Tolmount Gas Field

Field start up planning for the successful use of multi-well deconvolution

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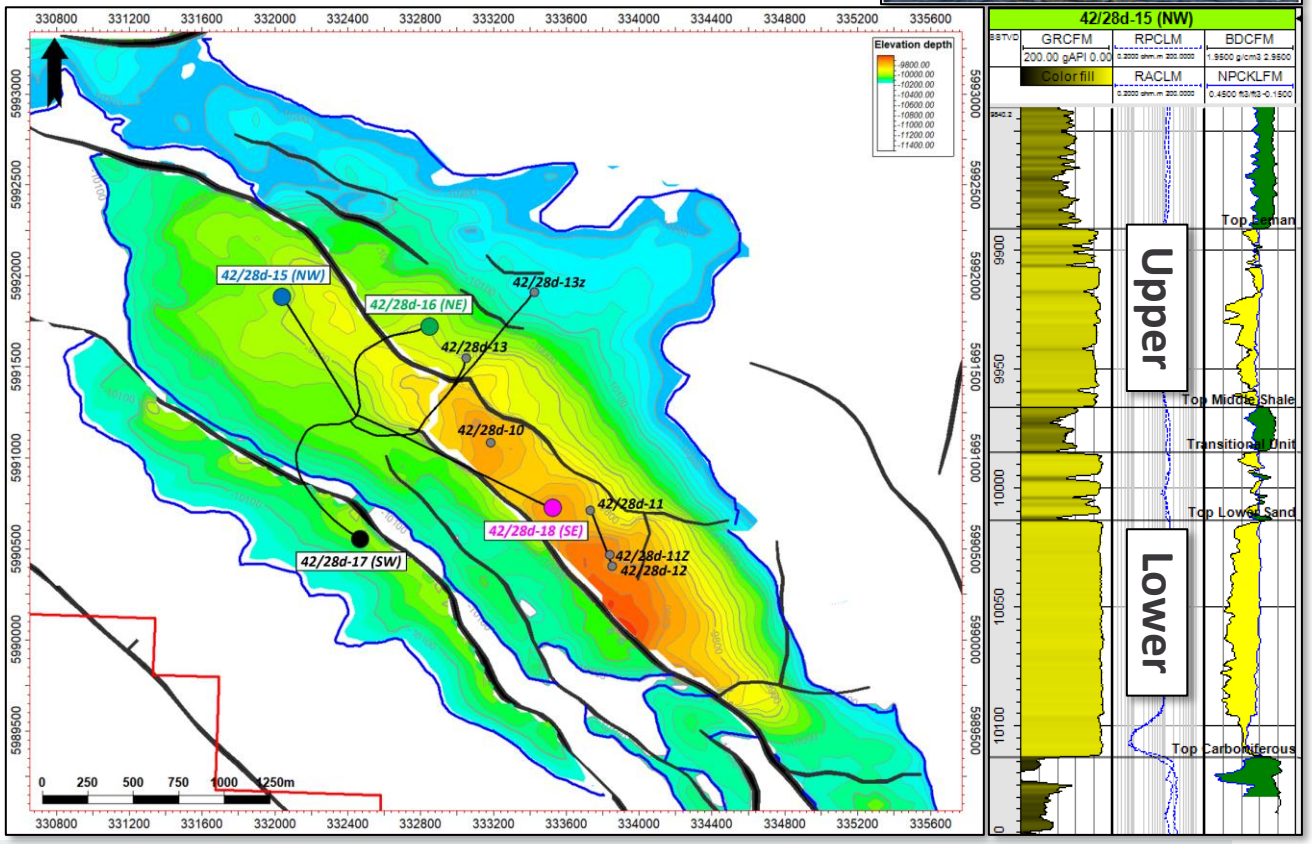
Tolmount field

- Located in block 42/28d in the SNS east of Yorkshire coast
- 3 E&A reservoir penetrations
- Permian Leman Sandstone
- Lean gas condensate
- Reservoir split into upper and lower sand units divided by a middle shale
- 4 Development Wells – Tolmount NW, NE, SE and SW
- First gas – 24th April 2022



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Technical and business objectives

Technical objectives

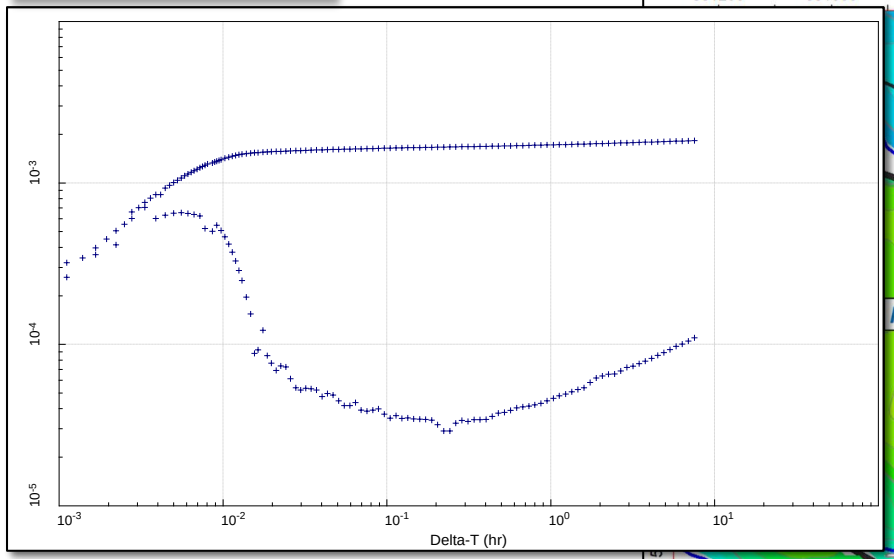
1. Confirm and monitor well performance
2. Determine reservoir geometry and architecture
3. Check for inter-well connectivity
4. Estimate connected volumes

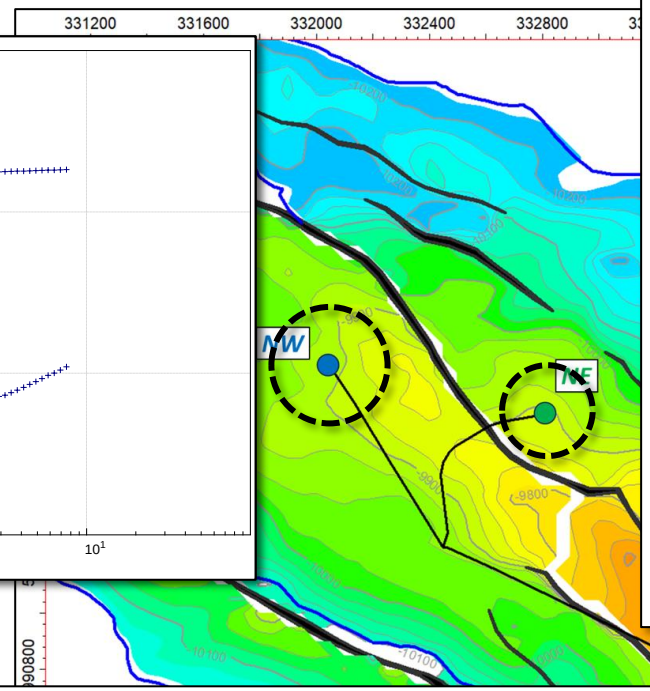
Business objectives

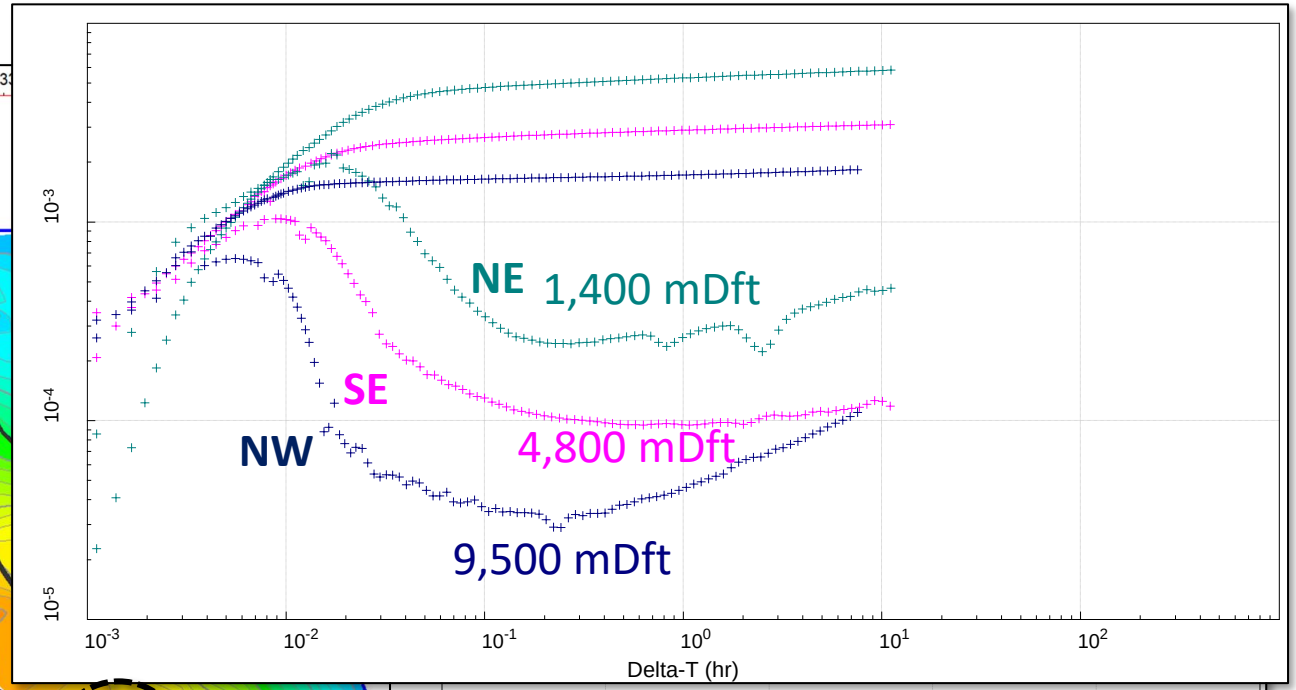
1. Minimise deferred production and maximise use of surveillance data
2. Understand reserves
3. Optimise the field development plan

Information gathered from clean up tests

Tolmount NW







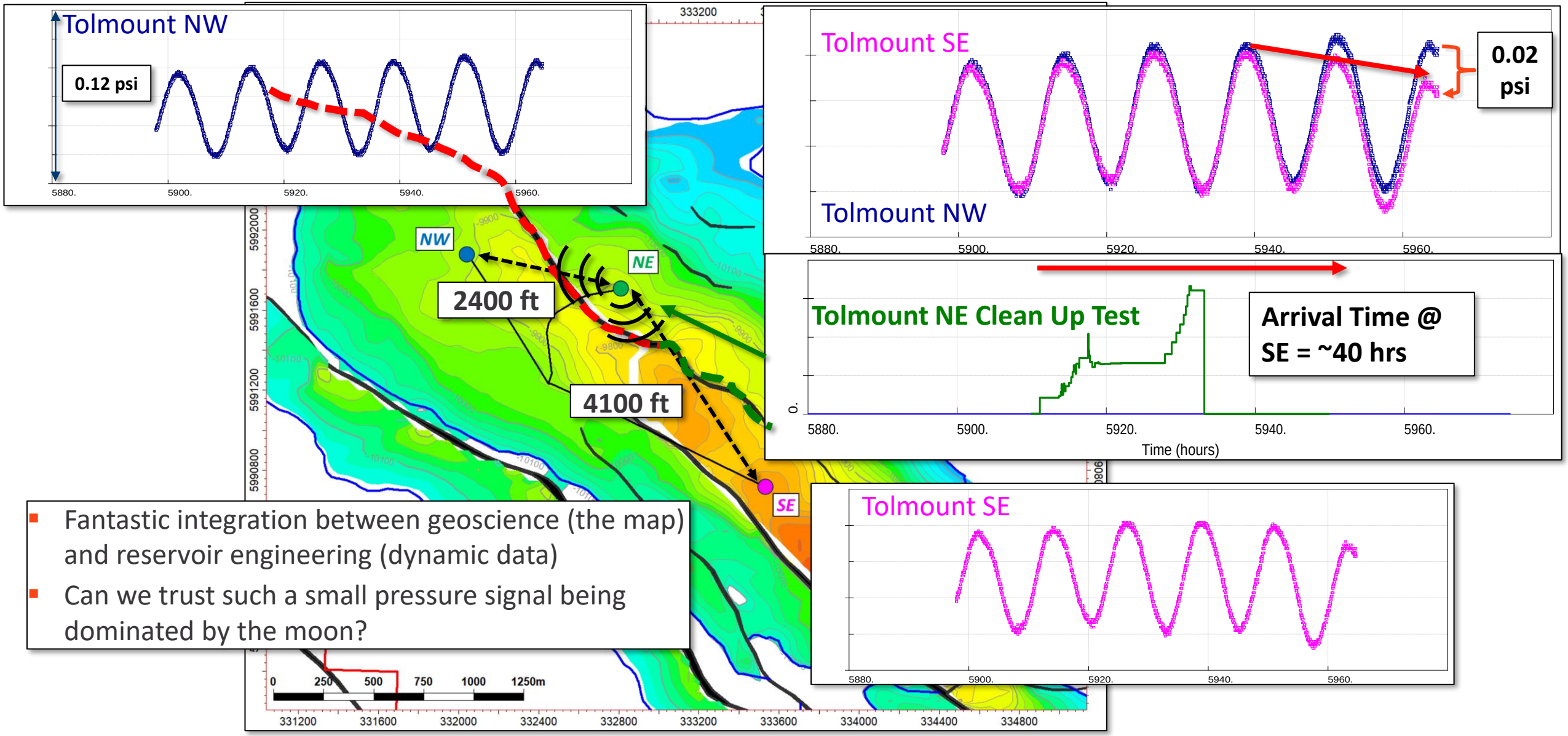
What did we learn?

- Near well reservoir properties and some geometry/heterogeneities
- Significant reservoir property distribution across the field

What did we NOT learn?

- Connectivity across reservoir, large scale characteristics of external reservoir boundaries and the volume connected to producing wells.

Initial signs of reservoir connectivity



- Fantastic integration between geoscience (the map) and reservoir engineering (dynamic data)
- Can we trust such a small pressure signal being dominated by the moon?

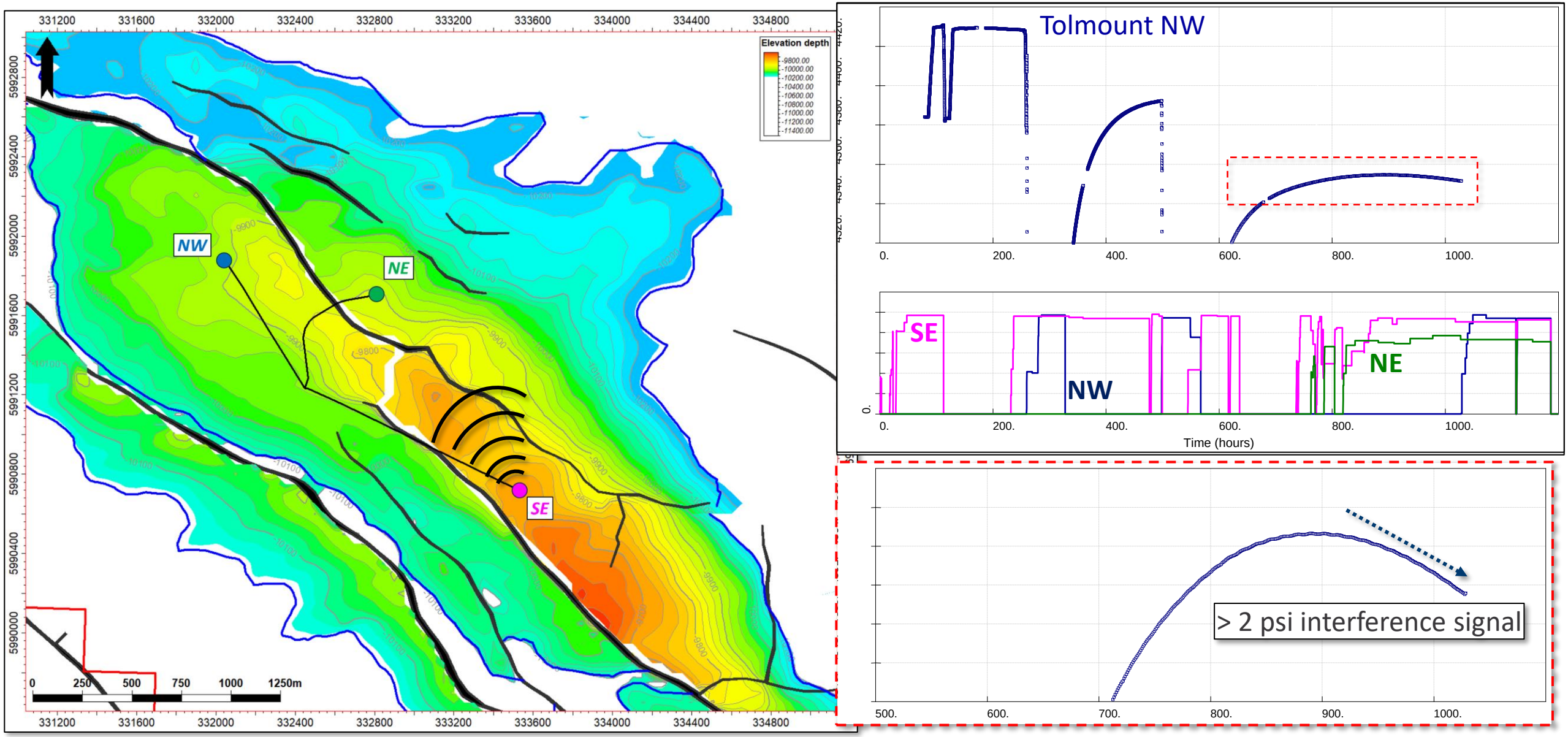
Field start up planning

1. Interference testing
    a) Do this at beginning of field life
    b) Start the field with one well – Tolmount SE
    c) Ensure the observation wells (NW and NE) DHPTG are recording a baseline for one week before field start up
    d) Estimate minimum interference test durations
        a) **SE to NE is 40 hrs** based on field observations
        b) **SE to NW is 72 to 120 hrs (3 - 5 days)** based on field observations and modelling

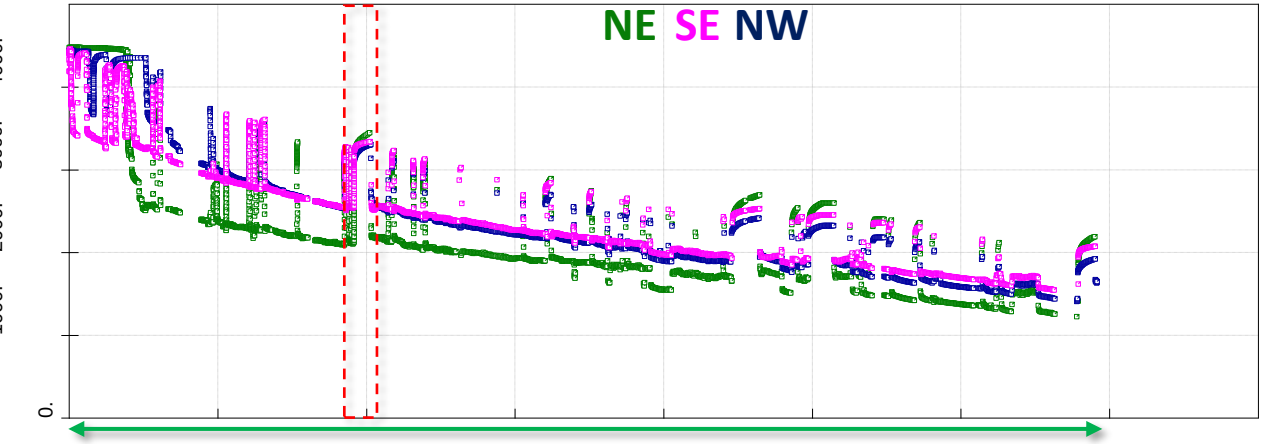
2. One short pressure build up (PBU) per week per well for the first month, reduce frequency based on analysis

3. Take advantage of any unplanned PBUs and cancel planned PBUs (minimise deferment)

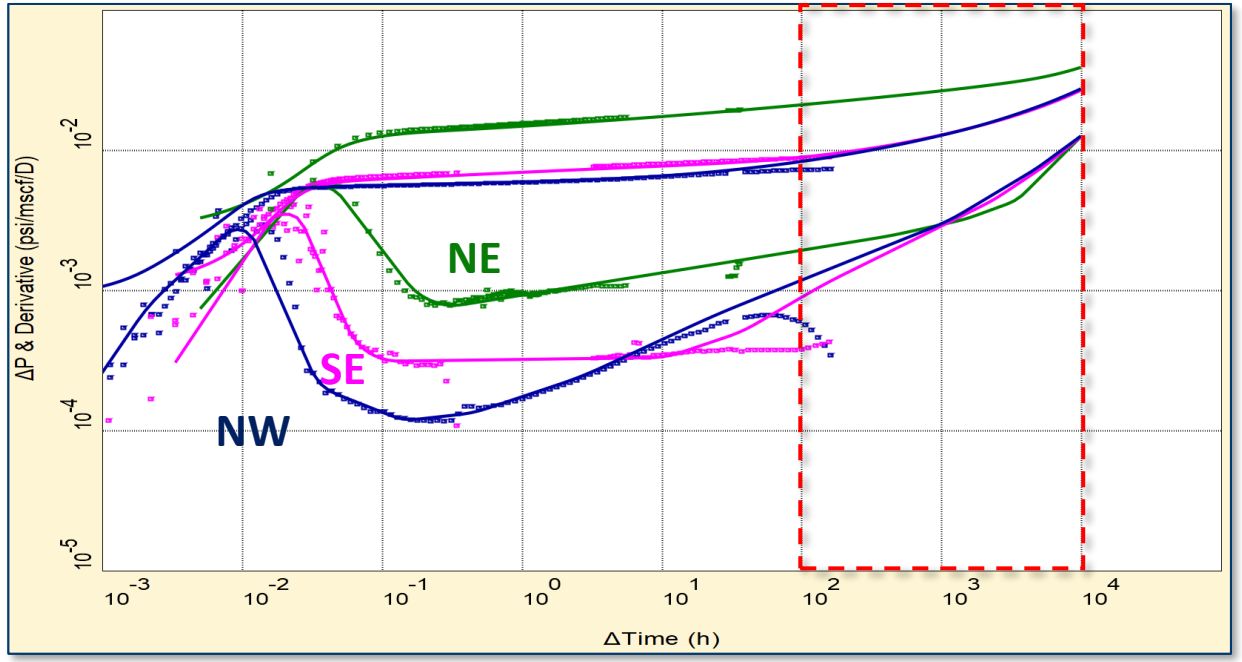
Interference test confirming reservoir connectivity



Multi-well pressure rate deconvolution



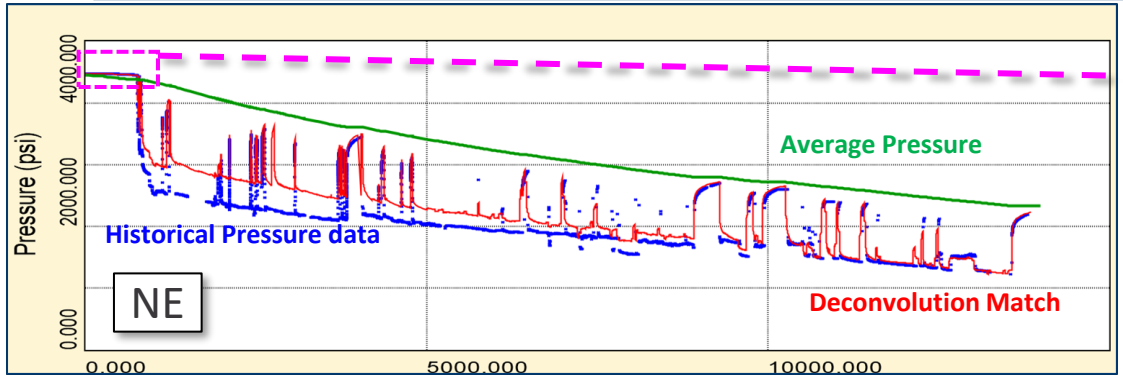
April 2022 Nov 2023

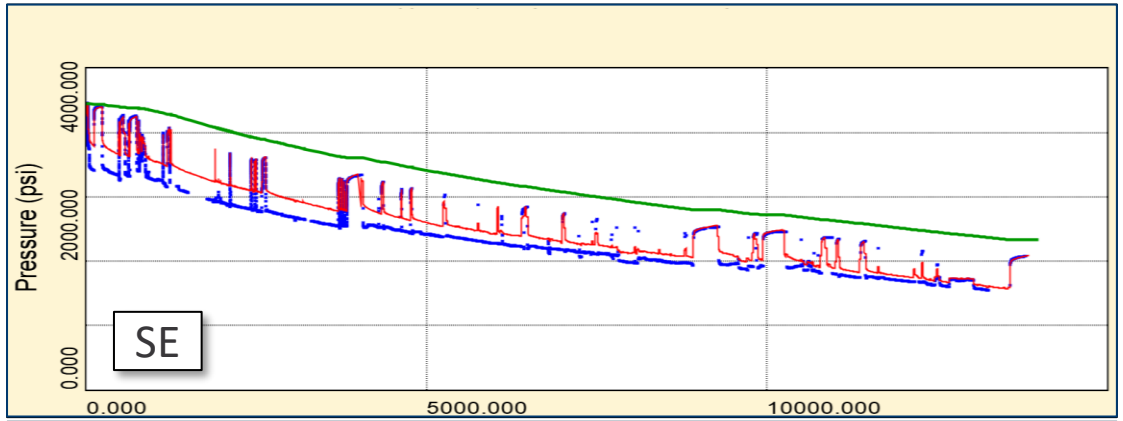


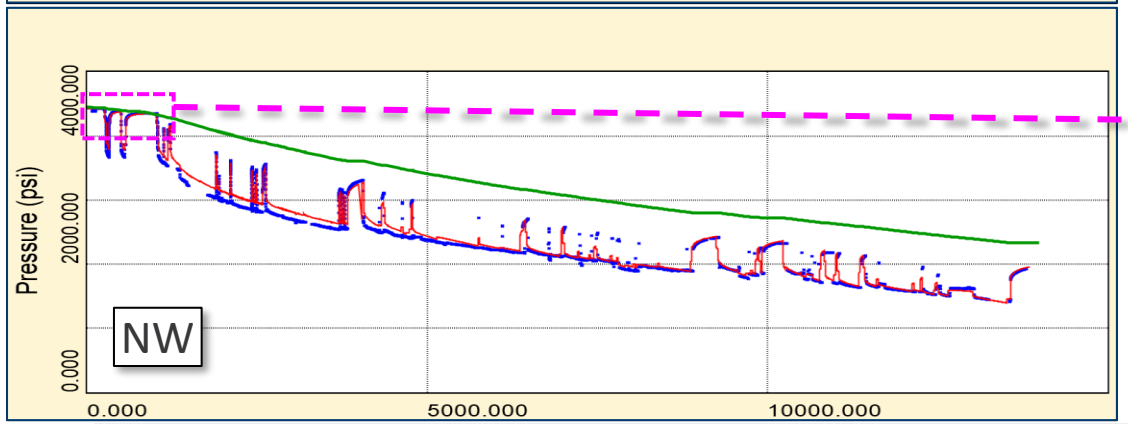
Advantages of multi-well pressure rate deconvolution

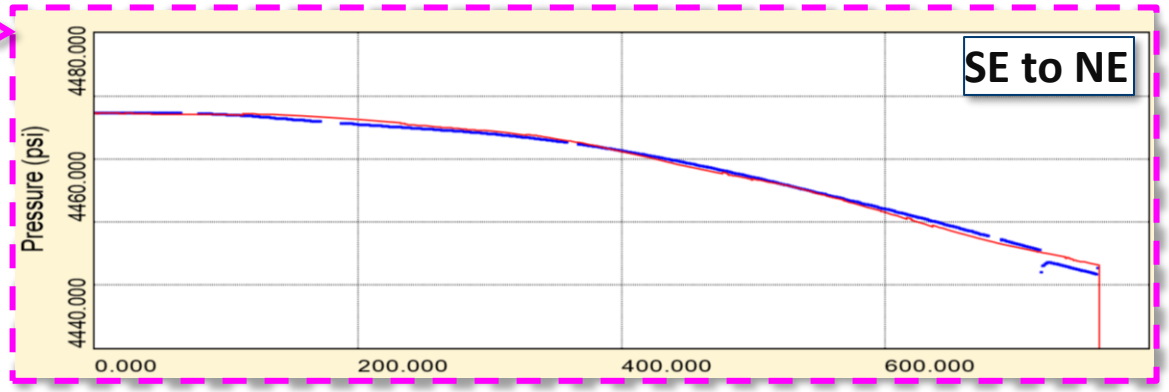
1. Enhances conventional PTA and fills in the knowledge gap
2. Accounts for well interference on pressure data
3. Quick to perform with accurate results
4. Does not require long costly planned PBUs deferring production
5. Considers both transient and pseudo steady state flow regimes
6. Gives an improved estimate of average pressure and connected volumes

Multi-well deconvolution match of Tolmount NW, NE, SE

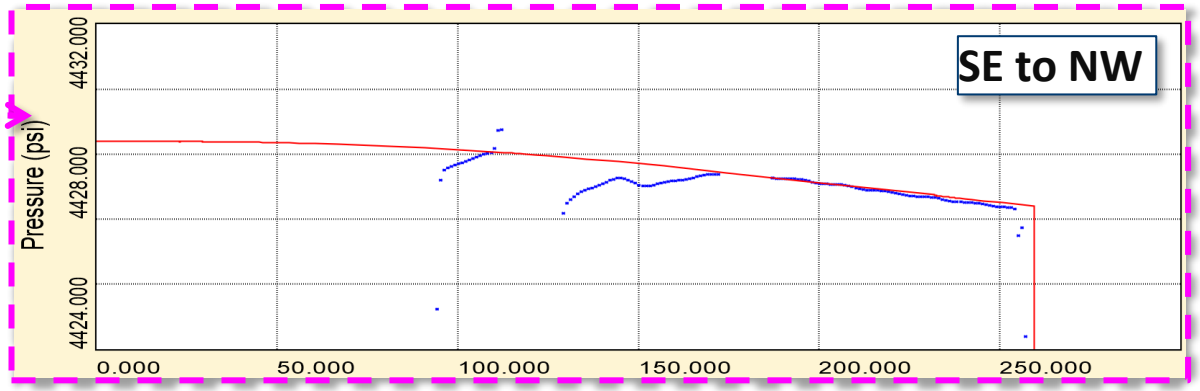




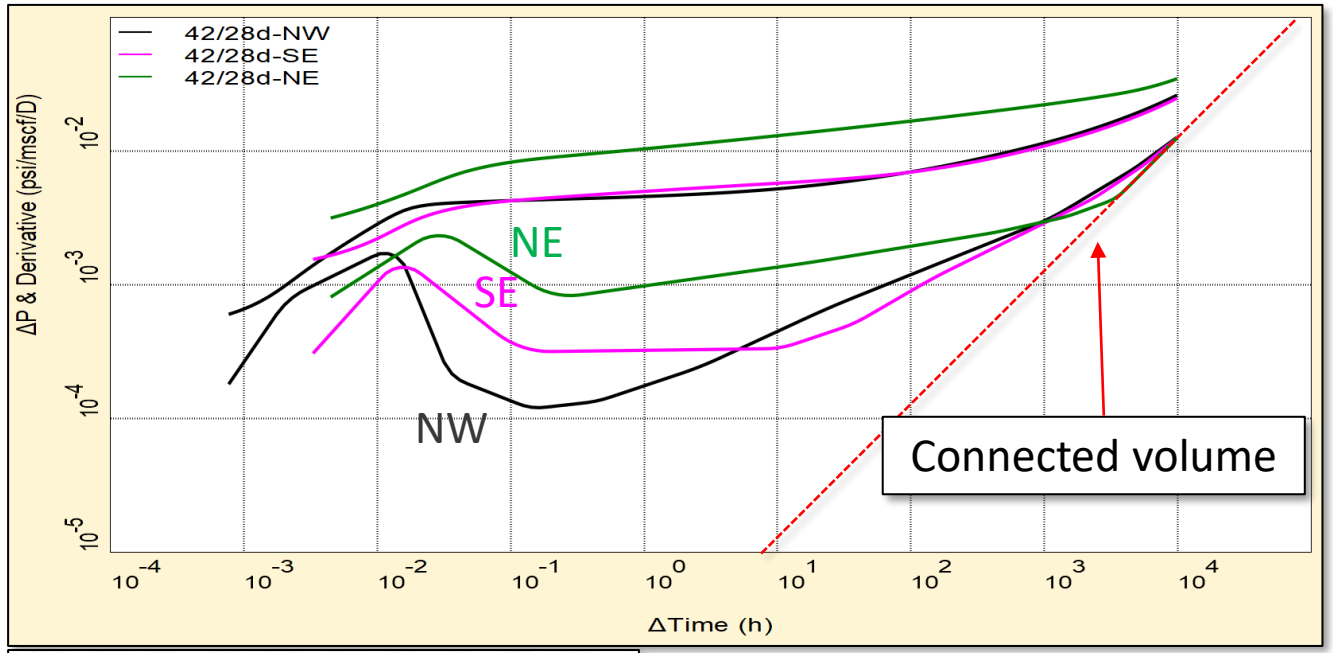


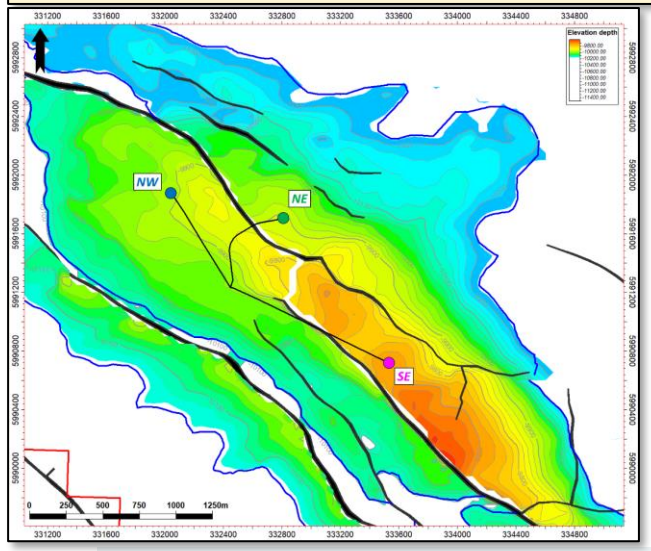


- Multi-Well deconvolution taking into account well interference



Results and insights of multi-well deconvolution of Tolmount NW, NE, SE

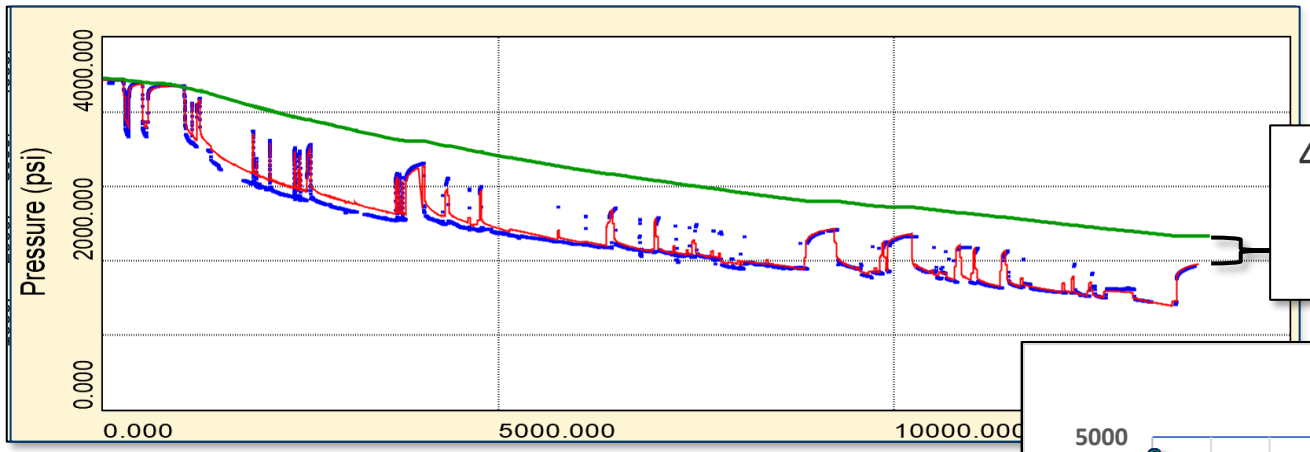




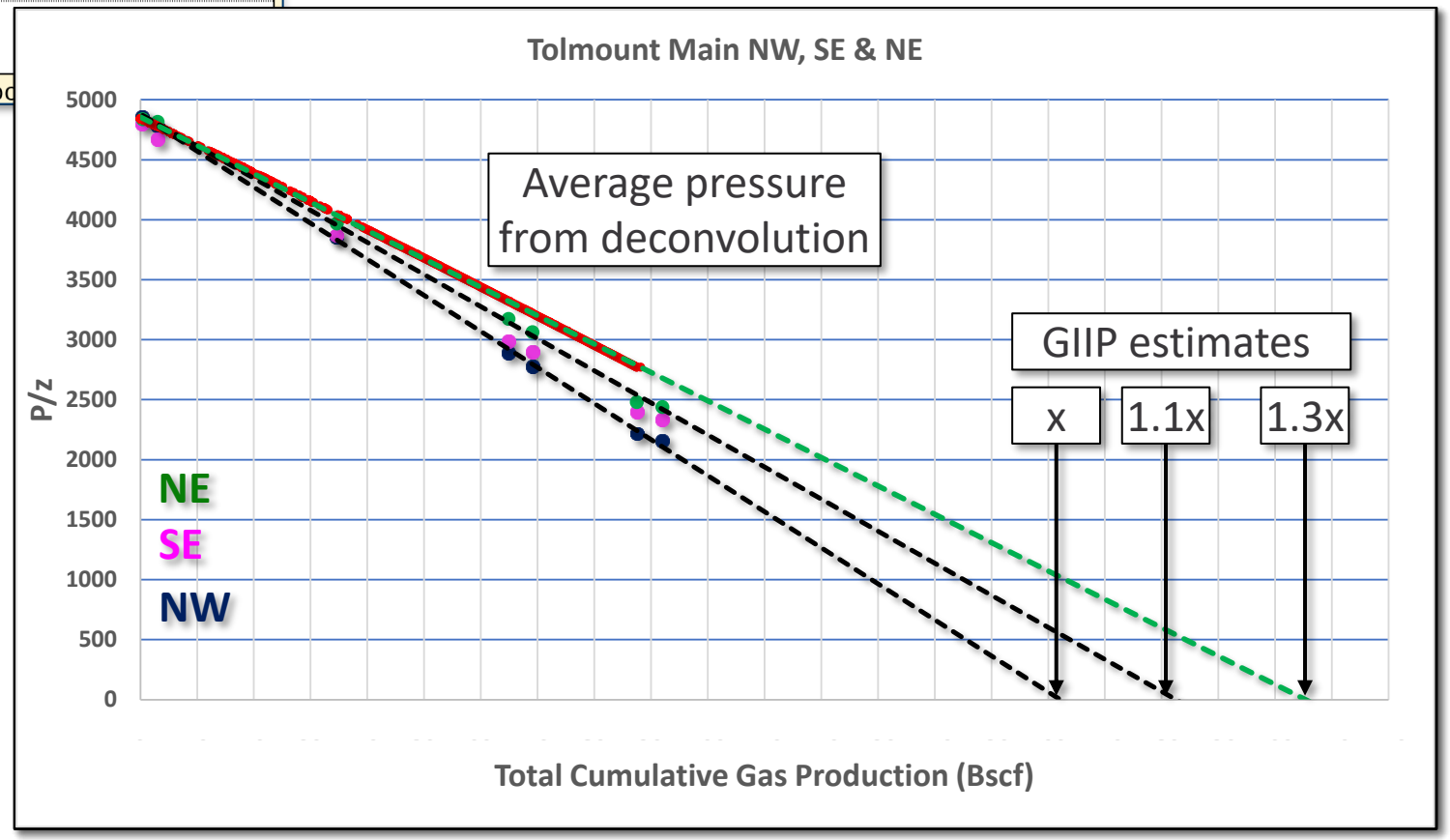
Observations:

1. Significant reservoir property variation in permeability thickness (kh) at the well
2. No changes in kh over time – Well health ✓
3. Decrease in skin over time – Well health ✓
4. Internal faulting exists creating baffling
5. Reservoir architecture – generally rectangular in shape
6. All responses converge to a unit slope
   a) All reservoir limits reached and in PSS
   b) GIIP connected to the three wells can be estimated and compared to static estimates
   c) Depletion with no noticeable aquifer support
   d) Average reservoir pressure determined

Comparison to conventional techniques gas material balance (p/Z)



400 psi difference between gauge pressure and average reservoir pressure at NW



Conclusions

1. Field start up presents a unique opportunity to get to know your reservoir
2. A considered approach making best use of all dynamic data can yield very useful information
    a) Interference testing, high resolution data and a sequence of short PBUs is required
    b) Minimise costs by capitalising on unplanned PBUs and annual shutdowns
3. Multi-well deconvolution plays a significant role in this
    a) First time a field startup was planned with the intention of using these techniques
    b) SPE-210492 & SPE-195441 for more info
4. Ensure assets are optimised as quickly as possible
5. These methods are currently being used on many other Harbour Energy assets enhancing our reservoir characterisation

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Convolution Explorer

A tool for analysis of dynamic behavior of oil and gas reservoirs

Acknowledgements / Thank You / Questions

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