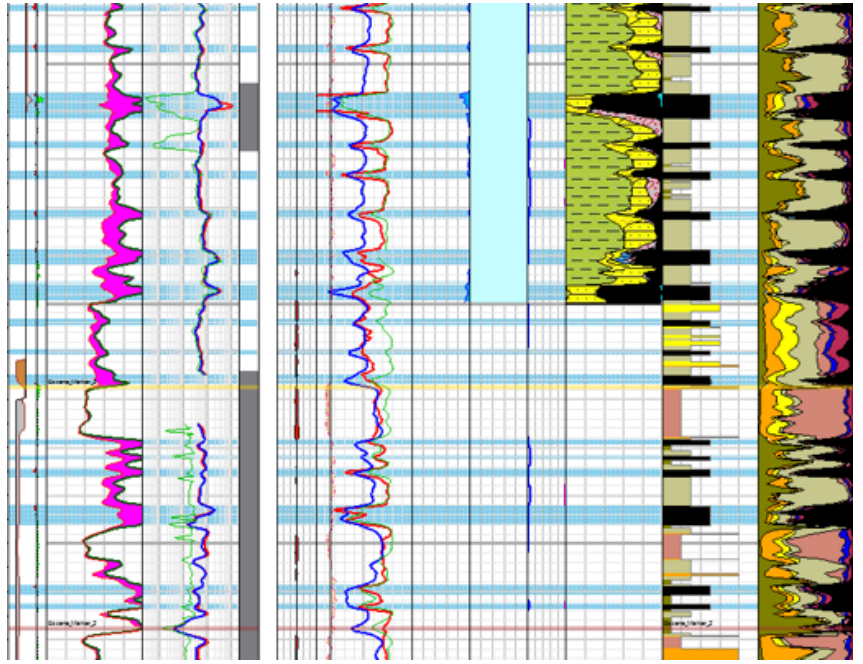
IPSOM™ – (RE-)INDEXATION



	Variable	Color
1	Gamma Ray	
2	Gamma Ray Minus Uranium	
3	Bulk Density	
4	Neutron Porosity	
5	Photoelectric Factor	
6	Compressional Slowness	
7	Deep Resistivity	

Example of interactive selection: *Coal beds*

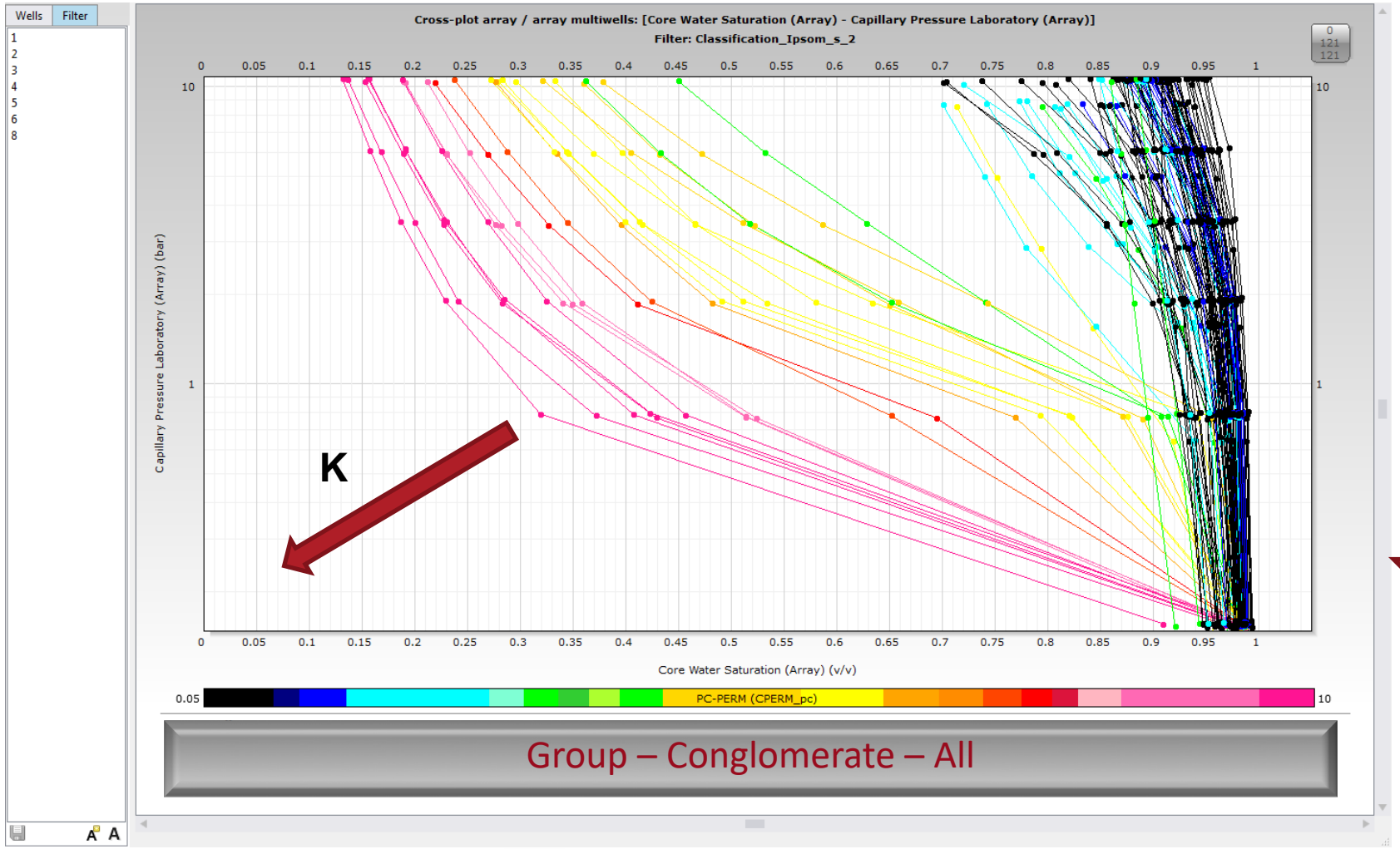
Input of local knowledge and experience



ROCK TYPING

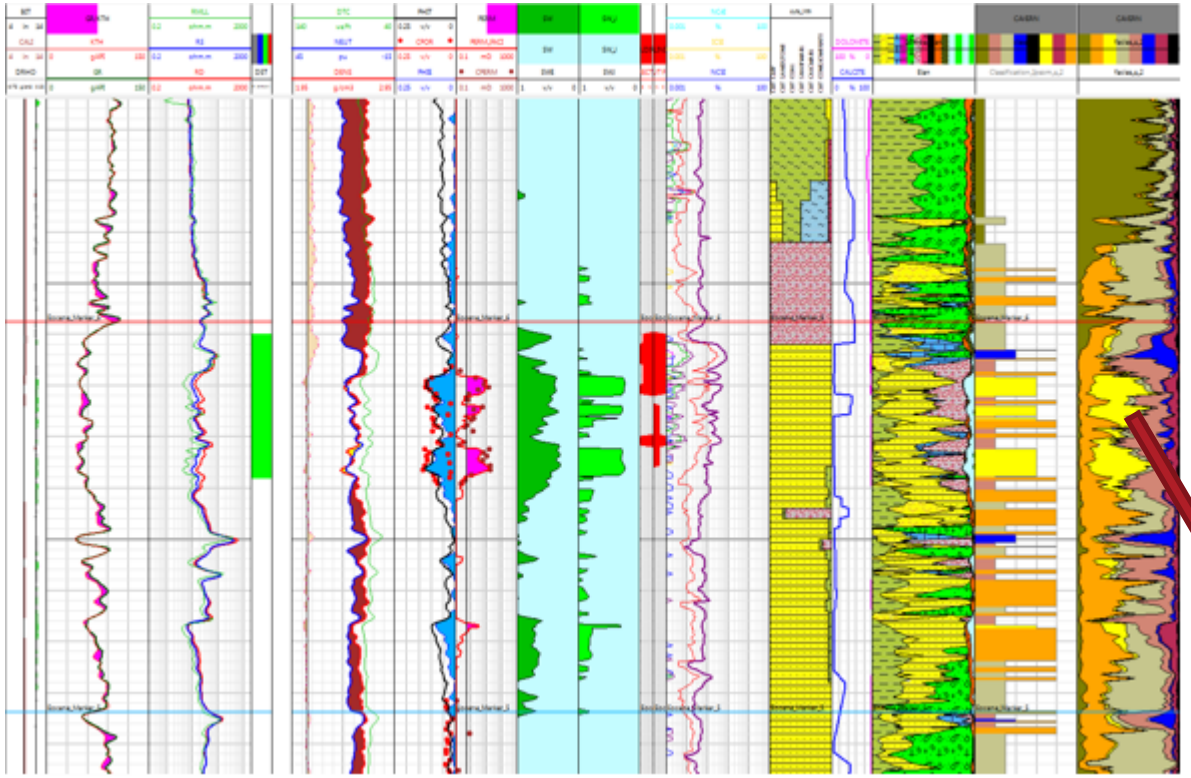
IPSOM™ – VALIDATION

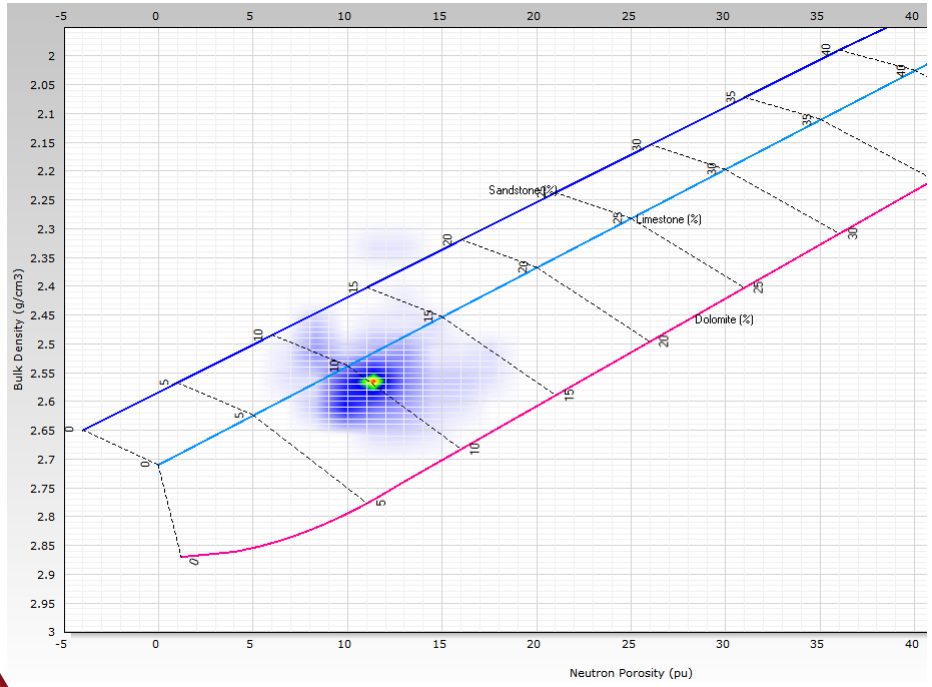
- SCAL – Pc CURVES (CENTRIFUGE LAB DATA FROM 3 WELLS)
- CORE PERMEABILITY COVERS 3 ORDERS OF MAGNITUDE (COLOUR SCALE)
- HETEROGENEOUS ROCKS ARE WELL REPRESENTED
- VALIDATION CHECK MADE BY FILTERING PER ROCK GROUPS



ROCK TYPING

IPSOM™ – MODEL APPLICATION

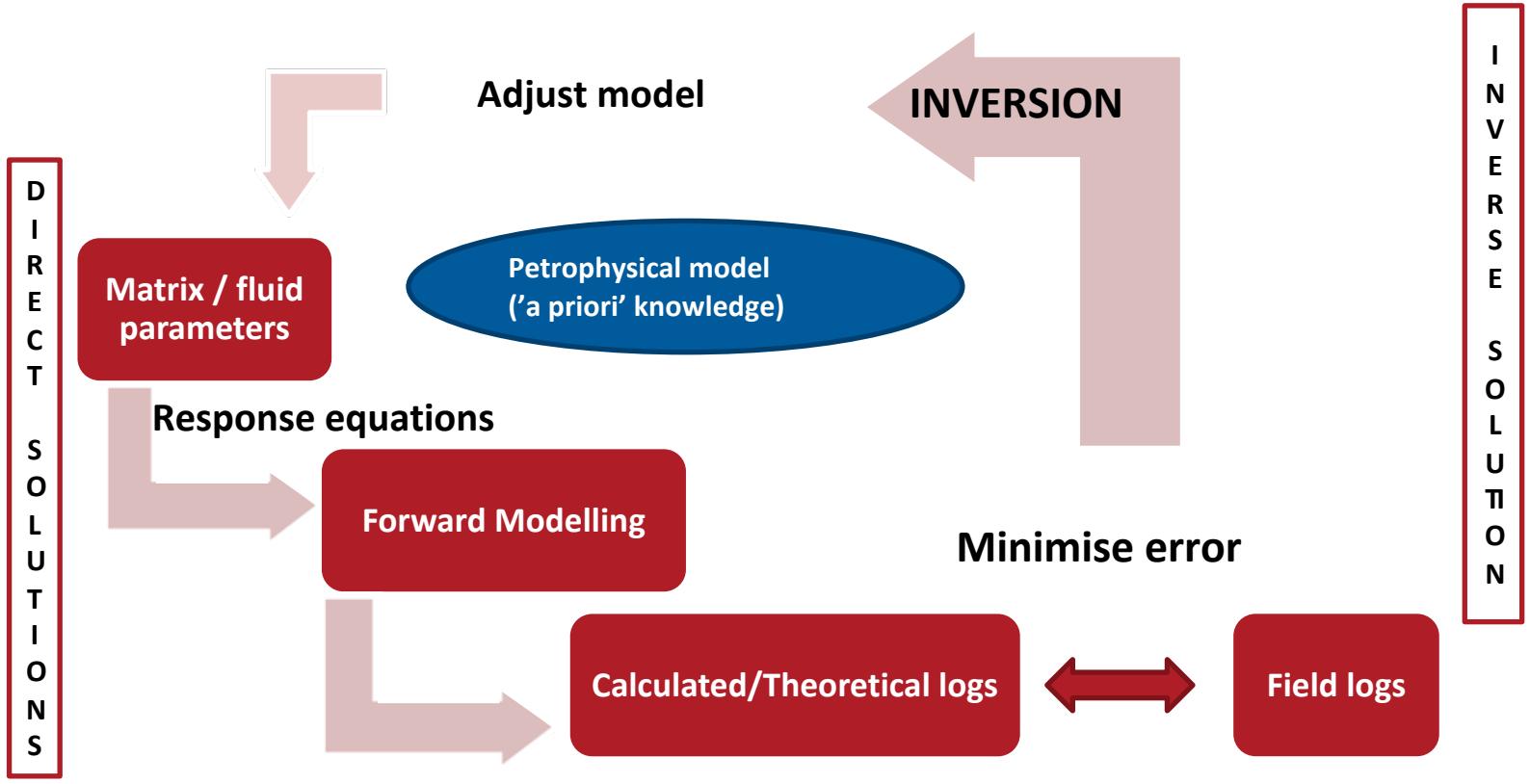




- KEY ROCK GROUP IN FIELD (EOCENE M-6)
- EQUIVALENT – SHALY/SILTY SANDSTONE
- D/N X-PLOT INDICATES ITS MIXED NATURE

PP QUANTITATIVE RE-INTERPRETATION – CPI

- Techlog Quanti.Elan™
- Probabilistic (inversion) method for complex/multimineral lithology

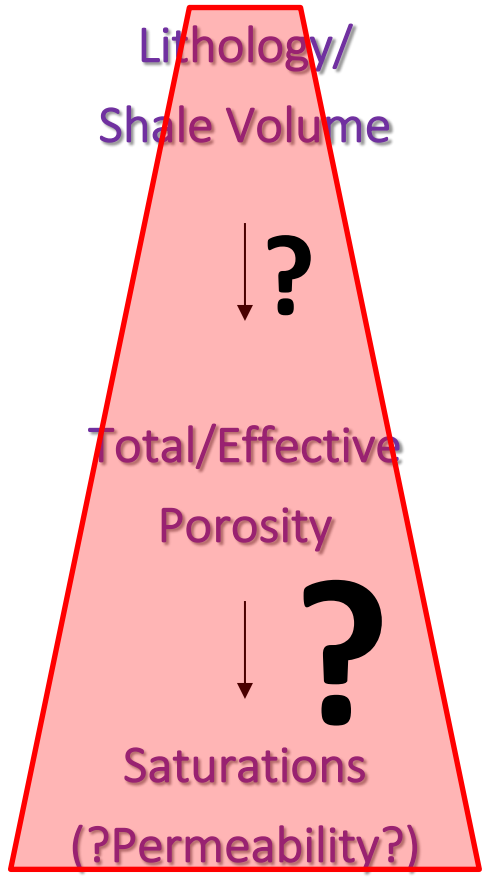


PP QUANTITATIVE RE-INTERPRETATION – SW?

- 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

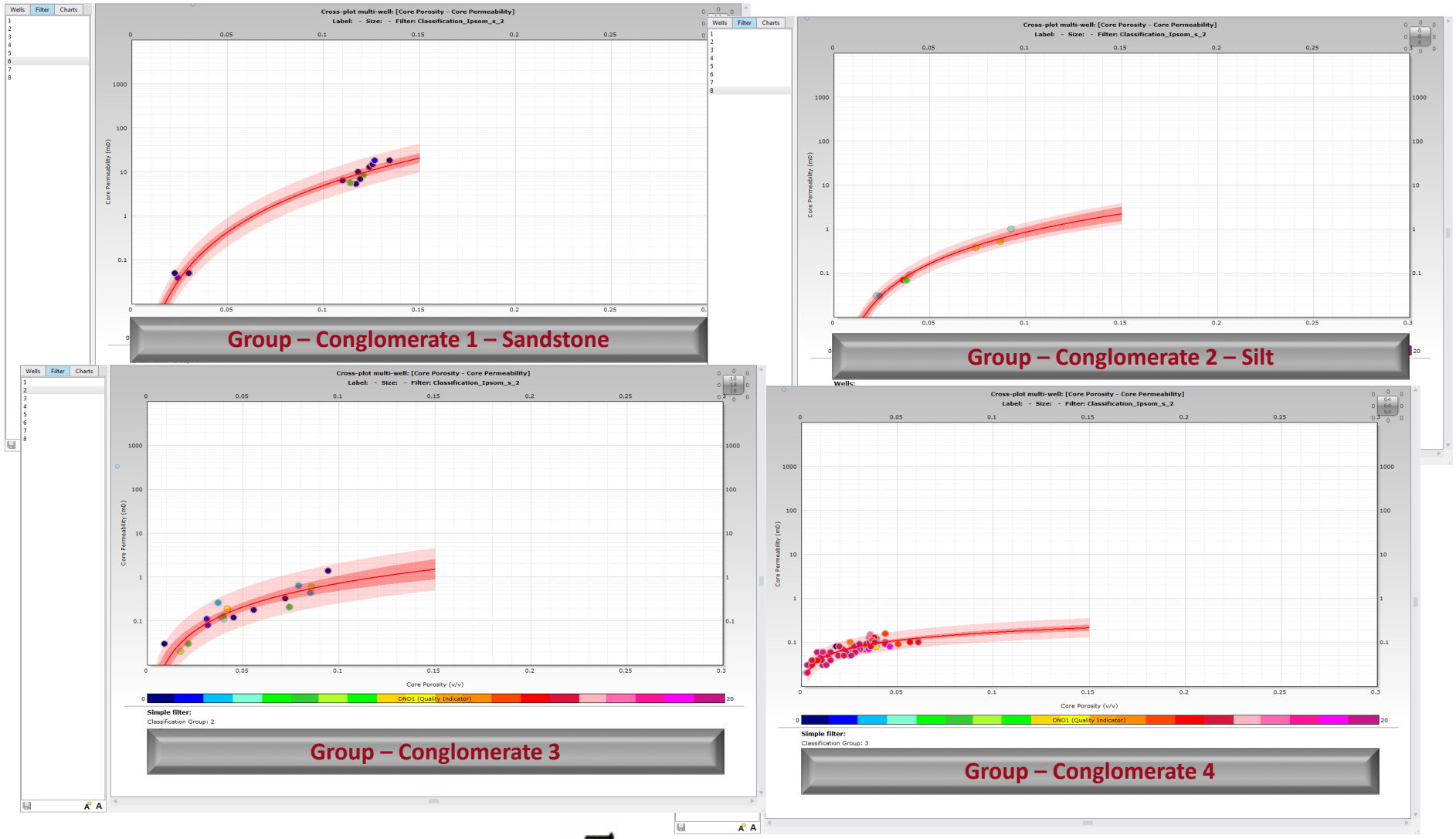
$$R_{formation} = f(Rw, \Phi, Sw, a\text{-}m\text{-}n, Vsh, R_{matrix})$$

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

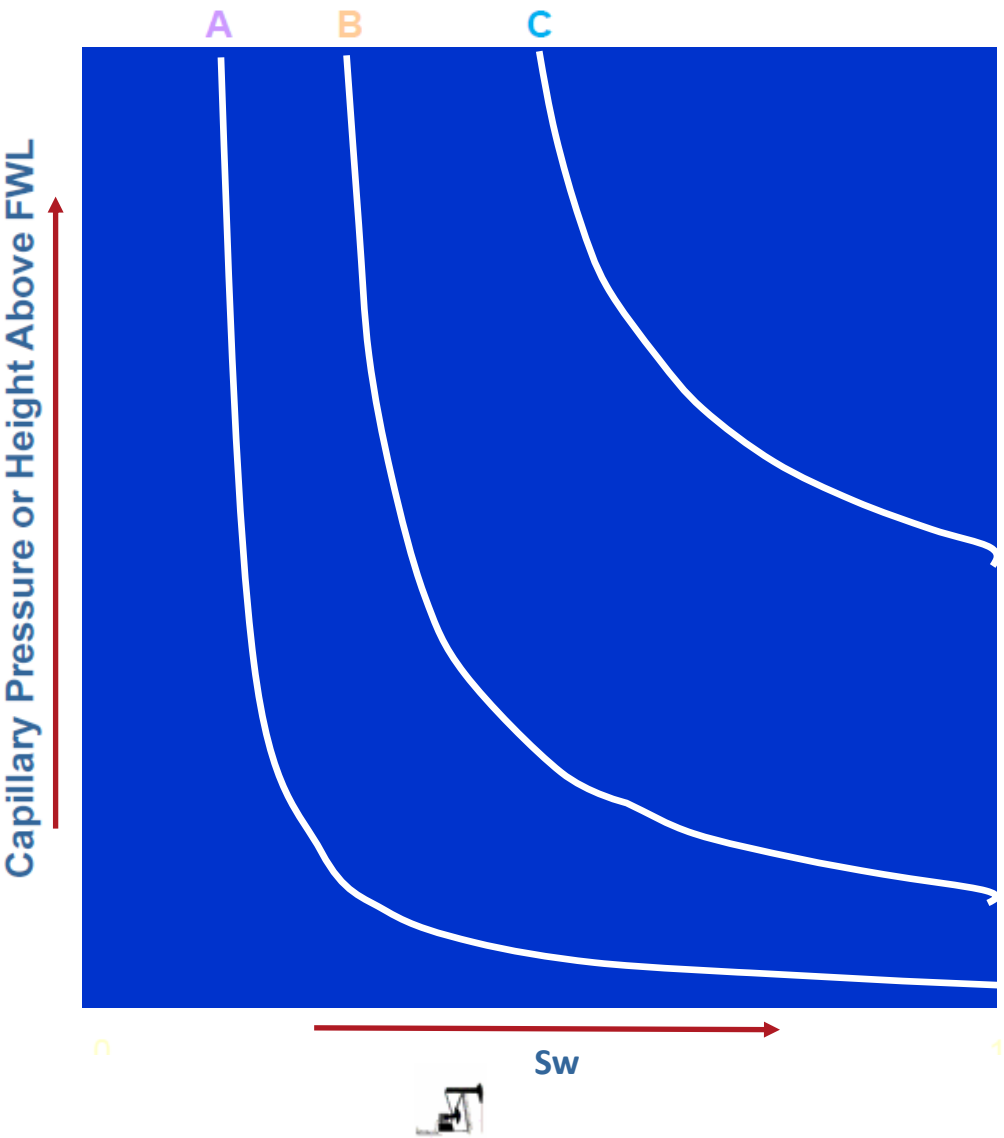


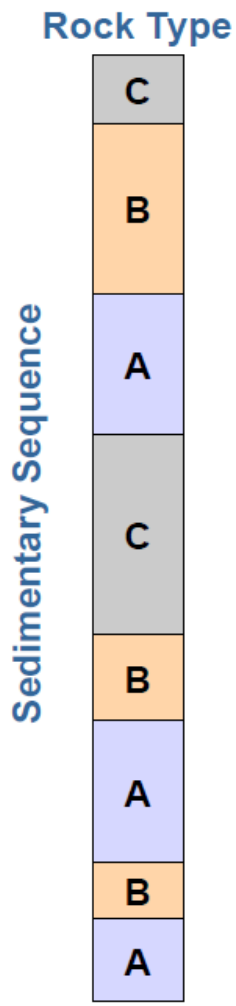
FUNCTIONS – FACIES-SPECIFIC PERMEABILITY

- PORO-PERM RELATIONS DERIVED FOR EACH ROCK GROUP
- INPUT TO MODEL AND SATURATION HEIGHT FUNCTIONS
- PROPAGATION OF CORE DATA TO LOG DOMAIN



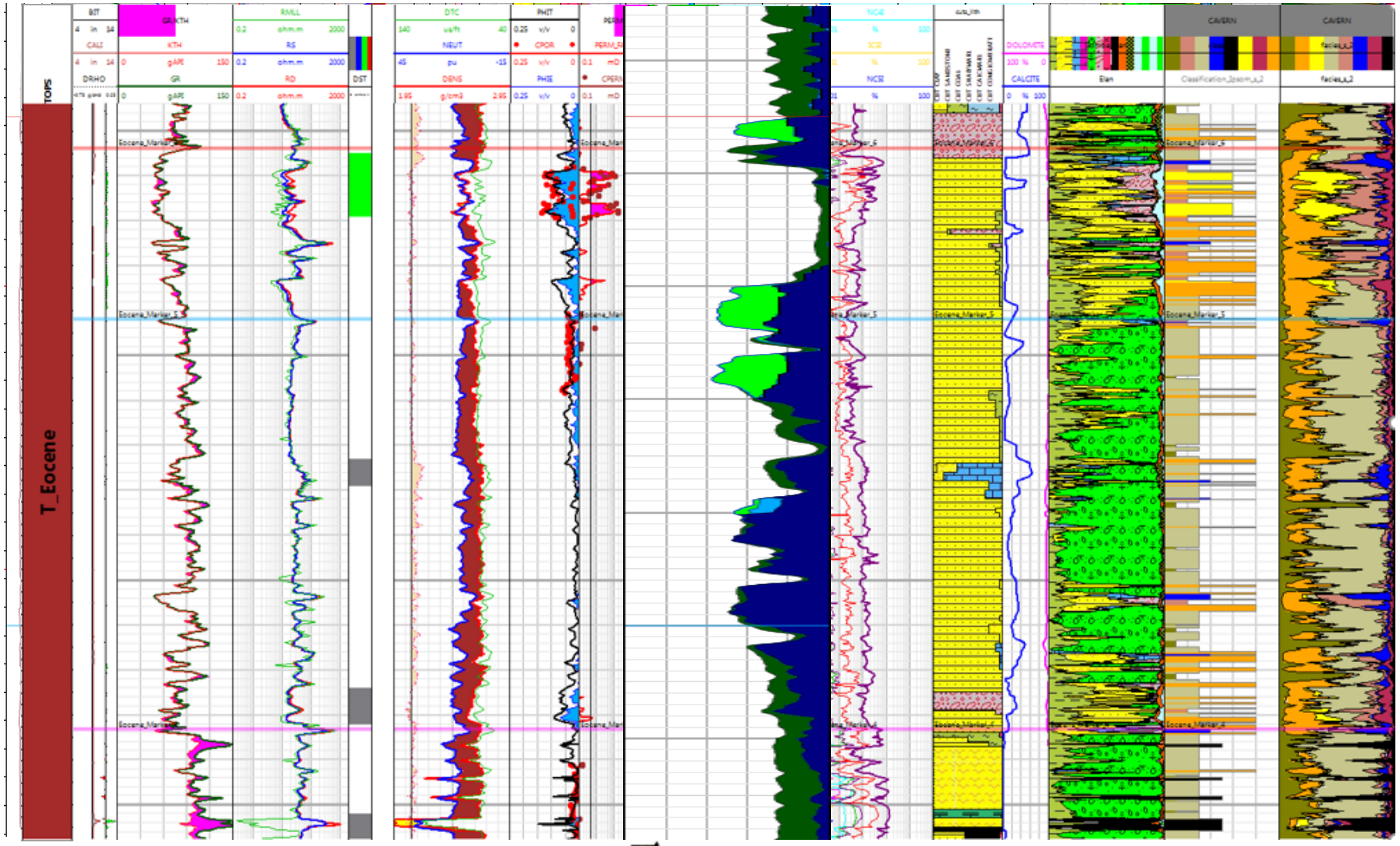
FUNCTIONS – FACIES-SPECIFIC SATURATION - SHM





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 ☺
- *SLB SIS Team (Vienna)* – Tireless support to Techlog

- Q & A