

# Cycling Storage and Recovery of Injected Hydrogen in Underground Porous Media

Mitchell Ellis, Quan Xie

WA School of Mines: Minerals, Energy and Chemical Engineering, Curtin University, 26 Dick Perry Avenue, Kensington, Western Australia, 6151, Australia

## Significance

- The Government of WA has stated that "Western Australia is committed to developing large scale renewable hydrogen industry ... (which)... could see Western Australia produce over 100 gigawatts of renewable energy for hydrogen by 2030, which could increase to 200 gigawatts by 2040."
- To embrace massive scale renewable energy development, 100s GWhs to 13s TWhs energy storage will be required. Underground hydrogen storage in depleted gas reservoirs provides a solution to achieve WA's clean hydrogen ambition.



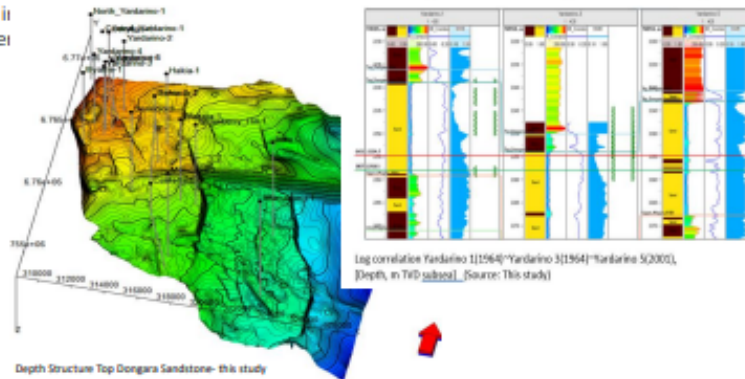
Western Australia Government (2023) Western Australia's Hydrogen Projects Developing the renewable hydrogen industry. October 2023. Department of Jobs, Tourism, Science and Innovation.

Bailey et al. (2012) Integration of Structural, Stress, and Seismic Data to Define Secondary Permeability Networks Through Deep Cemented Sediments in the Northern Perth Basin. *APPGA Journal*, pp. 455-474

## Results and Discussion

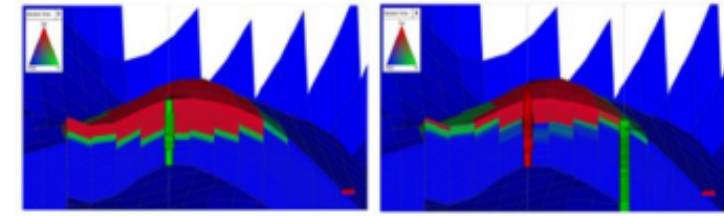
### Geological Static Modelling

Result #1: Numerical reservoir simulation model for Yardarino was constructed based upon data from 21 wells.



Depth Structure Top Dongara Sandstone- this study

Log correlation Yardarino 1(1564)-Yardarino 1(1964)-Yardarino 5(2001), Depth, in TVD subsea. [Source: This study]



saturation model section between yardarino-1 and yardarino-3 - this study

Result #4: It is envisaged that caprock integrity during underground hydrogen storage may not be an issue based upon previous studies in the northern Perth Basin (Bahar et al. 2021).

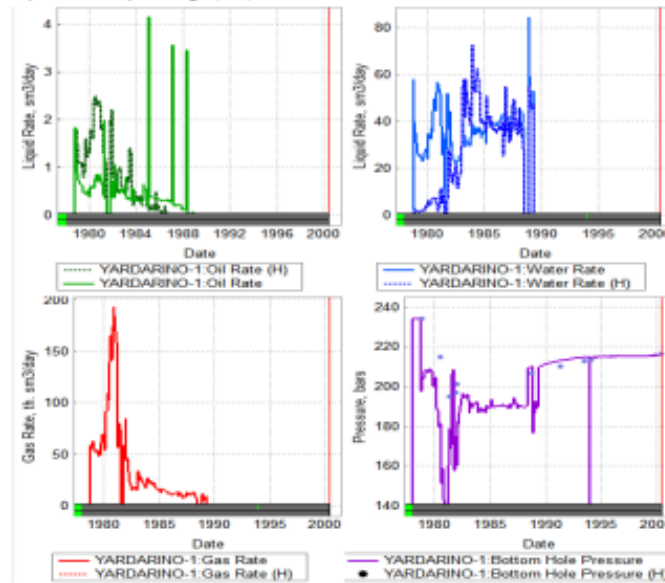
## Next Steps

- Produce remaining gas/oil to reduce reservoir pressure
- Utilise hydrogen Relative permeability from public sources (Yetka (2018), Lysy (2023), Edlmann (2023), Higgs (2023))
- Model diffusion of hydrogen, dispersion, and influence of aquifer
- Consider well location impacts and varying periods of injection, storage and production cycles
- Statistically analysing the existing hydrogen-water rock physics data and model the impact of the cycling process on hydrogen trapping associated with hydrogen-water contact movement.

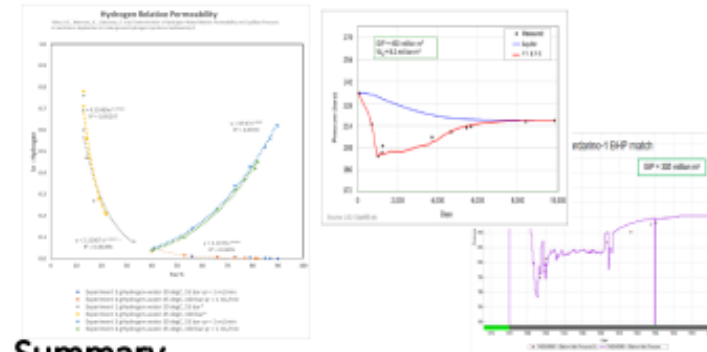
### Dynamic Modelling - History Matching

Result #2: Compositional numerical reservoir simulation model of the depleted Yardarino gasfield was constructed from first principles.

Result #3: The reservoir model was characterized through history matching of production period gas, oil, water and BHP.



History match of Yardarino-1 production and pressure data from compositional model - this study



## Summary

- A complex geologic static model was created based on 21 wells, log evaluation and geostatistical distribution of properties.
- A compositional model was created using representative fluids taken in the offsetting Dongara field, Dongara reservoir, in early development period.
- History match of Yardarino is suitable to progress the study.
- Current work is investigating cycling hydrogen storage and production at Yardarino, considering various well types and locations on the structure.

### Acknowledgements

RFD is acknowledged for the software package (tNavigator) and technical support.

## Objectives

- Using numerical reservoir simulation models, this research aimed to characterize the impact of cycling geological storage and withdrawal of hydrogen in depleted gas reservoir.
- Developing Yardarino depleted gas reservoir geological model
- Characterizing the geological model through field history matching

## Methodologies

- The current work has focused upon the depleted Yardarino gas field located in the northern Perth Basin in Western Australia (WA) as a target for the cycling storage of hydrogen within the highly permeable and porous Permian Dongara Sandstone, identified by RISC (2021) for hydrogen potential based upon their evaluation of 13 depleted oil and gas fields in WA.
- RFD's tNavigator was used to construct a new numerical reservoir simulation model, using available public domain information, with an aim to model cycling geological hydrogen storage and predict recovery and impact from the hydrogen storage.

