NORTHERN PERTH BASIN

Predicting reservoir quality of Permian sandstones

Project aims

- Help predict the distribution of reservoir-quality Permian sandstones within and surrounding the highly prospective northern Dandaragan Trough, northern Perth Basin (e.g. Senecio and Waitsia fields, West Erregulla 2; Figs 1, 2).
- HyLogger spectral data will be integrated with petrography, mineralogy, facies analysis and burial history of selected wells. The project is an expansion of an earlier investigation by the Geological Survey of Western Australia (GSWA) into the Late Permian Dongara and Wagina Sandstones, and Early Permian 'Kingia sandstone' and High Cliff Sandstone in the Senecio–Waitsia area (Table 1).

HyLogger application

- Previous HyLogger work on northern Perth Basin core proved extremely valuable in profiling diagenetic mineral assemblages, particularly from short-wave infrared (SWIR), namely kaolinite, dickite, illitic clays (e.g. illite, sericite, phengite), chlorite and carbonate (Figs 3–5). This methodology was tested on cuttings as a proof-of-concept to investigate if the HyLogger could be used as a tool for rapid basinwide reservoir studies where core is either unavailable or of limited extent (Figs 4,5).
- Results from a small area within the northern Perth Basin, verified against complementary HyLogged core and petrographic data, suggest that cuttings (5 m and 10 m composites) can provide valid diagenetic profiles.
- HyLogger data from cores and cuttings from the Dongara and Wagina Sandstones show a clear change in diagenetic clay composition with depth (1960 m – 3150 m), from kaolinite to dickite to dickite–illitic clays or illitic clays only. There is also a coincident decrease in average core porosity (from 17 to 8%) and permeability (from 811 mD to <0.1 mD). Kaolinite and dickite are typically present at depths <2500 m, and dickite–illitic clays between 2500 and 3500 m. Carbonate cement is present at >3000 m in Irwin 1 (Fig. 5) and Warradong 1.

Table 1. HyLogging complete – Perth Basin wells

Well	Dongara and Wagina Sandstones			'Kingia sandstone' and High Cliff Sandstone		
	Core	Cuttings	Existing petrography	Core	Cuttings	Existing petrography
Centella 1	X	X	✓			
Corybas 1				X	X	✓
Hakia 2		X				
Hovea 3	X		✓			
Irwin 1		X	✓			✓
Mondarra 8	X	X				
Mountain Bridge 1				X		✓
Senecio 1		X				
Senecio 3	X	X	✓			
Waitsia 1		X		X	X	✓
Waitsia 2				X		✓
Waitsia 3		X				✓
Warradong 1	X	X	✓			
Yardarino 1	X		✓			
Yardarino 2	X	X	✓			

Planned work

- Additional cores and cuttings from the Dongara and Wagina Sandstones, and the 'Kingia sandstone' and High Cliff Sandstone will be HyLogged and petrography undertaken, extending the dataset across the Dongara, Allanooka, Beharra and Donkey Creek Terraces, and the northern Dandaragan Trough (Table 2).
- In addition to documenting the spatial distribution of diagenetic clays and cements, the project will also investigate their relationship to:
  - facies and provenance
  - porosity–permeability data
  - formation-water salinity
  - depth of burial

Table 2. Planned HyLogging – northern Perth Basin wells

Well	Dongara and Wagina Sandstones			'Kingia sandstone' and High Cliff Sandstone		
	Core	Cuttings	Existing petrography	Core	Cuttings	Existing petrography
Agonis 1		X				
Apium 1	X	X	✓			
Arrowsmith 2		X			X	
Beharra 2		X			X	
Behara Springs 1		X	✓			
Beharra Springs 2	X	X	✓			
Corybas 1		X				
Denison 1		X			X	
Depot Hill 1		X			X	
Dongara 4	X	X	✓			
Dongara 11	X	X	✓			
Dongara 12	X	X	✓			
Dongara 23	X	X	✓			
Dongara 24	X	X	✓			
Dongara 27	X	X	✓			
Drakea 1		X	✓		X	✓
Ejarno 1	X	X	✓			
Eremia 1		X			X	
Erregulla 1	X	X	✓			
Eurangoa 1		X			X	
Evandra 1		X	✓			
Hakia 1		X				
Hakia 2					X	
Jingemia 4	X	X	✓			
Kingia 1		X	✓		X	✓
Lockyer 1	X	X	✓			
Mondarra 1	X	X	✓			
Mondarra 2	X	X	✓			
Mondarra 3	X	X	✓			
Mondarra 7	X	X				
Mt Adams 1	X	X	✓			
Mt Horner 1	X	X				
Mt Horner 7	X	X	✓			
Mountain Bridge 1		X			X	✓
Mungenooka 1		X	✓			
Narlingue 1		X			X	
North Erregulla 1	X	X	✓			
North Yardarino 1					X	
Redback 2		X				
Senecio 3					X	
Strawberry Hill 1	X	X	✓			
Waitsia 2					X	✓
Waitsia 3				X	X	✓
Waitsia 4		X			X	✓
Wayvanerry 1		X				
West Erregulla 1	X	X	✓			
Xyris South 1		X				

For more information, contact:
Iain Copp (iain.copp@dmirs.wa.gov.au)

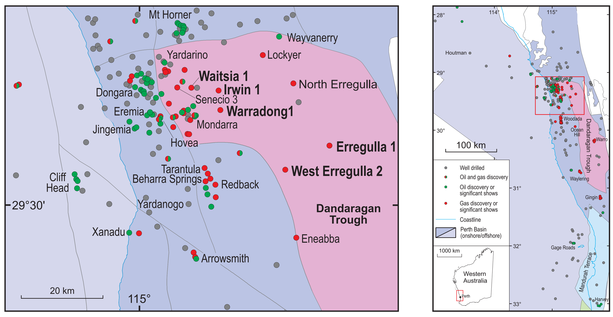

Figure 1. Location of the northern Perth Basin study area, showing tectonic elements, exploration wells and petroleum discoveries

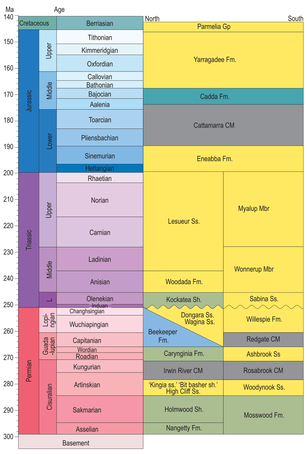

Figure 2. Stratigraphy of the Perth Basin

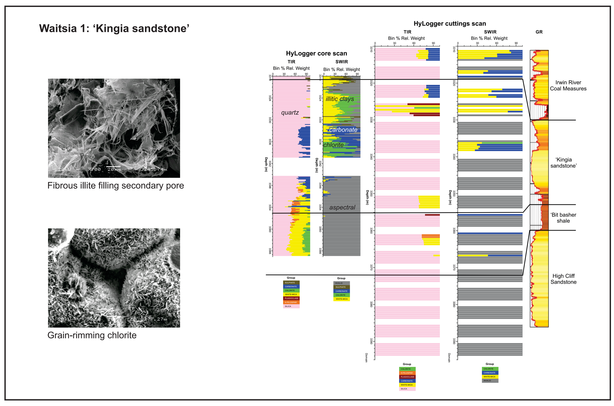

Figure 3. HyLogger analysis of cores and cuttings from 'Kingia sandstone' gas reservoir in Waitsia 1. Chlorite clays have helped preserve primary porosity by partially inhibiting quartz-overgrowth cements Abbreviations: TIR, thermal infrared, SWIR, short-wave infrared, GR, gamma ray

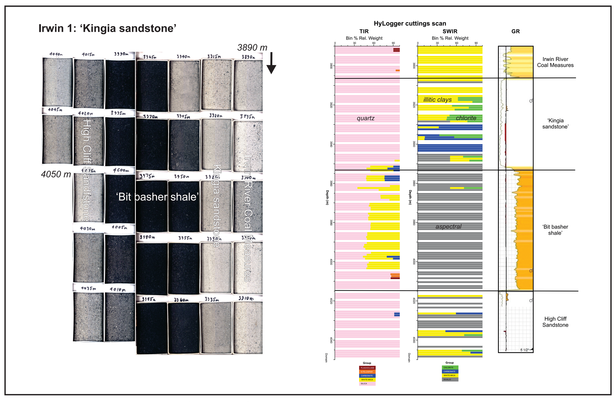

Figure 4. HyLogger analysis of cuttings from the 'Kingia sandstone' in Irwin 1, showing chlorite clay zones that have helped preserve primary porosity by partially inhibiting quartz-overgrowth cements

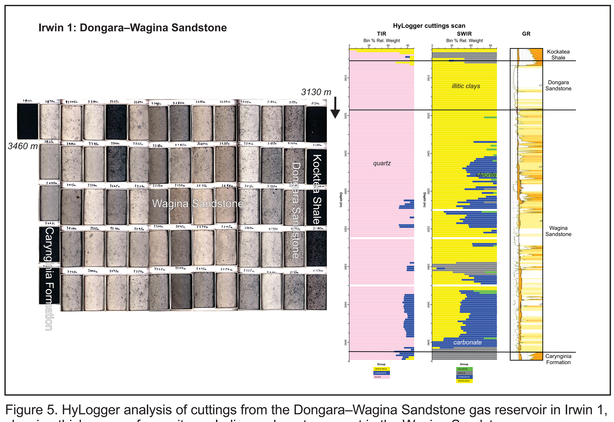

Figure 5. HyLogger analysis of cuttings from the Dongara–Wagina Sandstone gas reservoir in Irwin 1, showing thick zones of porosity occluding carbonate cement in the Wagina Sandstone

AUGUST 2019