26th International Congress on Modelling and Simulation, Adelaide, SA, Australia, 30 Nov–4 Dec 2025
mssanz.org.au/modsim2025

Leveraging petrophysical logs in data-scarce groundwater environments

Daan Herckenrath [a], **Sukesh Shanmugam** [a], **Rodrigo Rojas** [a] **and Keith Phillipson** [a]

[a] *Australasian Groundwater & Environmental Consultants Pty Ltd., Bowen Hills, QLD 4006, Australia*
Email: daan@ageconsultants.com.au

Abstract: Petrophysical data, such as wireline logs, are rarely used in modelling tools developed to support groundwater impact assessments. However, these logs can provide powerful data in environments where traditional monitoring data, such as groundwater level data, is scarce. This is especially true for projects targeting deep hydrogeological formations where traditional monitoring data is expensive and challenging to acquire. By leveraging available wireline log data — both from project exploration phases and public portals such as QLD's GSQ Open Data Portal (https://www.business.qld.gov.au/industries/mining-energy-water/resources/minerals-coal/online-services/gsq-open-data-portal) and NSW's SEED portal (https://www.seed.nsw.gov.au/) — the presented approach can offer a powerful modelling workflow to improve groundwater impact predictions.

This presentation describes an innovative workflow, building on similar methods previously used by the QLD's Office of Groundwater Impact Assessment (OGIA, 2019), for integrating wireline log data into groundwater impact simulations. We first detail how raw wireline data are processed to generate high-resolution lithological and permeability logs. This process involves applying established petrophysical relationships and using machine learning methods, such as neural networks, to derive permeability estimates with limited hydraulic testing data.

Next, we use the generated lithofacies logs to build ensembles of detailed three-dimensional hydrogeological representations using geostatistical software such as SGEMS (Remy, 2011) and Petrel (Schlumberger, 2025). These high-resolution models are then parameterised with petrophysical-based hydraulic property estimates to be used for subsequent groundwater flow simulations.

Finally, we demonstrate two key applications of these high-resolution groundwater models. In the first application, these models are directly used for stochastic groundwater impact predictions relevant to the project. In the second application, these models can be used for numerical permeameter computations to obtain upscaled hydraulic parameters to develop robust prior parameter distributions for use in regional-scale groundwater models.

The presented approach provides a rigorous and data-driven method to enable the inclusion of a largely untapped data source in groundwater modelling tools, thereby improving groundwater impact assessments in data-scarce environments, and ultimately supporting better-informed decisions for resource development projects.

REFERENCES

Office of Groundwater Impact Assessment, 2019, Groundwater Modelling Report – Surat Cumulative Management Area, OGIA, Brisbane.
Remy, N., 2011, Applied Geostatistics with SGeMS: A User's Guide.
Schlumberger, 2025, Petrel™ subsurface software.

Keywords: *Groundwater modelling, petrophysical data analysis, machine learning, hydrogeology*