Handil Recovery Optimization Through Machine Learning Approach

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Pertamina Hulu Mahakam

MAHAKAM OVERVIEW

PRODUCTION OUTLOOK 2022:

- 508 MMSCFD
- 23.8 KBLPD

CUMMULATIVE PRODUCTION:

- 20.2 TCF, RF : 34 – 57%
- 1.7 BSTB, RF : 48 – 55%

EXTENSIVE OPERATING PERIMETER

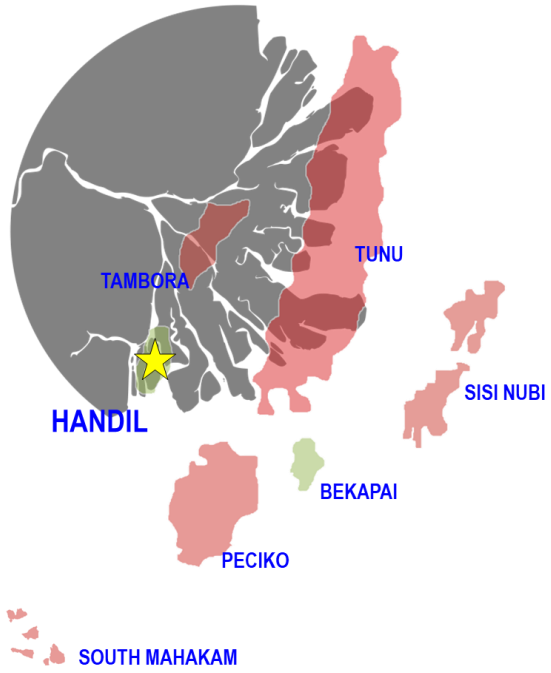
- **7** PRODUCING OIL & GAS FIELDS
- **6** PROCESSING CENTERS
- **77** GTS & CLUSTERS
- **33** OFFSHORE PLATFORMS
- **>1,700 km** PIPELINE NETWORK
- **3,500** WORKFORCES

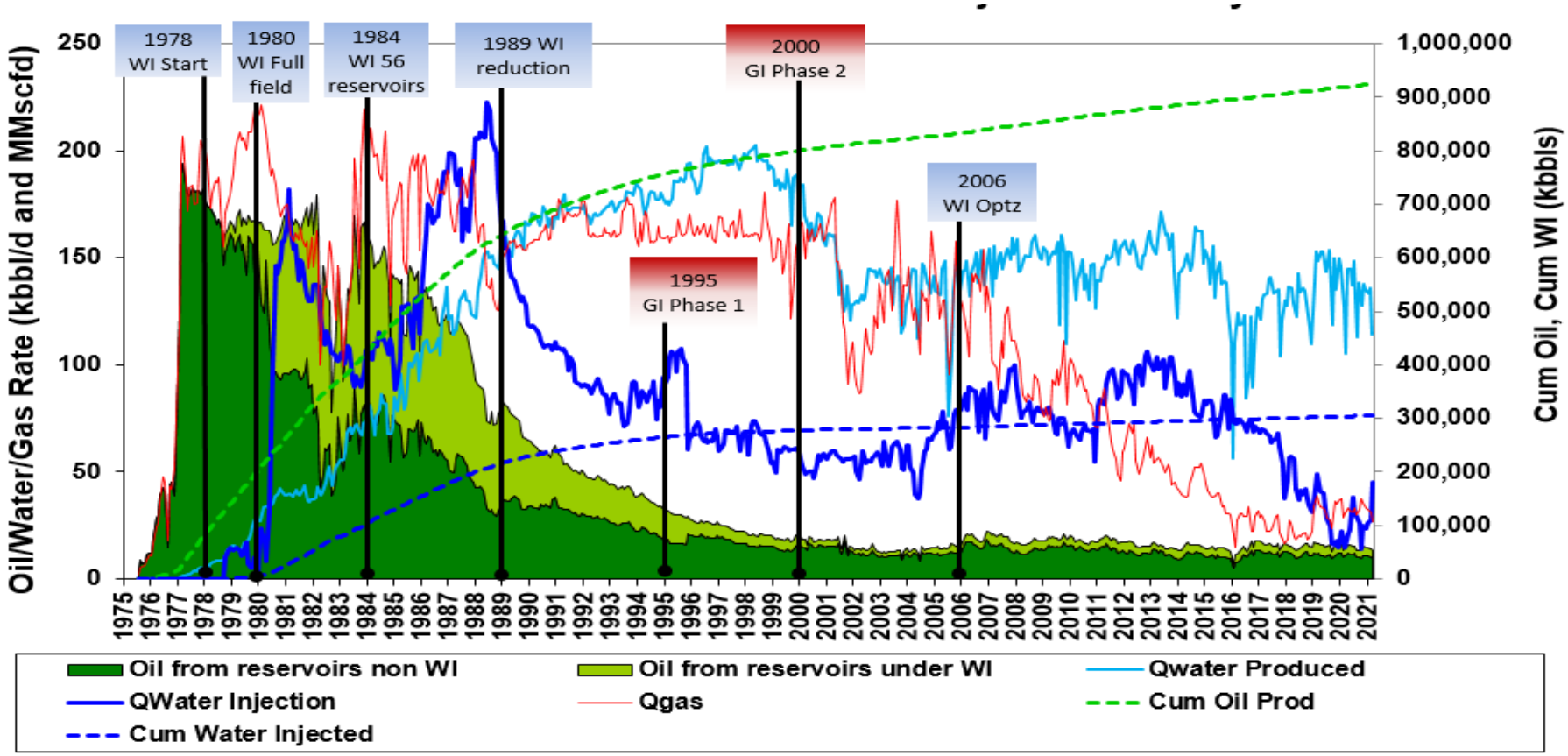
INTENSIVE OPERATION

*2022 FIGURES

- **4** DRILLING RIGS
- **92** WELLS DRILLED
- **17** WELL INTERVENTION BARGES
- **4.4 K** WELL INTERVENTION ACTIVITIES
- **27 MM** MAN HOURS
- **0.65 Bn USD** ABI RKAP 2022
- **0.5 Bn USD**

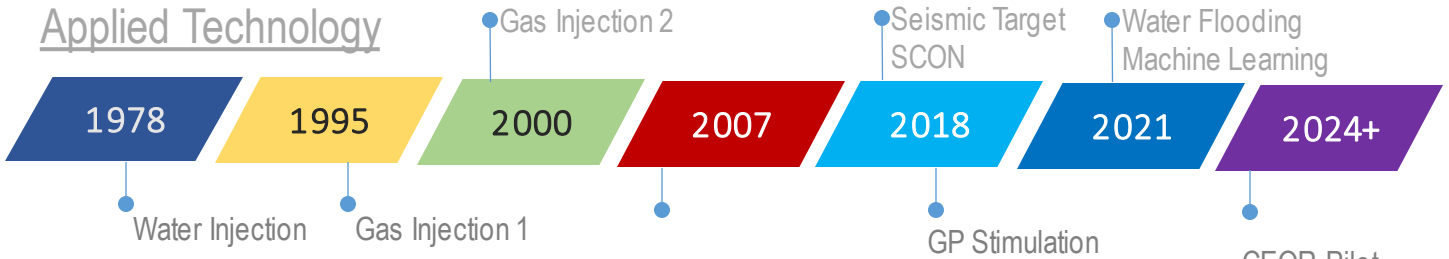
HANDIL PRODUCTION HISTORY





- Handil is one of the largest fields in the Mahakam area, which poses significant heterogeneity.

Applied Technology



HANDIL MAIN ZONE - SUBSURFACE CONTEXT

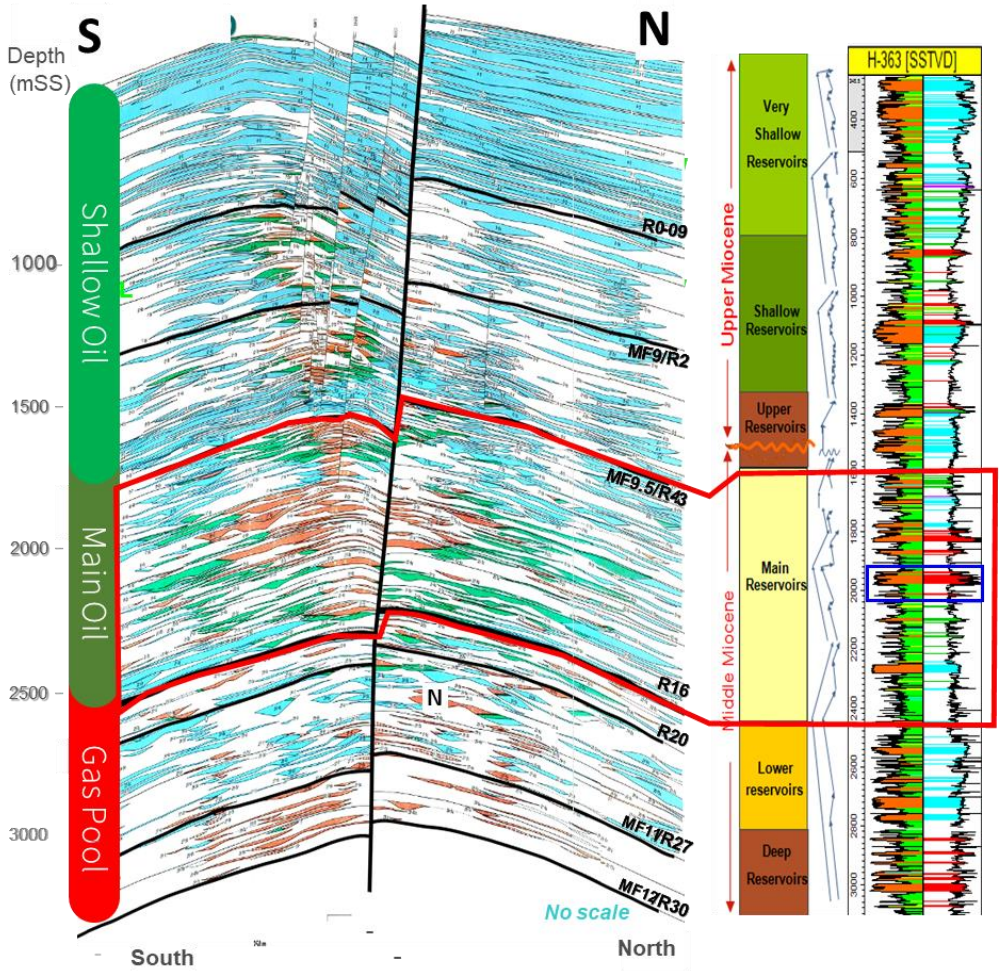
Discovery in 1974

~500 wells

~150 layers

~300 HC Pool

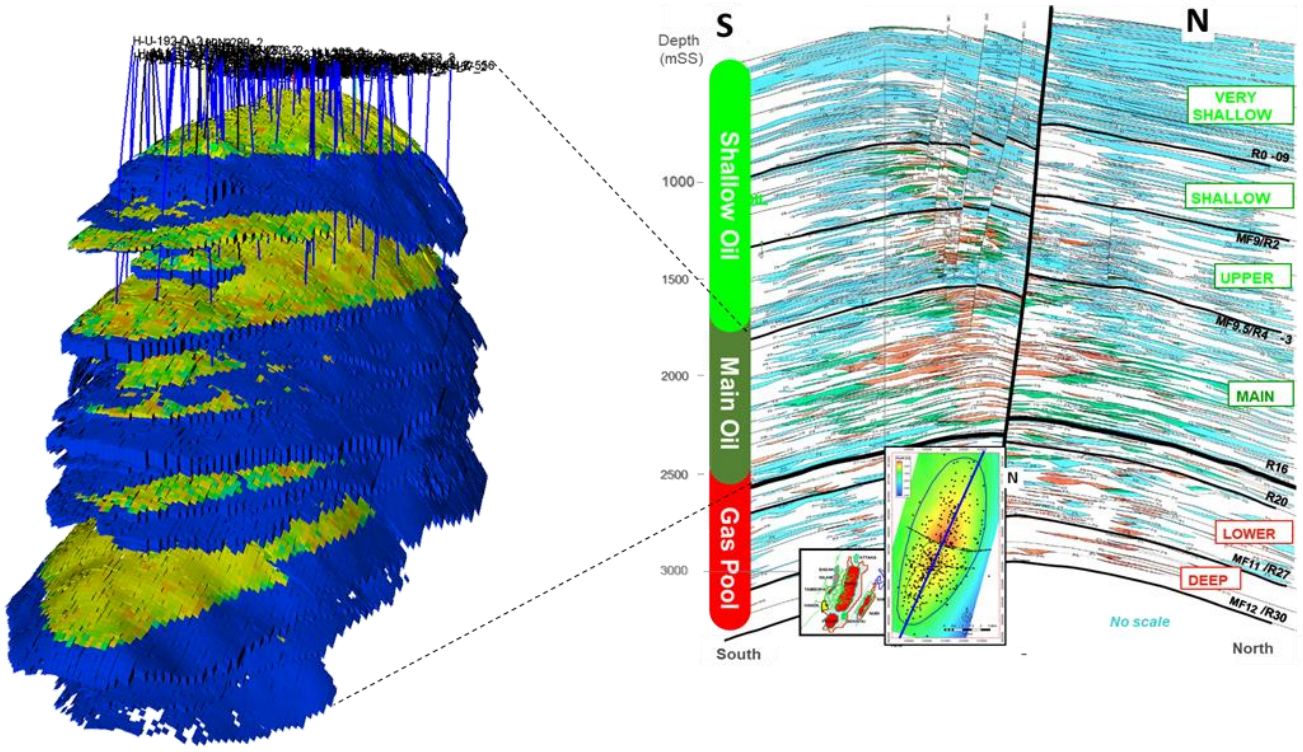
- Deltaic environment : Fluvial to Delta plain
- Channel complex reservoirs with medium aquifer support
- Good reservoir properties
- Oil dominated with gas cap
- Huge number of reservoirs accumulations: 300+ reservoirs
- Massive water injection or water flooding since 1978. Some reservoirs also have a history of gas injection.



HANDIL MAIN ZONE – CHALLENGES

- Often unpredictable dynamic contact movement
- Major and minor faults with leaking uncertainty
- Fast-growing and complicated data
- 45+ years of production & injection
- 200+ drilled wells with more than 300 strings
- Commingle production causing back-allocation uncertainty
- Uncertainty in terms of recovery factor

With a complex geological setting and fast-growing data, the traditional approach of field depletion plan is becoming obsolete.



OBJECTIVE

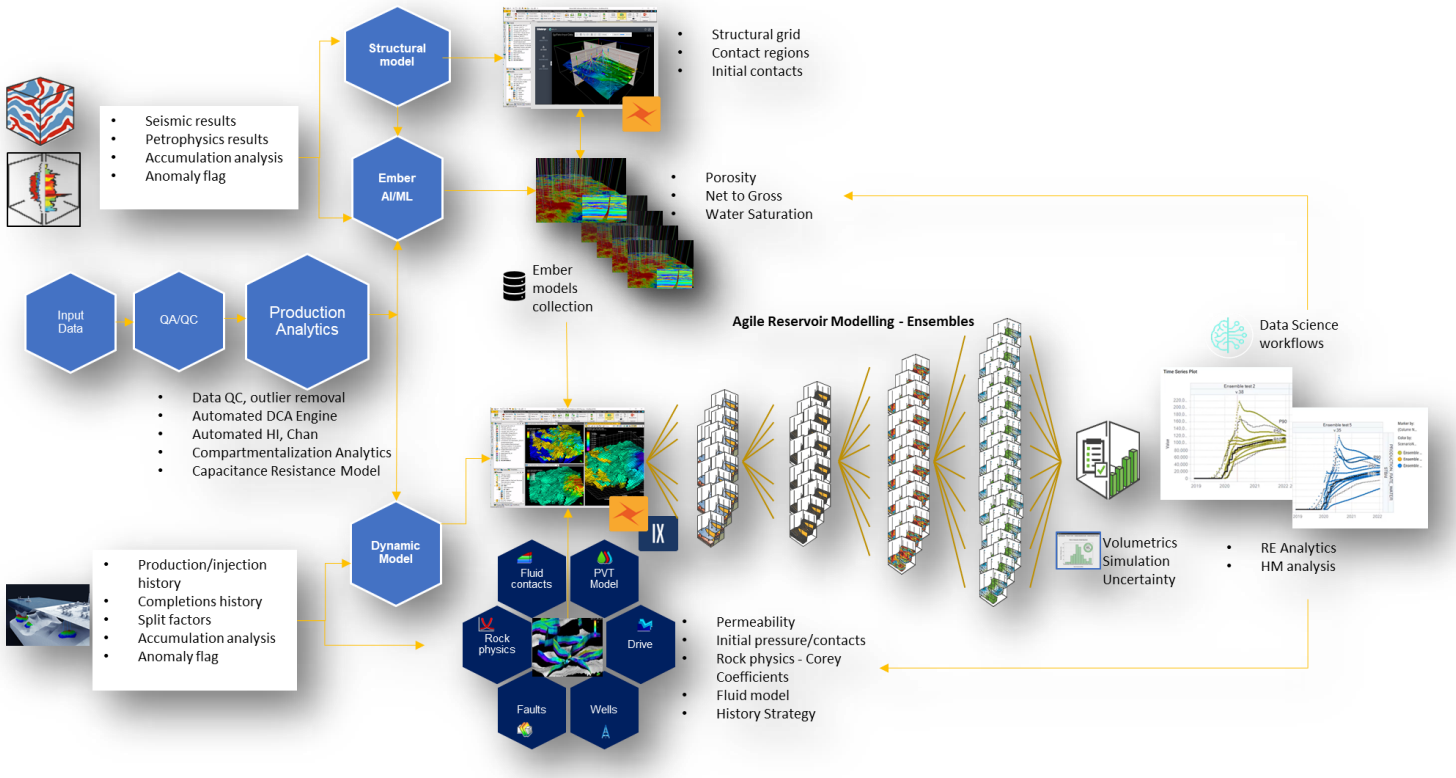
- With a complex geological setting and fast-growing data, the traditional approach of field depletion plan is becoming obsolete.
- Thus, the main challenges in maximizing the area's recovery were identifying sweet spots for infill well and identifying the optimized water flooding scheme (i.e., best performing and underperforming wells within a specific reservoir), identifying wells for production optimization, and wells that require pressure support.

- The key objectives in 2022 are the *sweet spot for infill wells and water injection optimization.*

STRATEGY

With a complex geological setting and fast-growing data, the traditional approach of field depletion plan is becoming obsolete.

- Leveraging the latest advances in modeling and AI/ML technology ranging from geological modeling, agile reservoir modeling to history matching.

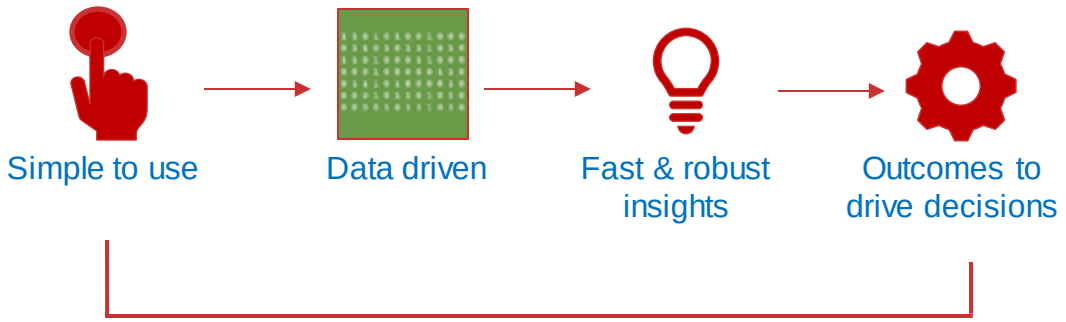


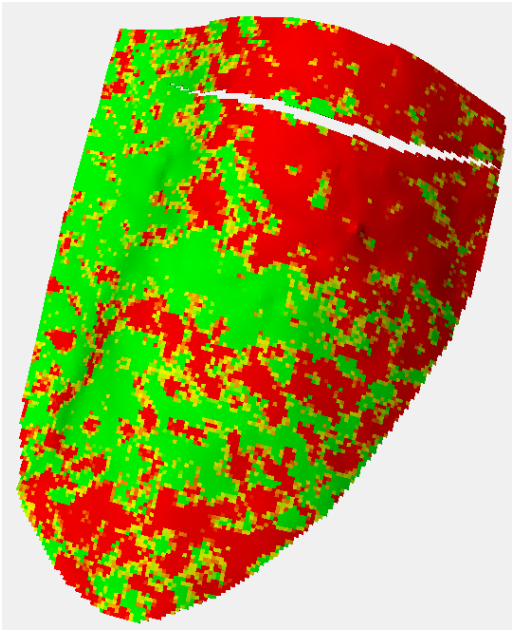
MACHINE LEARNING FOR PROPERTY MODELING

Rapidly deliver reservoir models with increased efficiency and confidence to make better decisions.

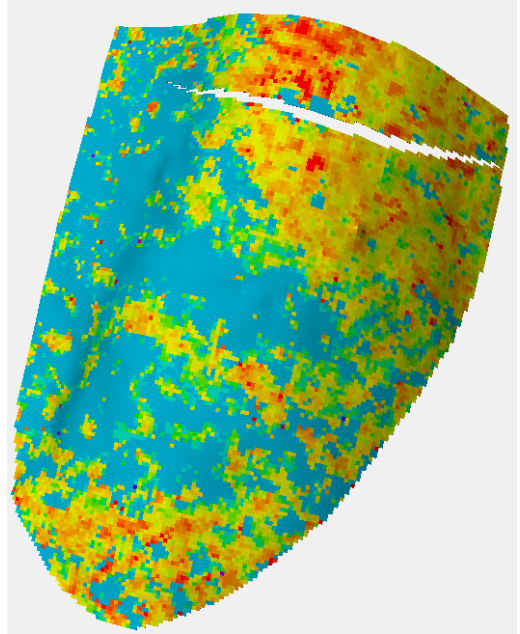
The EMBER model, combining machine learning and geostatistics, was used to model the Handil field

Combined Geostatistical Modeling with Machine Learning





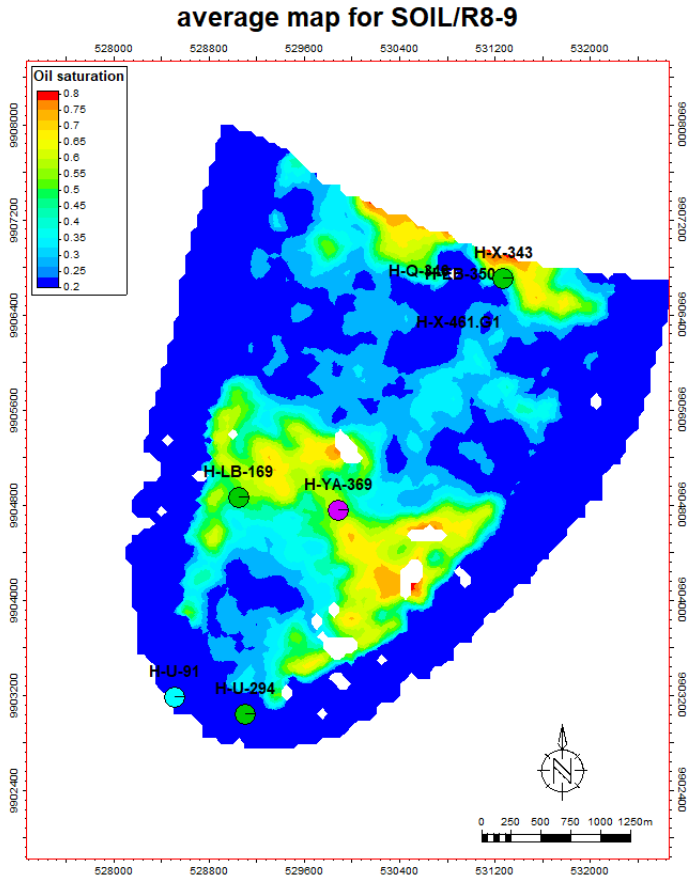
NTG Realization

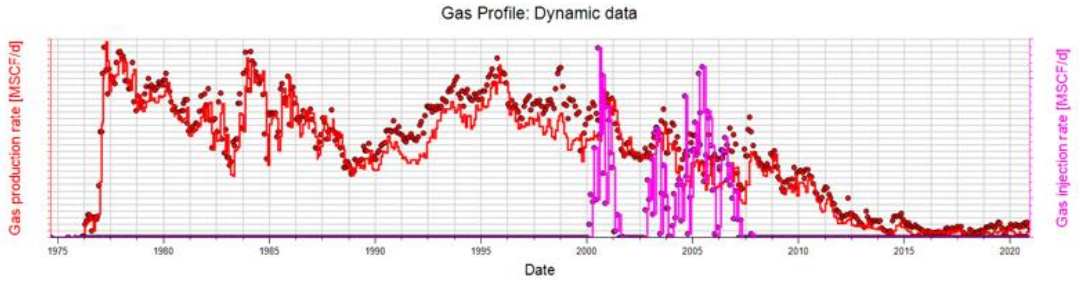


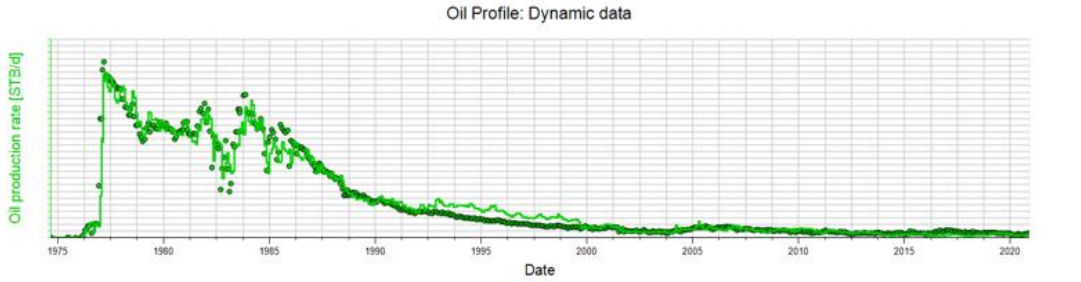
Porosity Realization

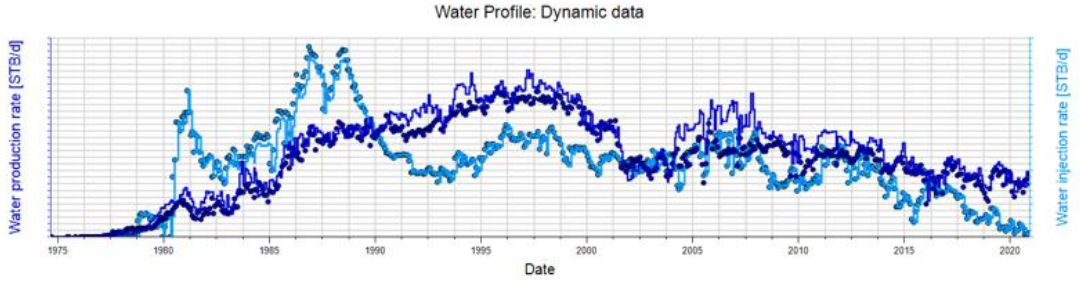
HISTORY MATCHING RESULT

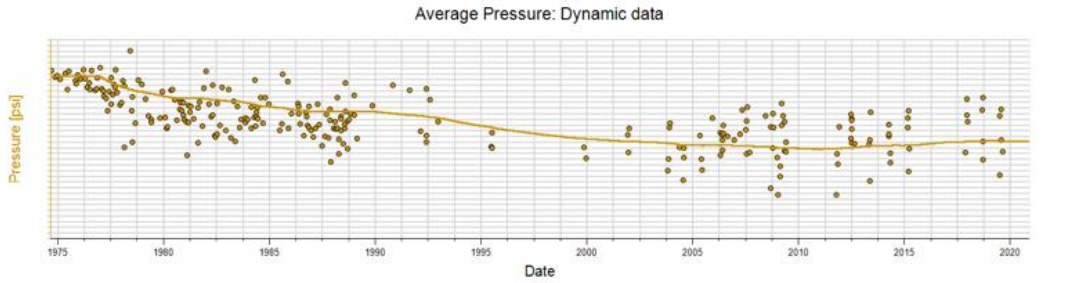
45+ years of production and injection, and 200+ drilled wells with more than 300 strings





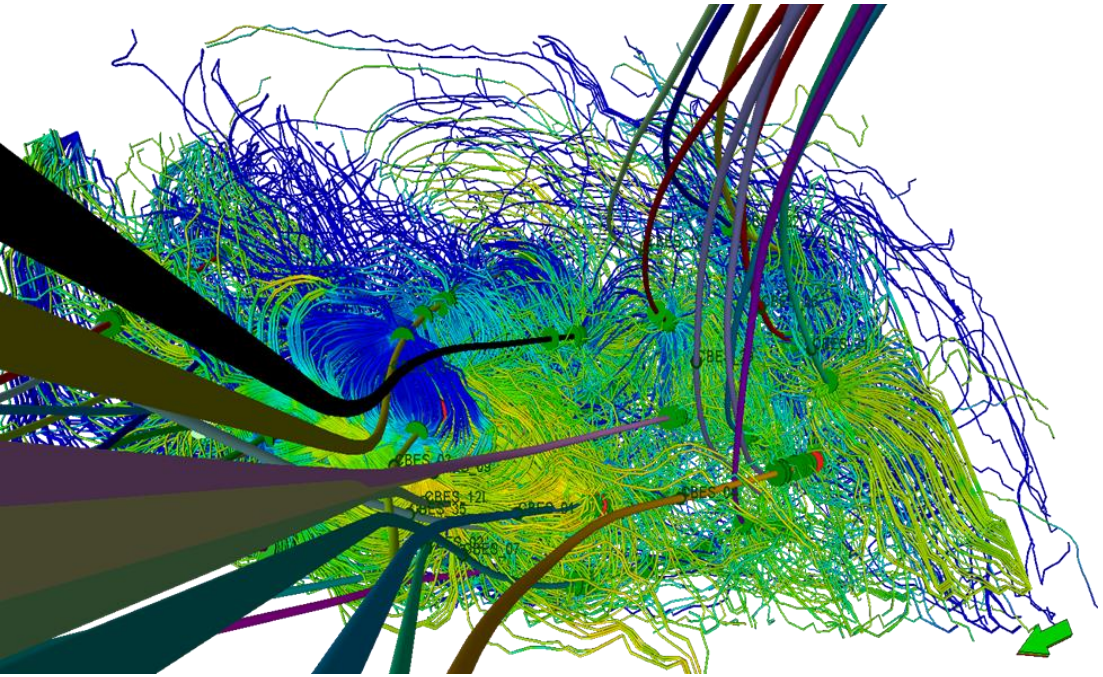






WAY FORWARD - Waterflood Optimization with PFM Technology

High HC saturation area and the waterflood management are performed by applying injection pattern analysis and intelligent optimization workflow through the combination of conventional and AI methods



Three main strategies will be applied for waterflood optimization :

- Achieve voidage replacement ratio (VRR)
  - Inject quantity based on the VRR
- Balance oil recovery rate
  - Allocate more water to higher mobile oil recovery pattern
  - Target mobile oil in place
- Reduce water recycling
  - Allocate more water to high oil cut pattern
  - Reduce water recycling and loss of water injection into the aquifer

CONCLUDING REMARKS

- The complex geological setting and fast-growing data of Handil field has made the traditional approach of field depletion plan is becoming obsolete.
- Schlumberger has been working with Pertamina Hulu Mahakam (PHM) since 2020 in applying an innovative solution: leveraging the latest advances in modeling and AI/ML technology ranging from geological modeling, agile reservoir modeling to history matching.
- The main objective is to determine the sweet spot for infill wells and water injection optimization and recommendations.
- High HC saturation area and the waterflood management are performed by applying injection pattern analysis and intelligent optimization workflow through the combination of conventional and AI methods.