



Coorikiana Sandstone play, Cooper Basin region

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**Energy Resources Division,
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Coorikiana Sandstone play, Cooper Basin region

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EXECUTIVE SUMMARY

The early Cretaceous Coorikiana Sandstone has been proven to be a bona fide exploration, appraisal and development target in the South Australian sector of the Cooper/Eromanga basin. This report is a comprehensive documentation of the play and is aimed at providing explorers with a better understanding of the geology and potential importance of these regressive marine shoreface sandstone reservoirs.

Recent activity in the South Australian portion of the Cooper/Eromanga basin has proven successful via low-cost shallow drilling campaigns, focussing on delivering additional production rate and reserves for both oil and gas. These positive results in the Coorikiana Sandstone have not only placed the spotlight on this formation as a legitimate hydrocarbon target but it has also increased our knowledge on the importance of understanding the value of shallow hydrocarbon plays in the Eromanga Basin.

Play	Coorikiana Sandstone
Basin	Eromanga
Location	Cooper Basin region
Age	Early Cretaceous
Reservoir	Coorikiana Sandstone
Seal	Oodnadatta Formation / Bulldog Shale – intraformational siltstones and shales
Charge/migration	Underlying gas/oil fields via faulting
Hydrocarbon phase	Oil/gas
Production[#]	0.931 million barrels of oil produced in South Australia 35.9 billion cubic feet of gas produced in South Australia
Hydrocarbon flow rates	Highest rate unfracked, Isoptera 1 averaged 46 BOPD. Isoptera 3 averaged 121 BOPD in May 2022 after fracture stimulation. Mudera 15 averaged 3.47 MMscf/d in October 2008. Fracture stimulation can improve flow rates by 3-fold.
Undiscovered potential resources	If 10 fields were to be discovered it is not unreasonable to expect that there would be at least 10 MMstb of oil in place based on existing fields. Confidential information available to DEM suggests it is likely that the undiscovered oil potential for the Coorikiana Sandstone in South Australia could be significantly larger than this. Gas production from the Coorikiana to the end of July 2022 was 35.9 BCF from 4 fields. A similar amount may be as yet undiscovered.

[#] 31st July 2022

1. INTRODUCTION

The Eromanga Basin covers around 1,000,000 km² of central-eastern Australia, about 360,000 km² of which lies in South Australia. The Eromanga Basin encloses the multi-aquifer system of the Great Artesian Basin (Fig. 1).

Petroleum exploration of the Cooper/Eromanga basin commenced in 1954 with the granting of an exploration licence to Santos. The dominant focus for operators being gas resources of the deeper Permian reservoirs of the Cooper Basin, which are overlain by the younger shallower Eromanga Basin. But a recent industry focus to specifically target the shallower reservoirs, viz., Coorikiana Sandstone of the Eromanga Basin has yielded rewarding outcomes, thus adding to the Cooper/Eromanga basin reputation as Australia's most prolific onshore oil and gas basin.

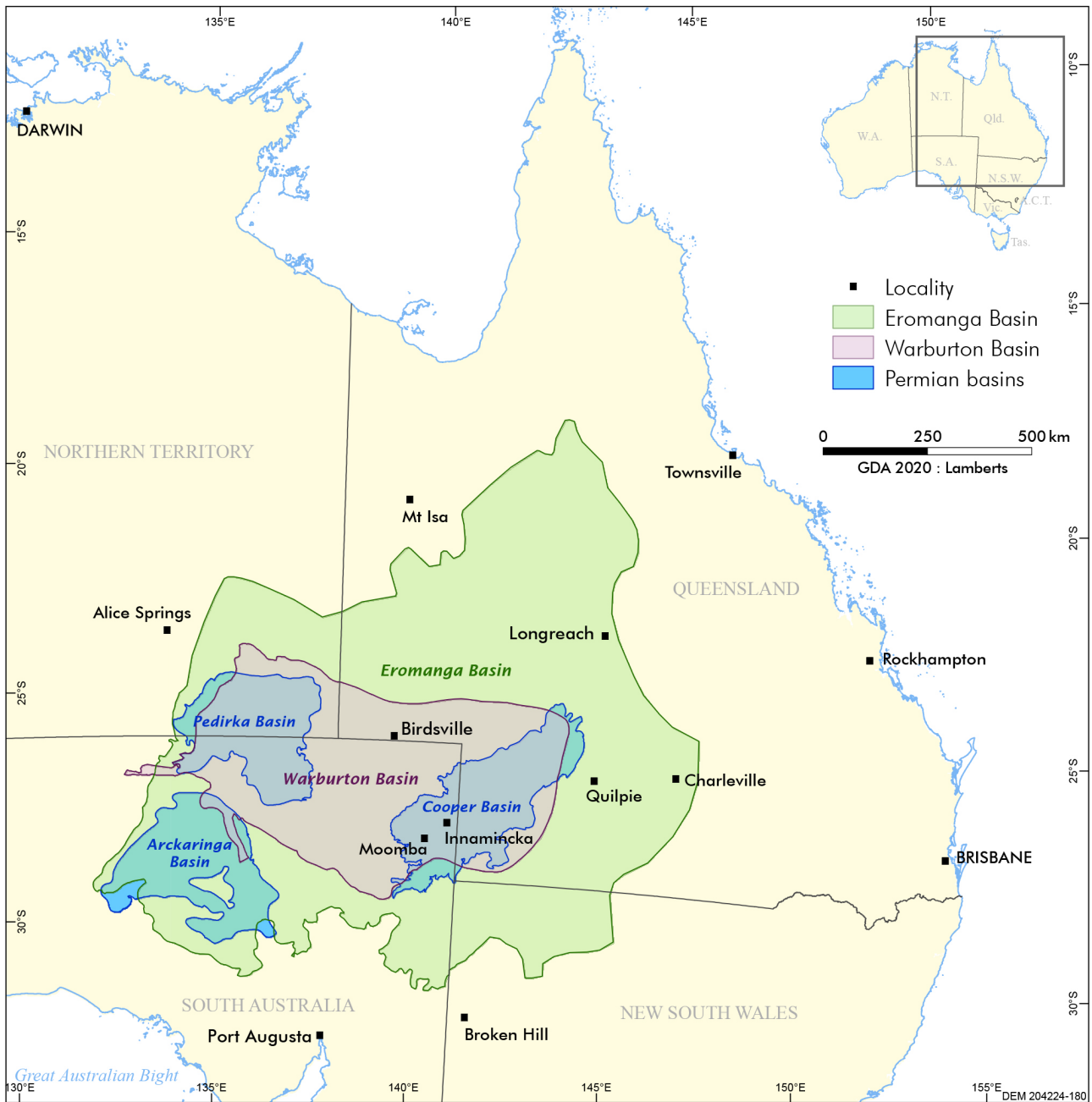


Figure 1. Location map and outlines of geological basins.

The Coorikiana Sandstone, typically a regressive shallow marine reservoir that can either free flow gas to surface or recover oil in both the open drillhole and post-drill production test, is typically compartmentalised via a network of polygonal faults. Fracture stimulation of these reservoirs has proven successful in maximising both rates and reserves.

This study is concentrated on the Coorikiana Sandstone play that exists in the South Australian portion of the Eromanga Basin in the Cooper Basin region (Fig. 2).

Note: This report quotes both metric and imperial measurements as some of the data shown were collected and reported prior to the mandatory reporting in the metric system in South Australia.

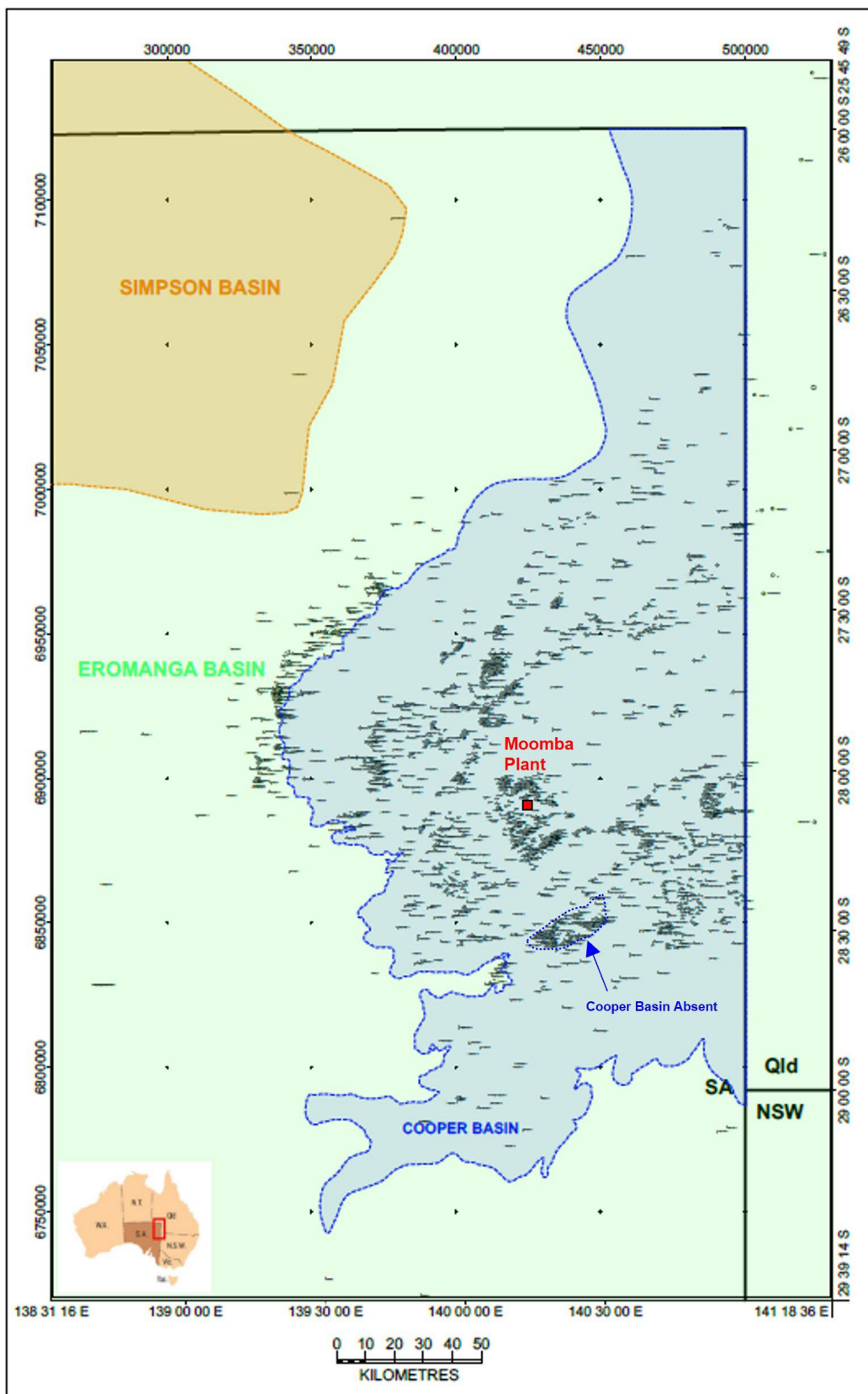


Figure 2. Coorikiana Sandstone play area of study, Cooper Basin region. The ‘Cooper Basin absent’ polygon is an area often referred to as the Murteree Horst.

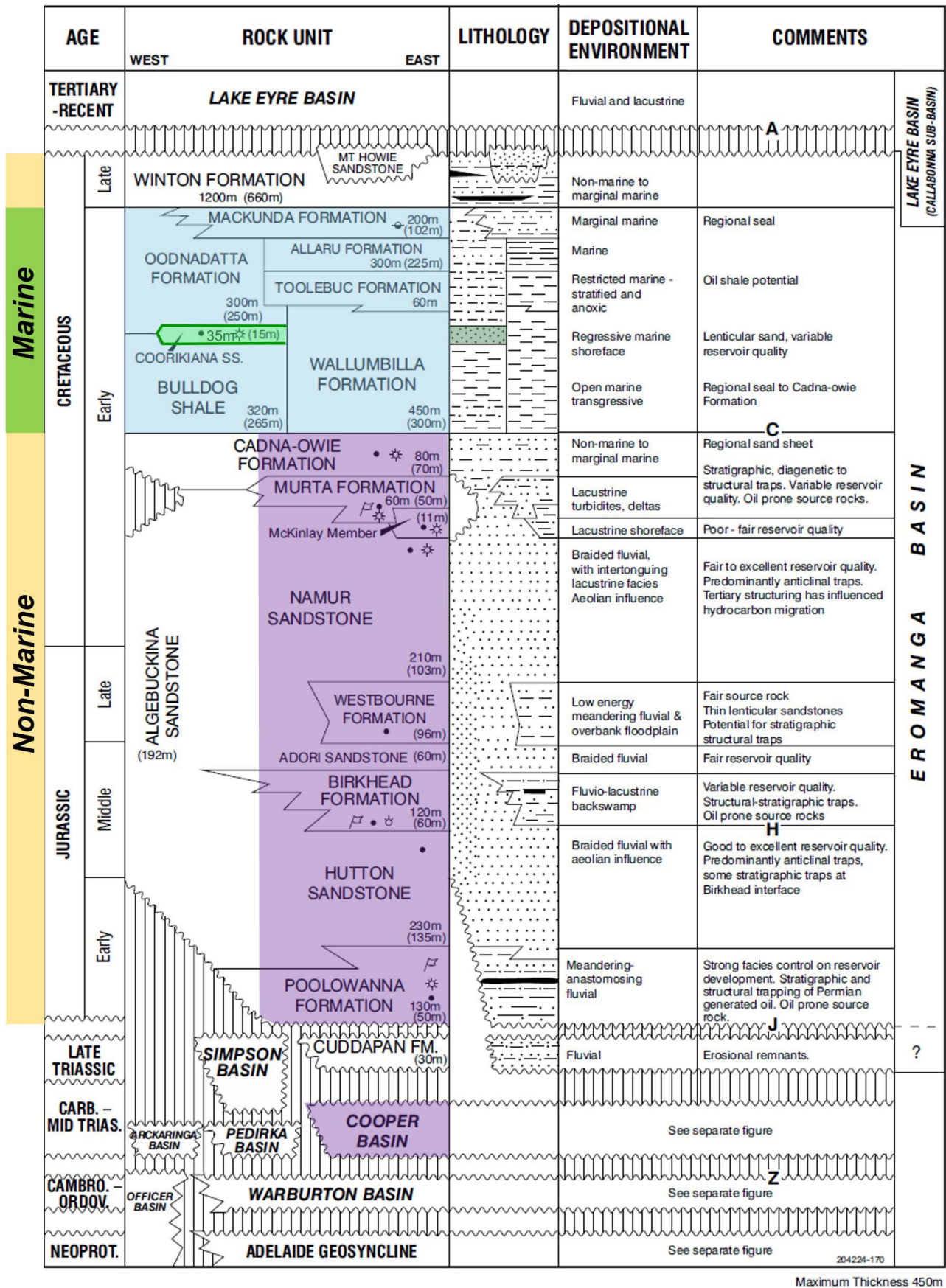
2. GEOLOGICAL SETTING

In South Australia, the Eromanga Basin overlies late Paleozoic and older basins. It consists of a broad downward basin with two main depocentres separated by the NE-trending Birdsville Track Ridge — the Cooper Basin region and the Poolowanna Trough — containing up to 3,000 m of sediment. The central Eromanga Basin is overlain by the Tertiary to Recent Lake Eyre Basin. Eromanga Basin units crop out extensively on the western and southern margins. Eromanga Basin stratigraphy can be divided into three sequences: lower non-marine, marine and upper non-marine (Fig. 3).

Along the southwestern margin of the Eromanga Basin, the Bulldog Shale is conformably overlain by Coorikiana Sandstone (Thomson, 1980; Moore and Pitt, 1982), formerly a member of the Oodnadatta Formation, with a type locality at Coorikiana Creek (Freytag, 1966; see Figs 3 and 4). From the southern margin, the formation extends northwards in the subsurface to the Cooper region where it attains an approximate thickness of 35 m. In this region Moore et al. (1986) mapped by gamma-ray log correlation a broad east-west-orientated zone extending at least 200 km through the Moomba area and into Queensland. The Coorikiana Sandstone passes laterally basinwards into marine shale of the Lower Oodnadatta Formation (Figs 4 and 5). Drillhole sections of Coorikiana Sandstone show an upward-coarsening profile with a sharp, conformable upper boundary and a gradational lower boundary. This entire section, shown in blue and green in Figure 3, is of marine origin. Figure 2 shows the area covered by this study.

The regressive shoreface deposits of the Coorikiana Sandstone mark a eustatic sea-level fall in the Eromanga Basin in middle Albian time (Morgan, 1980). The global sea-level curve of Haq et al. (1987) shows a rising trend during the Albian with several minor regressions, but it is not clear which, if any, of these corresponds with the Coorikiana Sandstone. Coorikiana Sandstone consists of fine to very fine-grained, silty, calcareous, glauconitic, feldspathic and lithic sandstone with minor conglomerate with dark grey siltstone and mudstone interbeds at the base (Moore et al., 1986). Coorikiana Sandstone is typically <20 m thick, consisting of poor to good reservoir quality with inter-beds of siltstones and calcareous cemented bands. Alexander et al. (2007) interpreted from the sedimentary structures and fossil assemblages paleo-environments typical of subtidal, supratidal, shoreface, beach and fluvial channel.

Figure 6 illustrates the key petroleum system events for the Cooper-Eromanga petroleum system. Of key importance to the Coorikiana Sandstone play is the period of polygonal fault development. The development of the polygonal fault system has functioned as conduits in the first instance for vertical migration of hydrocarbons and the subsequent lateral migration to neighbouring fault blocks.



Maximum Thickness 450m

Figure 3. Coorikiana Sandstone highlighted in green and underlying section containing oil and gas fields as potential hydrocarbon charge highlighted in purple.

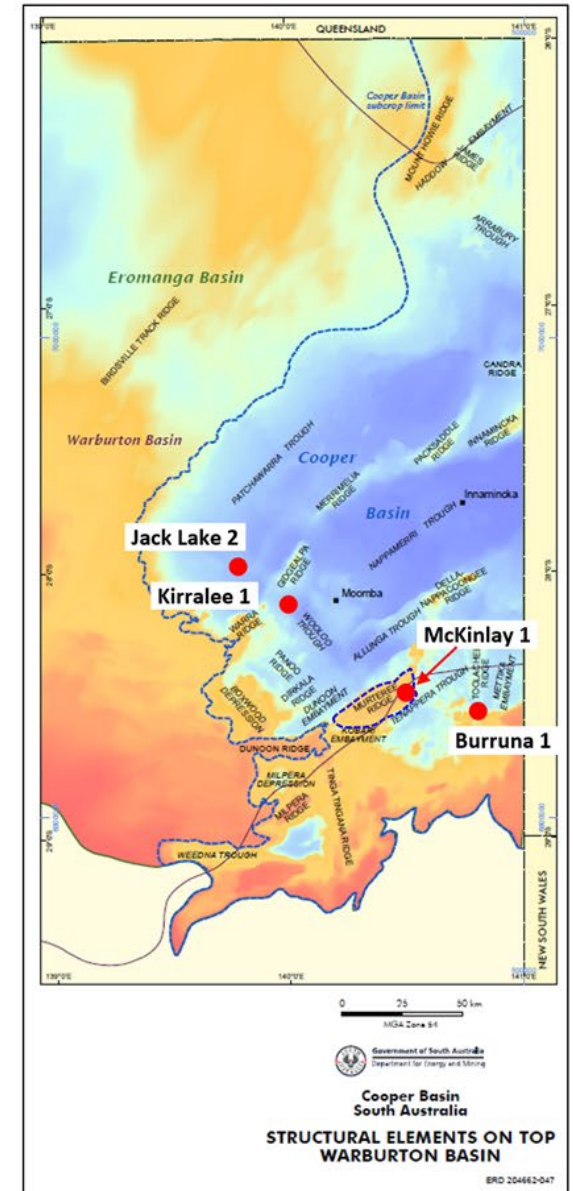
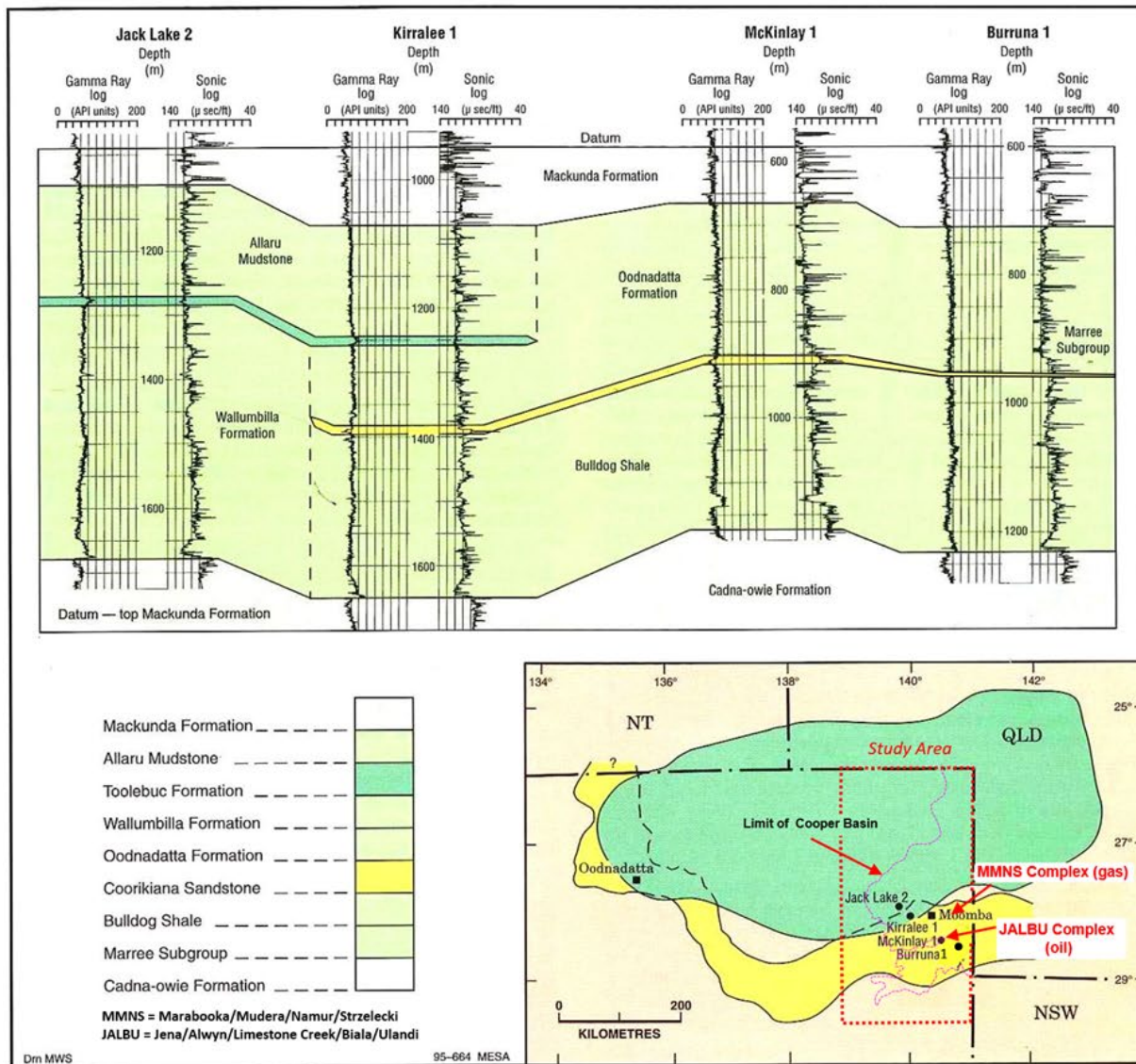


Figure 4. Distribution and wire-line log section of the Coorikiana Sandstone showing study area in red (modified after Krieg and Rogers, 1995).

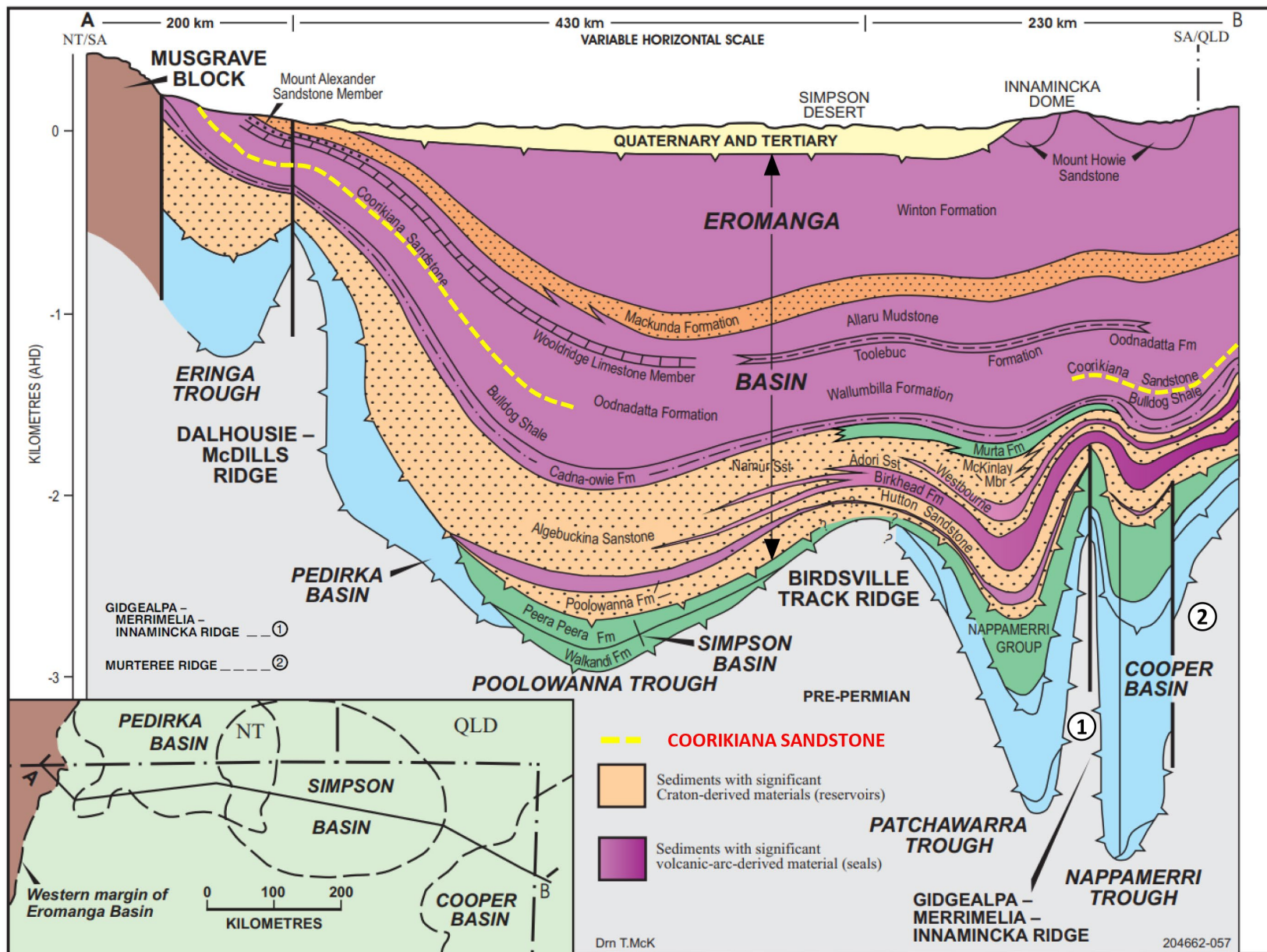


Figure 5. Cross-section through the Eromanga, Cooper, Pedirka and Simpson basins (modified after Alexander et al., 1995).

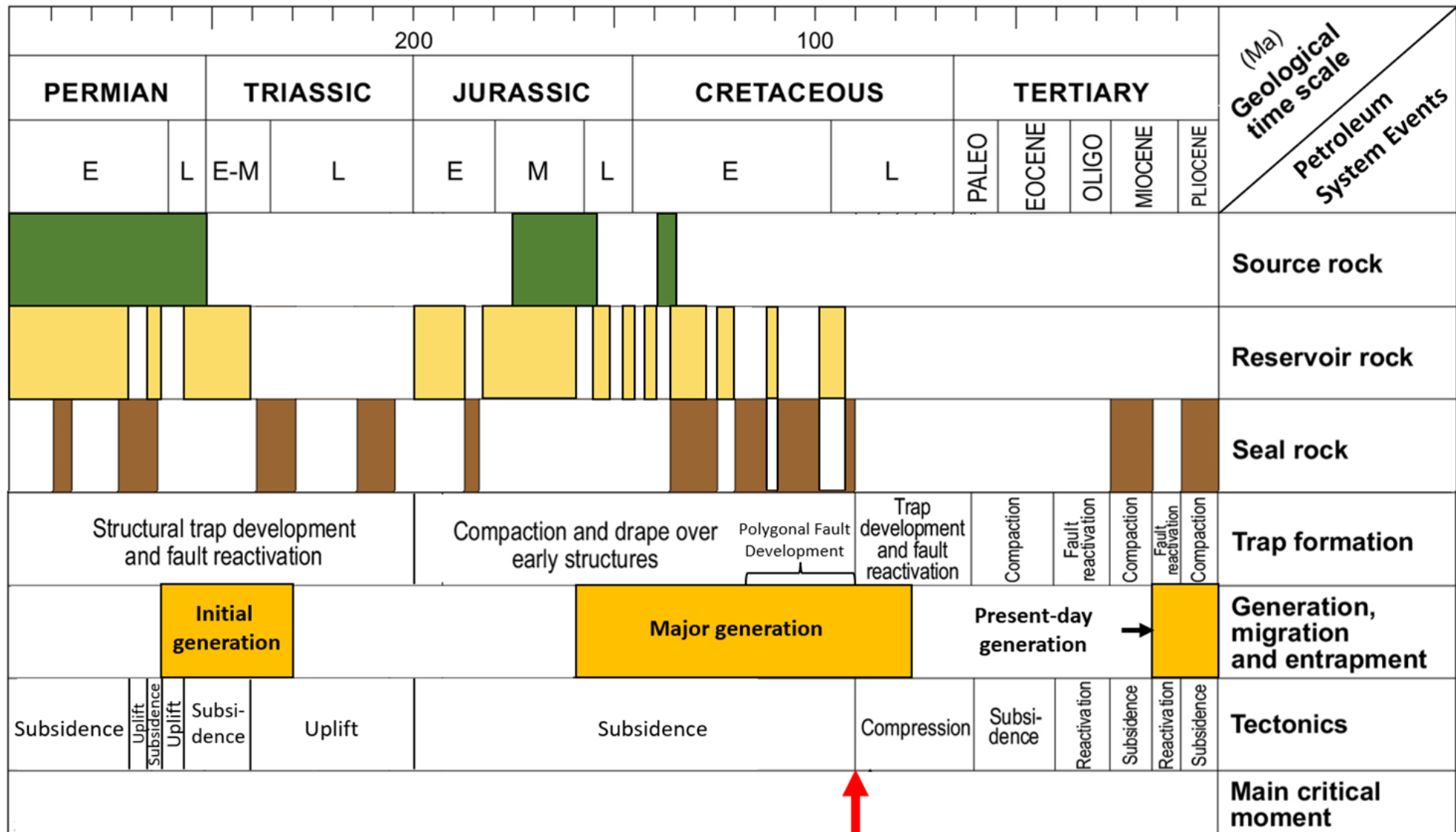


Figure 6. Key Petroleum Systems Events in the Cooper-Eromanga Basin (modified after Lowe-Young et al., 1997).

3. EXPLORATION HISTORY

Petroleum exploration commenced in the 1950s when licences covering the Cooper and Eromanga basins were first acquired by Santos, which went against conventional wisdom that commercial accumulations of oil would not be found in Mesozoic formations within the Great Artesian Basin.

Initial exploration involved surface mapping, stratigraphic drilling, aerial surveys, gravity, and aeromagnetic surveys and seismic. The first petroleum well was drilled in 1959 and Cooper Basin gas was discovered in 1963.

The first commercial hydrocarbon to flow from the Eromanga Basin was gas produced from Namur 1 in 1976 in the Cooper region. Oil was discovered in 1977 in the Poolowanna Trough with uneconomic flows of oil from basal Jurassic and Triassic sediments in Poolowanna 1. The first economic oil flow was recorded from Strzelecki 3 in the Cooper region in the following year, and this stimulated a major oil exploration program.

Since 1959 over 2000 wells have penetrated the Eromanga Basin sequence and over 100,000 km of seismic has been acquired. Exploration has concentrated in the Cooper region. A new phase of exploration for oil in the Eromanga Basin commenced in 2002 in the 27 new licences resulting from the expiry of PELs 5 and 6 in 1999. Most new entrant explorers have targeted Eromanga Basin oil plays, primarily utilising 3D seismic data to identify potential drilling opportunities, which has led to significant oil discoveries on the Western Flank of the Cooper Region in particular.

The Coorikiana Sandstone had until recently been considered as part of the overburden section, considered as a nuisance section to be drilled as fast and inexpensively as possible to arrive at the deeper oil and gas targets. Historically, in the early exploration phase of the Cooper Basin, the overlying Eromanga Basin section was interpreted to have been 'flushed', leaving only 'residual' hydrocarbons due to the significant and geologically active aquifers of the Great Artesian Basin. Often, hydrocarbon signs were either ignored or discarded as immaterial.

The discovery of economic oil in the Jurassic sequence of the Eromanga Basin in 1978 focussed more attention on the younger sedimentary section (Aptian to Cenomanian), although the Coorikiana Sandstone had been scantily addressed. In the 1980s, intersection of gas or gas/oil shows across the Coorikiana Sandstone were tested in the open hole with a drill stem test (DST) resulting in mixed results. The first Coorikiana Sandstone oil DST was undertaken in Corkwood 1 in 1981, the zone not flowing to surface but recovering mud with a trace of oil. The next successful DST across a potential oil zone, undertaken in Jena 5 in 1989 similarly did not flow to surface, recovering only 30 ft of oil, together with mud and water. These two results did not encourage explorers to pursue this reservoir unit for oil. Strzelecki 4, an oil exploration well drilled in 1981, encountered a significant gas show across the Coorikiana Sandstone (referred to as the Toolebuc Member at the time). One open hole DST was conducted resulting in gas to surface (GTS) at a rate too small to measure. Significant gas shows in Marabooka 3 across the Coorikiana Sandstone were tested successfully in the open hole DST in 1984, resulting in GTS at a rate of 0.65 MMscf/d. However, in the nearby Mudera Field, Mudera 2, also in 1984, tested the Coorikiana Sandstone via two open hole DSTs resulting in GTS at a very low rate of 0.05 to 0.09 MMscf/d. Although encouraging, these gas rates indicated a low permeability reservoir and hence this zone wasn't of economic interest at the time.

It was not until the late 1990s and early 2000s that the Coorikiana Sandstone was produced, with first gas in Mudera 6 in 1998 and first oil in Ulandi 12 in 2003. Nevertheless, it took a further 8 years and following acquisition of 3D seismic (Greater Strzelecki 3D survey) for the first dedicated gas drill program across the Mudera-Marabooka fields in 2006 and a further 17 years for the first dedicated oil drill program across the Jena-Alwyn-Limestone Creek-Biala-Ulandi (JALBU) fields in 2020. Appendix 1 captures significant events for the Coorikiana Sandstone for the South Australian sector.

Well and production data in the South Australian sector are available on the Department for Energy and Mining Petroleum Exploration and Production System at [PEPS - Home](#).

4. COORIKIANA SANDSTONE PLAY

The Coorikiana Sandstone play exists in the Eromanga Basin, Cooper Basin region area of study, proven by both oil and gas production from several discovered hydrocarbon pools in South Australia.

4.1. STRATIGRAPHY

As previously discussed, the Coorikiana Sandstone section is of early Cretaceous age, conformably overlain by the Oodnadatta Formation and conformably underlain by the Bulldog Shale (shaded in blue in Fig. 7). This section is entirely of marine origin, with the Coorikiana Sandstone obtaining a maximum thickness of 35 m (115 ft) in the South Australia portion of the study area but generally being around 20 m (66 ft) in thickness (shaded in green in Fig. 7). This interval consists of fine grained, glauconite-rich, feldspathic and lithic sands of poor to good reservoir quality with interbeds of siltstones. Calcareous cemented bands are common.

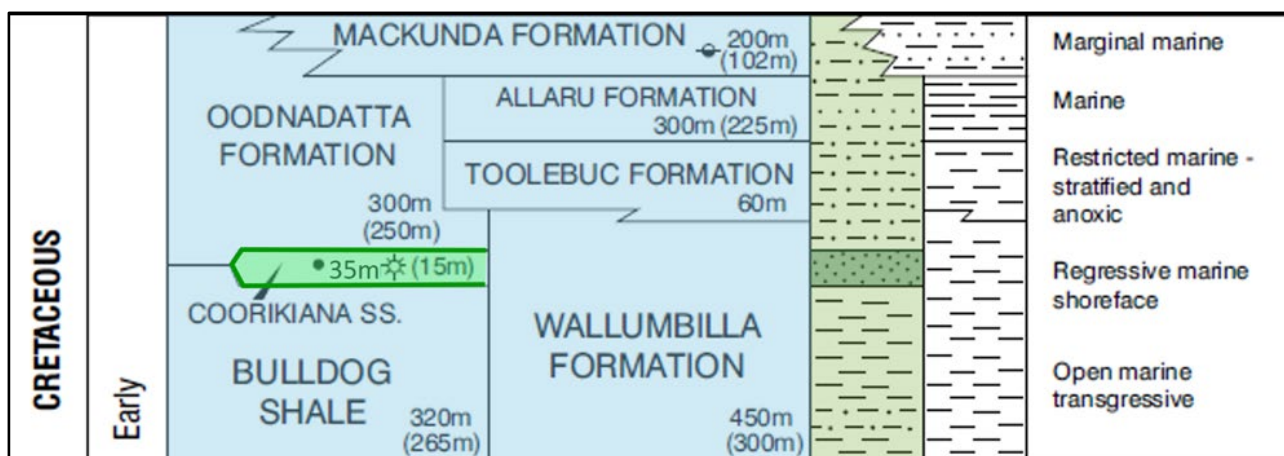


Figure 7. Coorikiana Sandstone highlighted in green and marine shales of the Oodnadatta Formation and Bulldog Shale in blue.

4.2. PALEOGEOGRAPHY

The depositional setting for the Coorikiana Sandstone is that of a partial marine regression marking a eustatic sea level fall in the Eromanga Basin during the Albian (early Cretaceous), approximately 105 Ma. At geological time ~105 Ma (Bulldog Shale, Fig. 8a and b), deposition of the Coorikiana Sandstone in a shoreface to shelf environment occurred because of continued regression during deposition of the Bulldog Shale. Fluctuations in sea levels has resulted in transgressive-regressive depositional pattern across a major part of the study area with the thicker lower section (the regressive section) followed by a thinner upper section (the transgressive section) as worldwide sea level again rose rapidly in the late Albian, with deposition of the Oodnadatta Formation marine shales and mudstones.

Coorikiana Sandstone (Fig. 4) is exposed discontinuously between South Australia and Northern Territory border and the Marree area and near the northern margin of the Flinders Ranges. From southern margin this reservoir extends northward in the subsurface where it passes laterally basinwards into marine shales of the upper Bulldog Shale/Wallumbilla Formation or Oodnadatta Formation (Fig. 3). On the southwestern margin of the basin, conglomerate layers interfinger with shoreface sands. Sibbons (2005), suggests that the overall distribution of Coorikiana Sandstone resembles that of a sand body prograding into a body of water (Fig. 8c). Moore et al. (1986) recognised that the deposit of the Coorikiana Sandstone maybe associated with uplift in the sediment source region in addition to a fall in relative sea level.

Figure 8d shows the location of two successful Coorikiana Sandstone plays in the basin, one oil, Jena-Alwyn-Limestone Creek-Biala-Ulandi (JALBU) and one gas, Namur-Marabooka-Mudera-Strzelecki (NMMS). These successes are described in detail within the following sections.

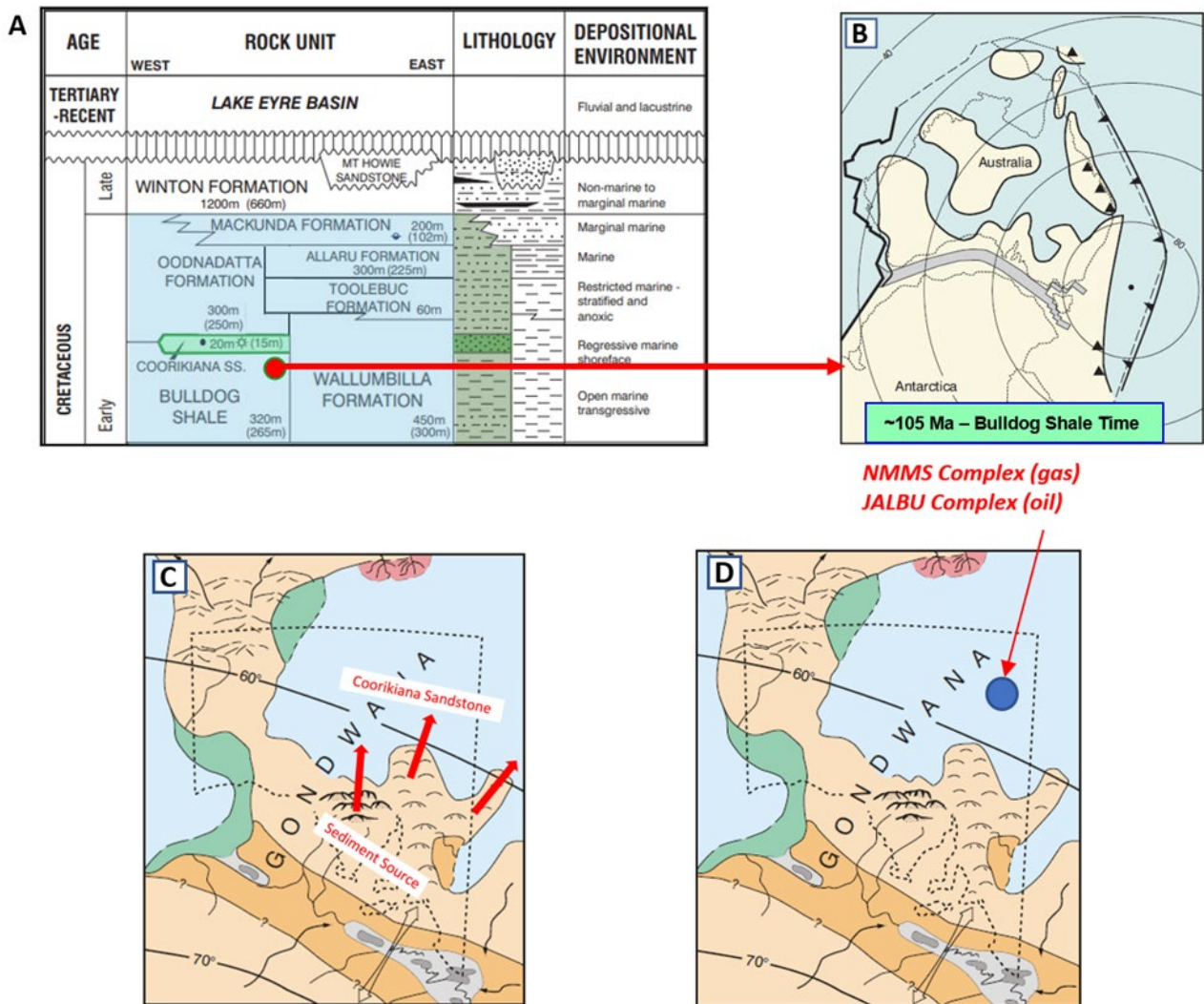


Figure 8. Paleogeographic setting for onset of Coorikiana Sandstone deposition. (a) Stratigraphy. (b) Onset of Coorikiana Sandstone deposition (after Veevers et al., 1991; Baillie et al., 1994). (c) Direction of the prograding sand bodies (after BMR Palaeogeographic Group, 1992; Frakes et al 1987; Veevers, 1984). (d) Location of Coorikiana Sandstone play oil and gas success, Namur-Marabooka-Mudera-Strzelecki (NMMS) and Jena-Alwyn-Limestone Creek-Biala-Ulandi (JALBU) (after BMR Palaeogeographic Group, 1992; Frakes et al 1987; Veevers, 1984).

4.3. TRAP/SEAL

Polygonal faulting is a key feature associated with the Coorikiana Sandstone play. These polygonal faults set up the trap that often can compartmentalise the reservoirs, which is the case in both the Coorikiana oil and gas discoveries made to date in the Eromanga Basin (Fig. 9).

Mapping these faults can be problematic and time consuming but the advent of 3D seismic acquisition in the study area has made inroads into obtaining good quality two-way-time and depth maps. This allows for more optimal drill locations to be identified for both exploration tests and appraisal/development for hydrocarbon production.

The polygonal fault patterns resulting from a combination of dewatering, compaction, and Tertiary age faulting are a series of randomly orientated extensional faults. In plan view they have the appearance of mud cracks (Fig. 10). The top Coorikiana Sandstone depth map (Fig. 11) across part of the Jena-Alwyn-Limestone Creek-Biala-Ulandi (JALBU) complex on the Nappacoongee-Murteree Horst, where oil has been discovered and produced from the Coorikiana, shows this typical polygonal type of fault pattern leaving a series of small irregular fault blocks.

Transgressive – regressive marine shoreface

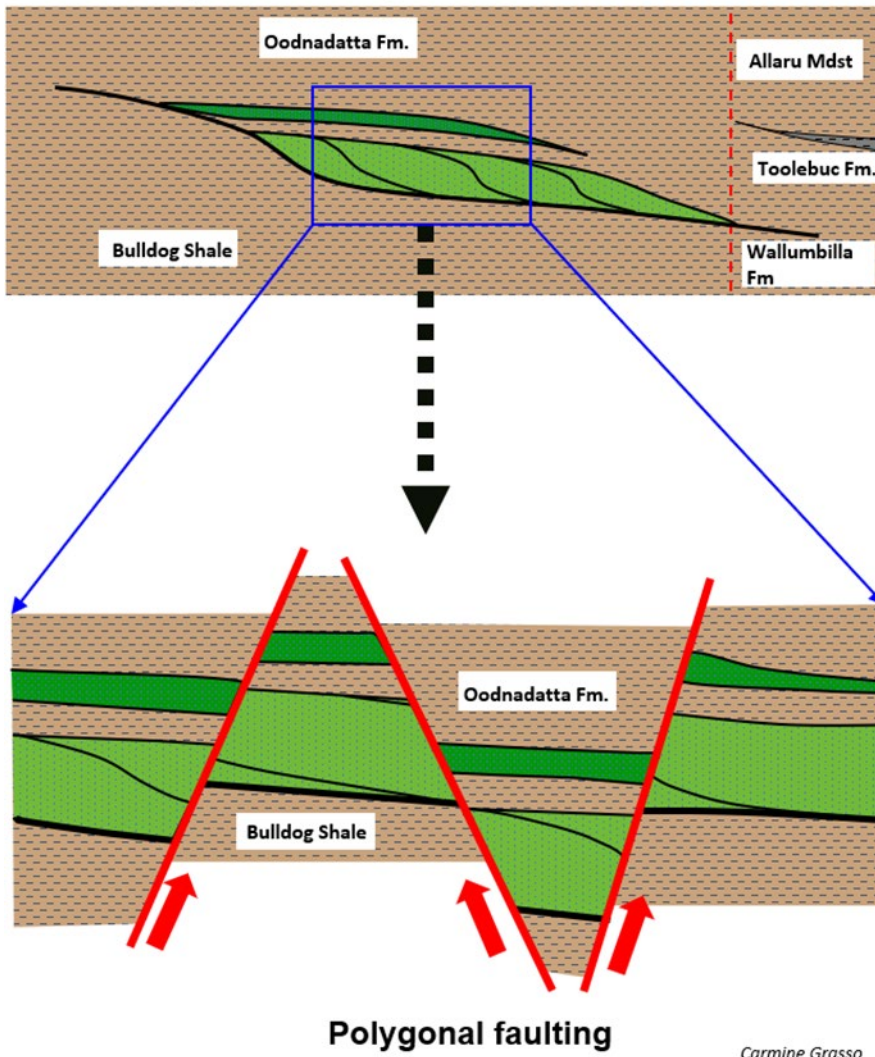


Figure 9. Schematic of polygonal faulting resulting from dewatering, compaction and Tertiary age faulting.



Figure 10. Mud cracks have a similar appearance to polygonal faulting in plan view (although these form under a different mechanism to the Coorikiana fault patterns).

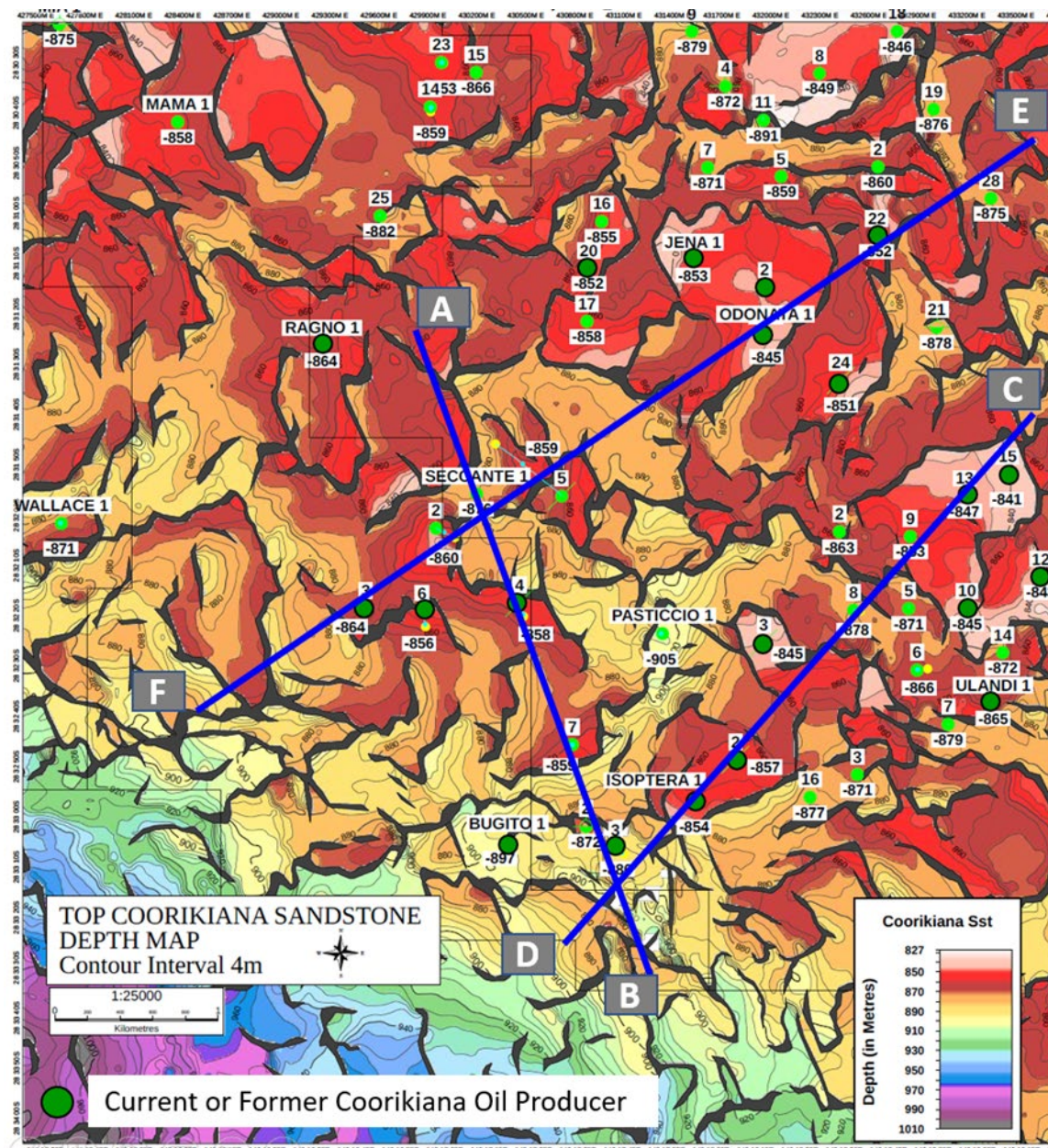


Figure 11. Top Coorikiana depth map over the JALBU Complex. Blue lines show locations of seismic traverses shown in Figures 12 and 13. Santos Seccante 7 Well Completion Report, July 2020.

The seismic traverses in Figures 12 and 13 from the 2006 Bugito-Kobari 3D seismic survey show that some faults extend through the Coorikiana down into the underlying Murta Formation and McKinlay Member/Namur Sandstone section. It is these deeper extensions into underlying hydrocarbon pools that are pivotal in allowing hydrocarbon charge into the Coorikiana Sandstone reservoirs.

Figure 14 shows the amount of 2D and 3D seismic that has been acquired that covers the Coorikiana Sandstone play within the study area. More importantly a majority of the deeper sub-Coorikiana Sandstone hydrocarbon pools are covered by 3D seismic surveys.

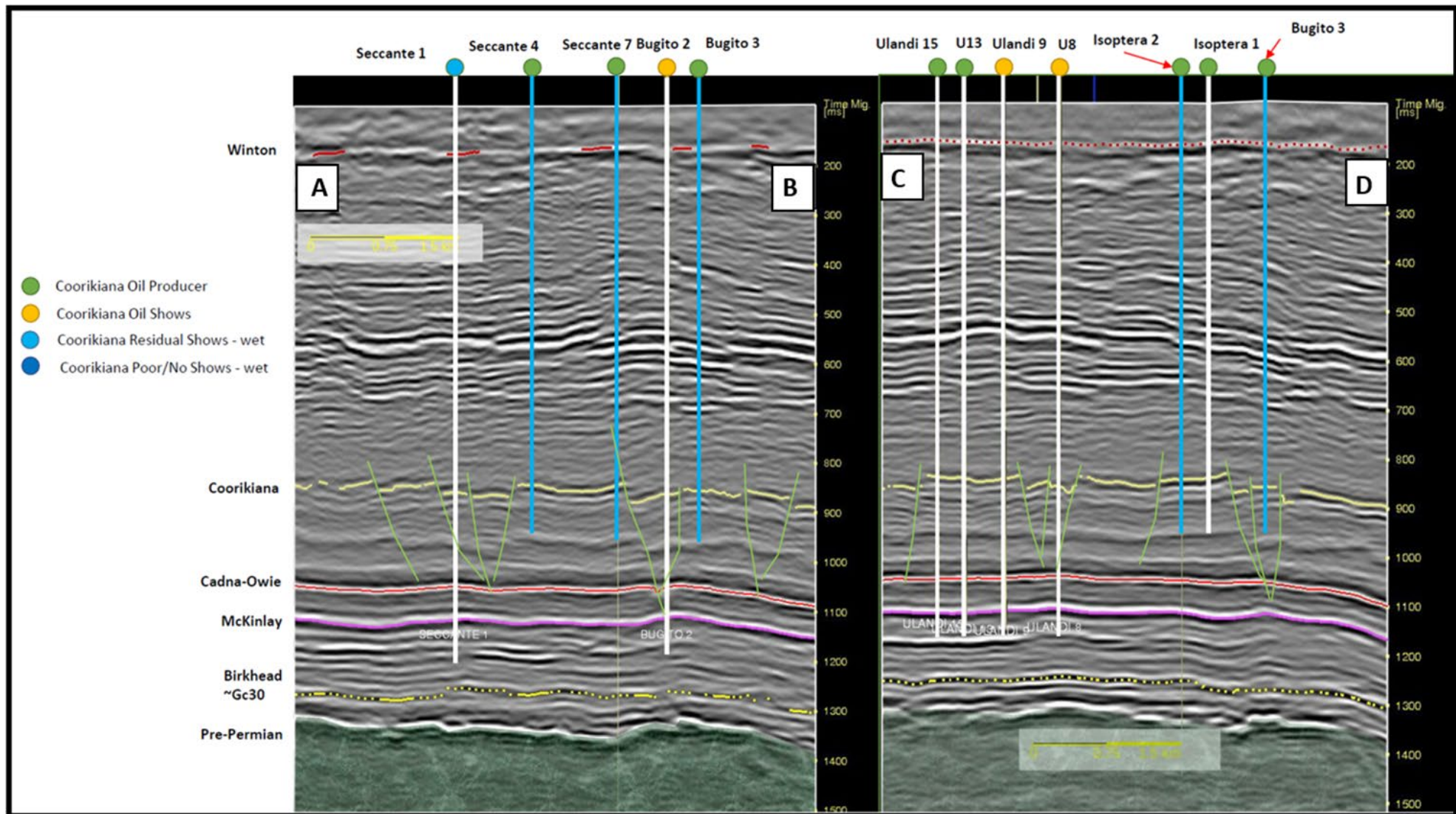


Figure 12. Seismic traverses in the JALBU Complex. See Figure 11 for traverse location. Santos Seccante 7 Well Completion Report, July 2020.

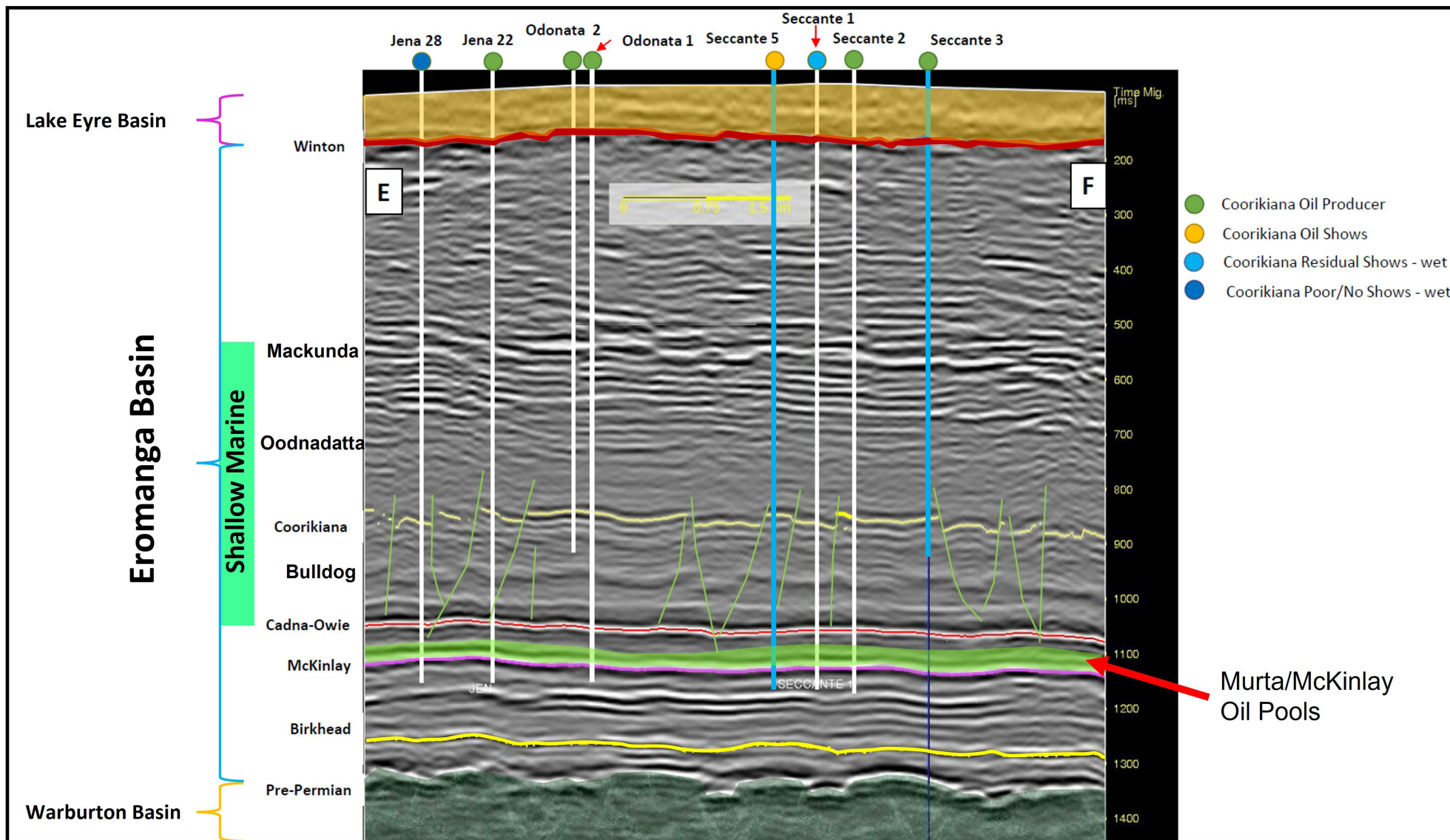


Figure 13. Seismic traverse in the JALBU Complex. See Figure 11 for traverse location. Santos Seccante 3 Well Completion Report, July 2020.

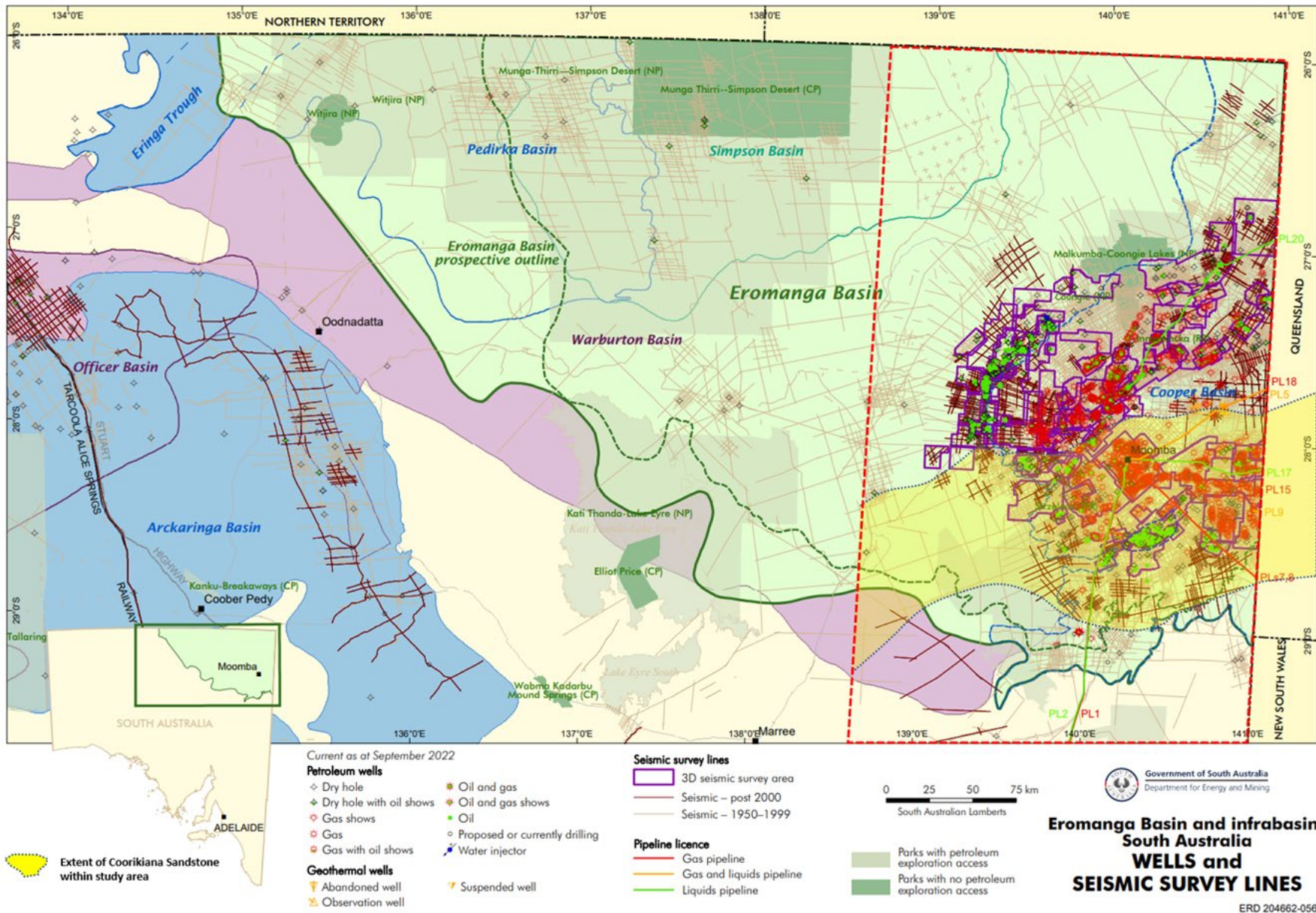


Figure 14. Seismic coverage across the Coorikiana Sandstone play within red outlined study area (as of September 2022).

4.4. RESERVOIR

The Coorikiana Sandstone is a fine to very fine-grained, glauconite-rich, calcareous, feldspathic and lithic sandstone with minor siltstone and calcite interbeds. Within the sand fairway the reservoir is ubiquitous (Fig. 15), although it may be absent in well-bores due to faulting. Within the study area it is predominantly up to ~21 m (69 ft) gross thickness generally consisting of 2 main reservoir cycles with the lower one more prominent, but toward the SA/QLD border thickness increases to ~35 m (115 ft) consisting of up to 4 reservoir cycles (Figs 16 and 17). It typically displays more elevated gamma-ray response due to its silty nature and it gives a characteristic low resistivity response on wireline logs due to its complex mineralogy. The Coorikiana Sandstone in Odonata 1, the first dedicated Coorikiana Sandstone oil exploration well in the Eromanga Basin, is the reference section for this unit across the study area (Fig. 18).

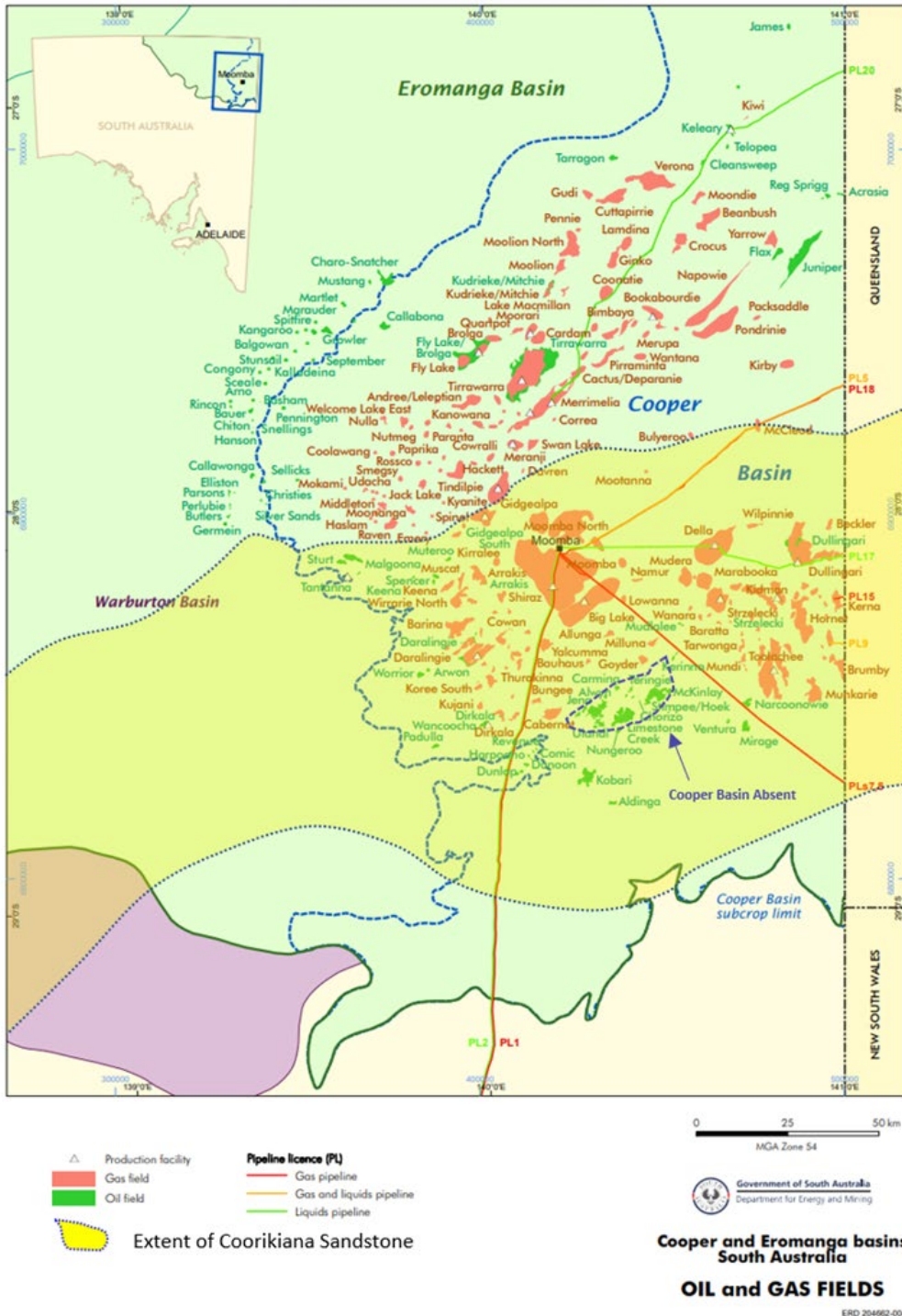


Figure 15. Distribution of Coorikiana Sandstone facies within the study area.

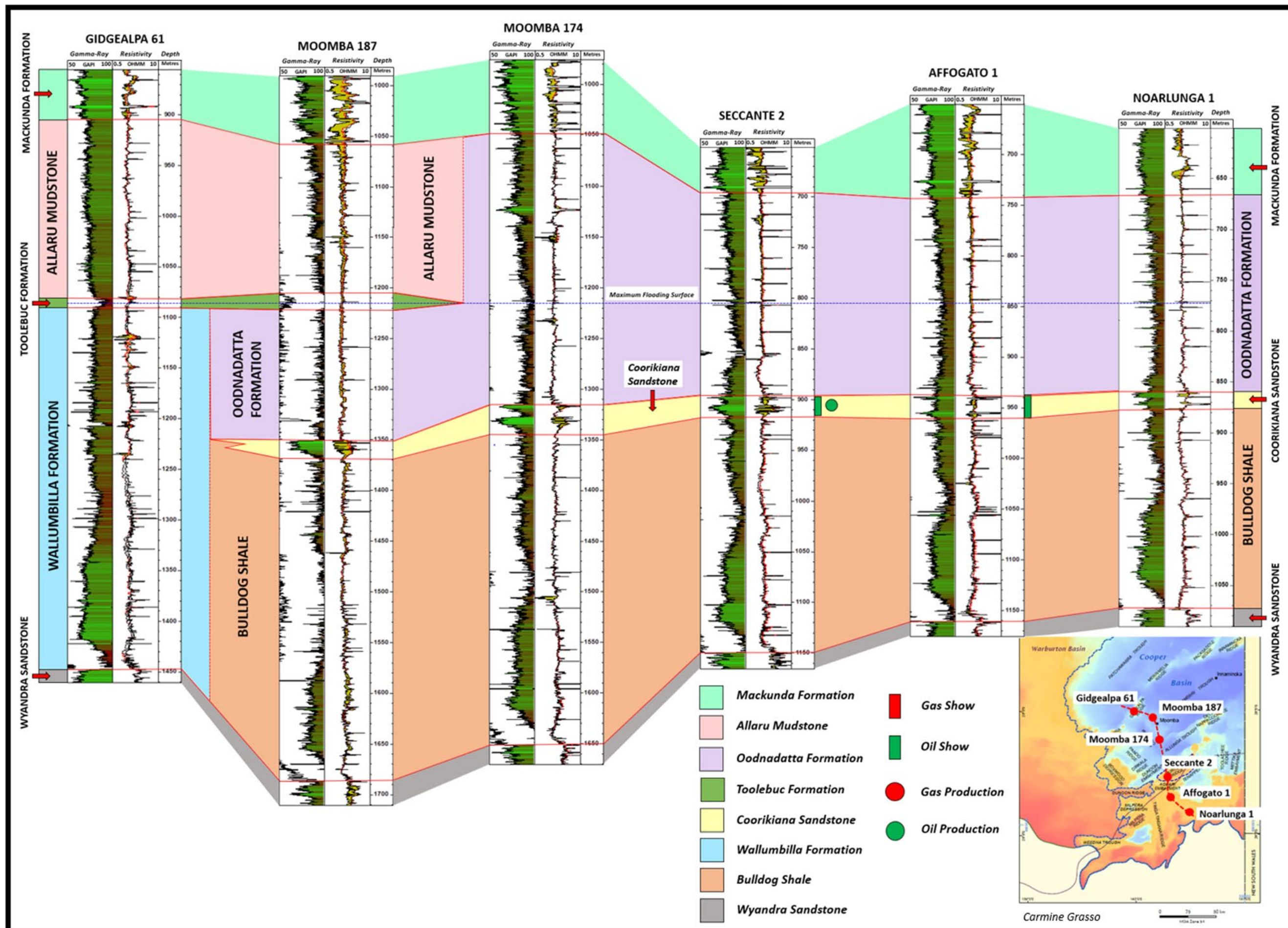


Figure 16. A north to south stratigraphic correlation showing the Coorikiana Sandstone and surrounding stratigraphic units, datumed on the Toolebuc Formation maximum flooding surface.

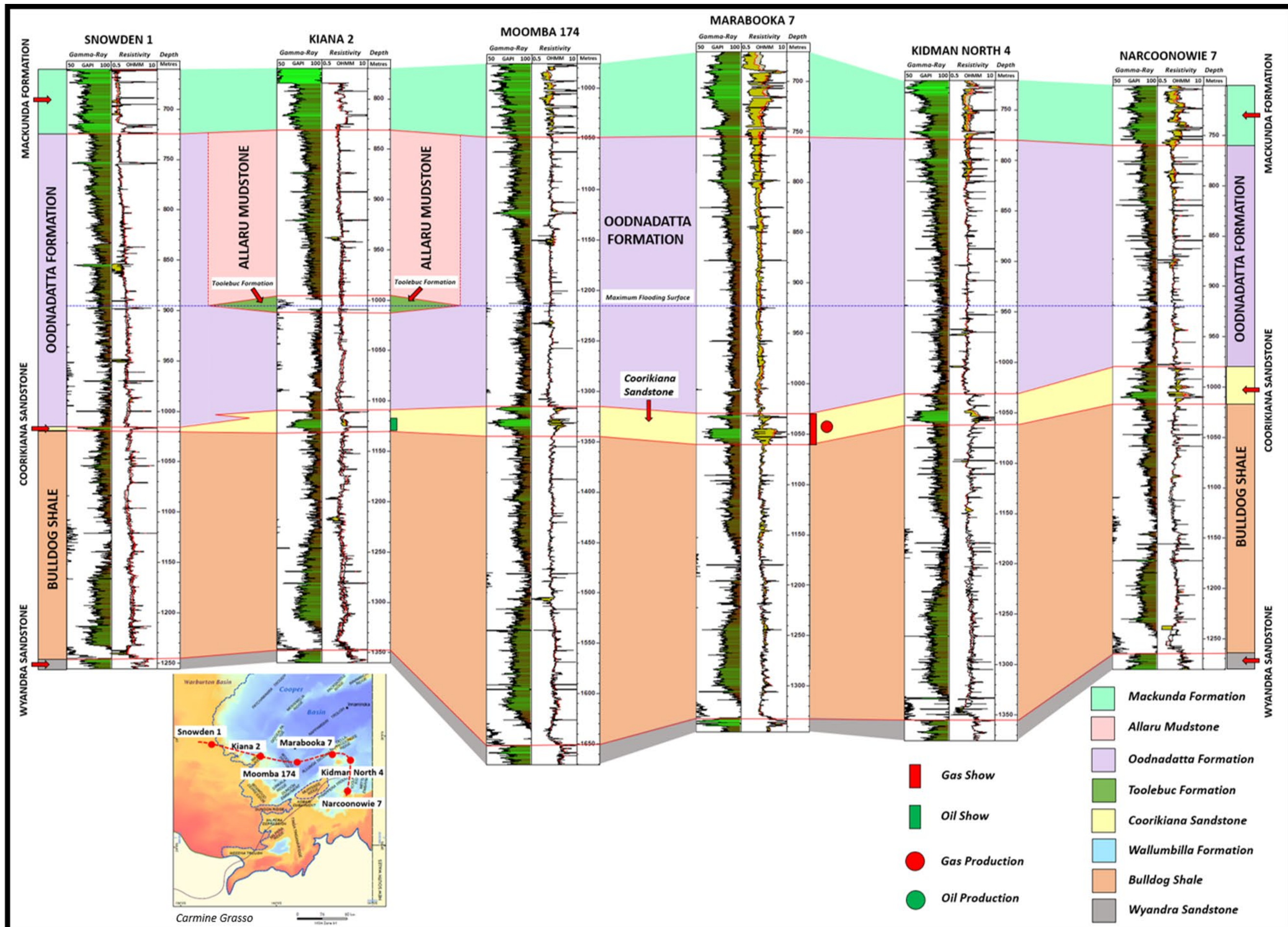
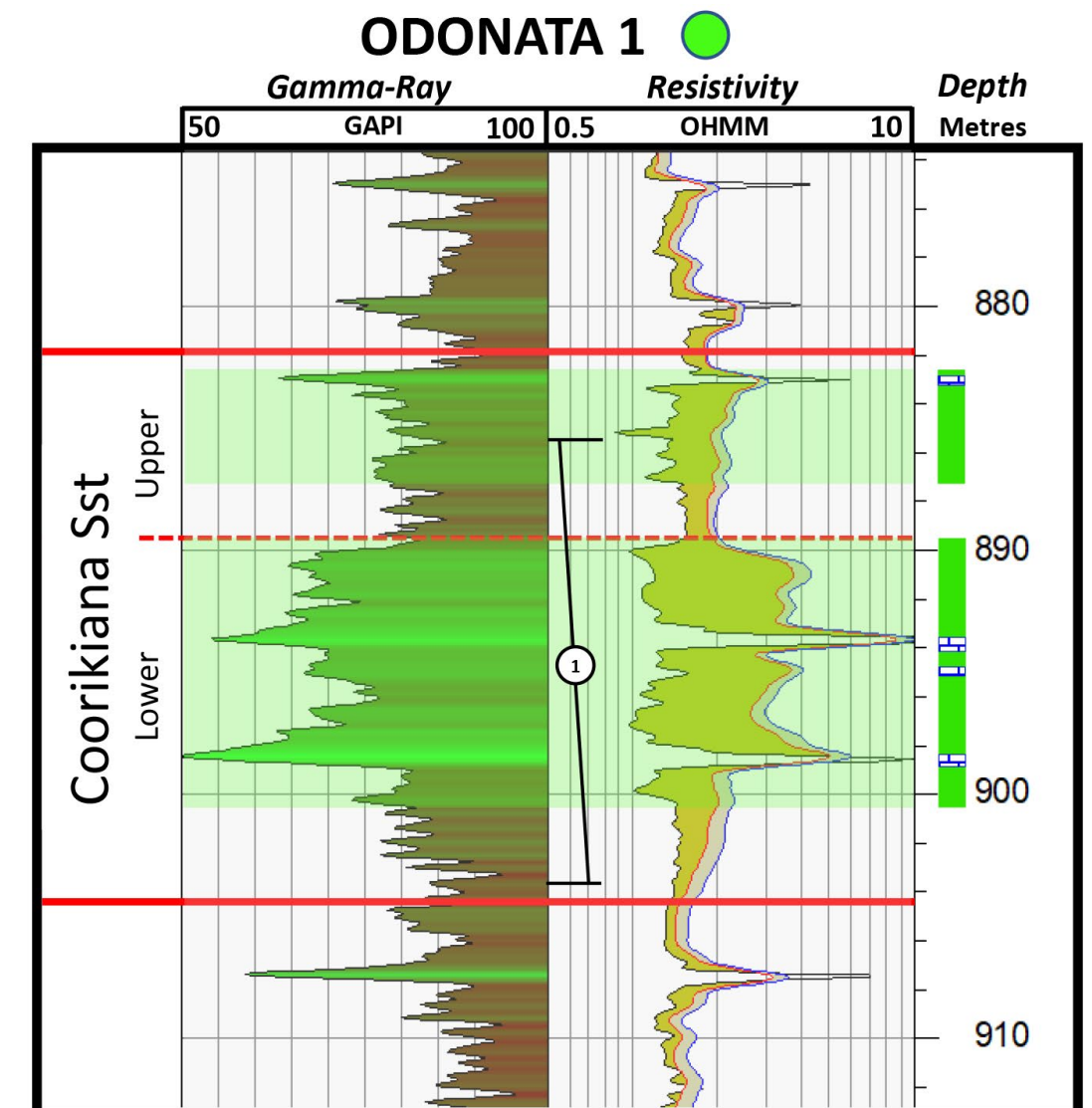
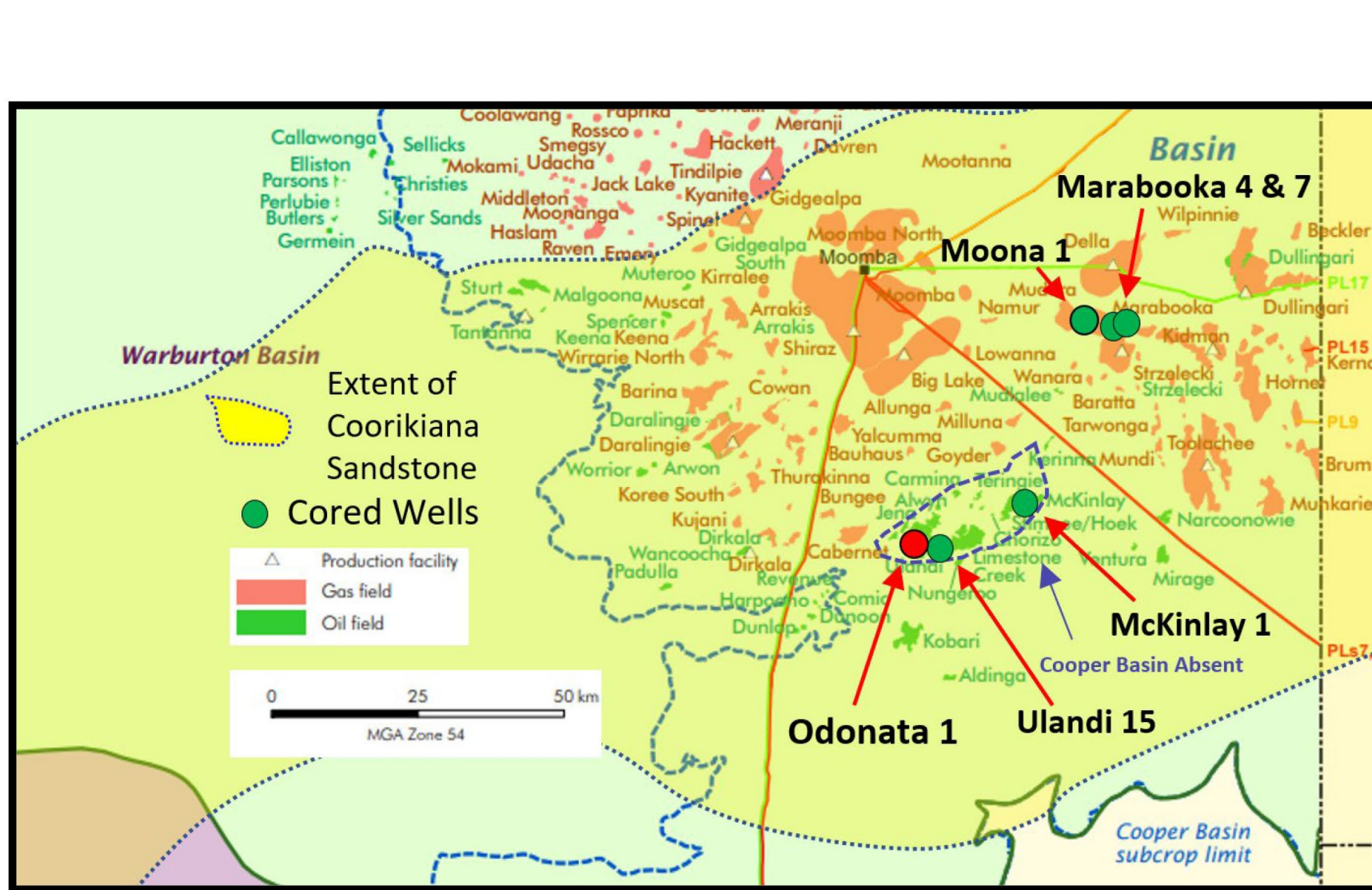


Figure 17. A west east stratigraphic correlation showing the Coorikiana Sandstone and surrounding stratigraphic units, datumed on the Toolebuc Formation maximum flooding surface.



DST # 1: NFTS. Recovery; 13 Bbls Oil, 1 Bbl Muddy Oil, 2 Bbls Muddy Water

Carmine Grasso

Figure 18. Coorikiana Sandstone wire-line log response in Odonata 1 and location of cored wells.

4.4.1. Lithology

The Coorikiana Sandstone from mudlog cuttings, can be very difficult to distinguish from the overlying Oodnadatta Formation and the underlying Bulldog Shale due to its high silt content and the fine-grained nature of the sand. This is primarily due to very minor lithology variations over the Coorikiana Sandstone as sandstone and siltstone percentages are approximately 50%. In some instances, in the absence of oil shows, the sandstone is very difficult to differentiate from the siltstone due to the very fine to fine grain size making the two virtually indistinguishable except under binocular microscope.

The most productive interval in the Coorikiana Sandstone identified on wireline logs occurs when sand percentage increases by 10 to 20%. The formation named as the Coorikiana Sandstone is not purely a sandstone in mineralogy. The main framework minerals and their corresponding percentage ranges are listed as: Quartz 20–80%, Glauconite 5–25%, Plagioclase 1–5% (only recognised in scanning electron microscope, SEM), Pyrite 1–5%, Lithics 1–10% (Santos Ulandi 15 Well Completion Report, 2007). This results in a challenging zone for petrophysicists to interpret.

4.4.2. Core

Within the area of study, only 5 wells have had full hole cores attempted and cut across sections of the Coorikiana Sandstone: McKinlay 1, Marabooka 4 and 7, Moona 1 and Ulandi 15 (Fig. 18).

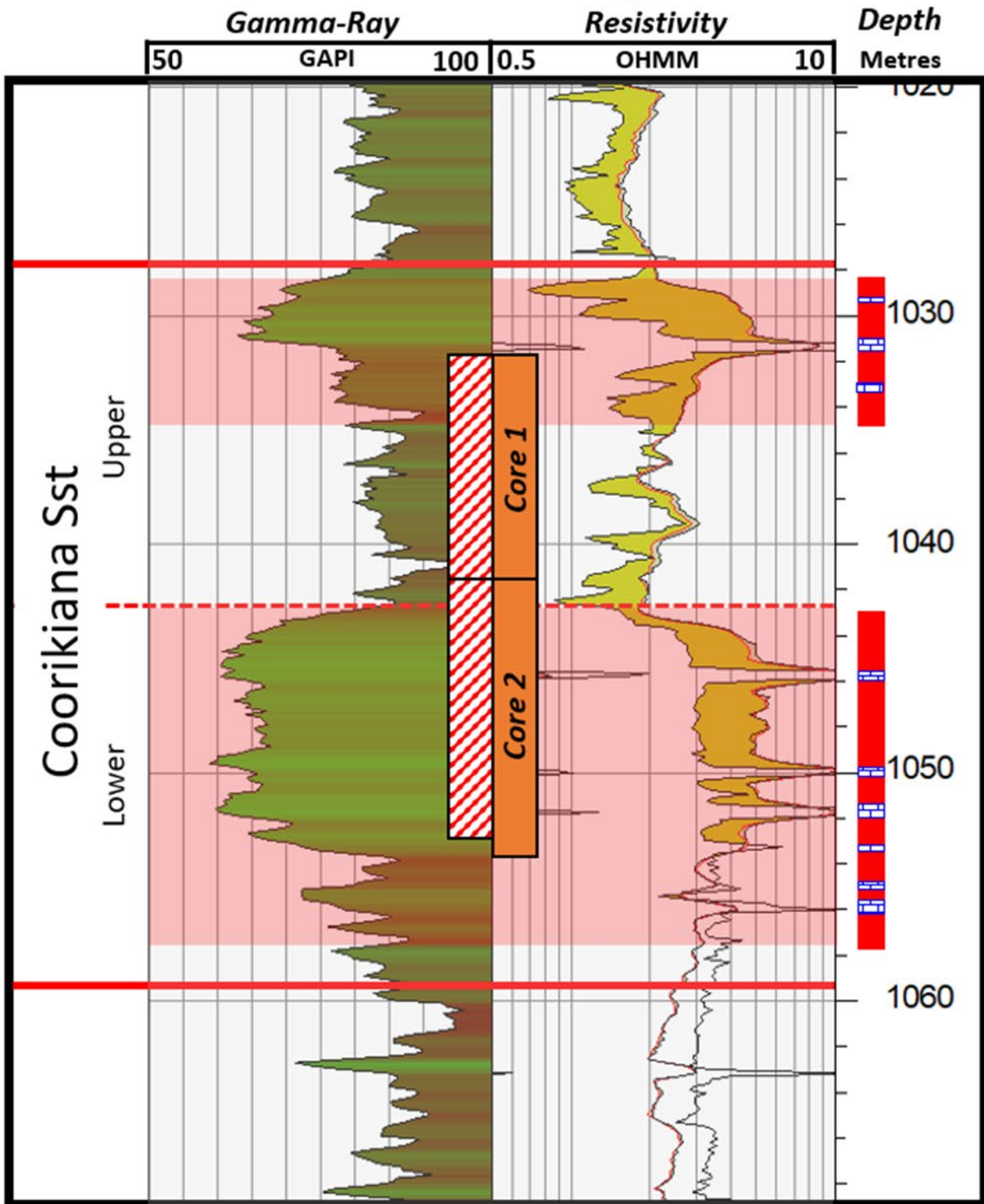
In McKinlay 1, an oil exploration well drilled in 1981, the first successful full hole core was cut across the uppermost, thinnest reservoir section in the Coorikiana Sandstone (originally mis-correlated as Toolebuc Formation). The oil show encountered is significant as it was possibly from the shallowest known depth of the formation at that time.

Marabooka 4, a gas development well in 1986, the first full hole core was attempted across the entire Coorikiana Sandstone. Although only 9 ft 10 in of 30 ft 11 in cut (32%) was recovered across the upper cycle in core 1, the second core (core 2) contained 19 ft 10 in of core 1's missing core together with an additional 38.5 ft of 40 ft 11 in, giving a total core 1 plus core 2 recovery of 95%. Importantly, core 2 was across the lowermost, thickest reservoir section in the Coorikiana Sandstone. Figure 19 shows the section cored in Marabooka 4 and Figure 20 shows that five attempts were made to DST this section in the open hole. From the Santos Marabooka 4 well completion report (1986): lithology descriptions and core analysis results of core 1 and 2 are shown in Appendix 2; and Appendix 3 contains core photos for both cores 1 and 2.

Please note the depth discrepancy between core description/photographs and Composite Log.

Several drill stem tests (DSTs) were attempted across the Coorikiana Sandstone interval. However, the highly faulted Winton Formation to Cadna-Owie Formation section (see Fig. 13 for an example of the level of faulting present) leads to numerous packer seat failures due to poor bore-hole conditions and hence failed DSTs. Another important consideration that has been well documented in the Cooper-Eromanga Basins is that the mechanical process of cutting a full hole core across low permeability sandstones will generally lead to near well-bore damage. This results in poor gas or oil flow rates during testing in either the open or cased hole.

MARABOOKA 4



 **Full Hole Core Cut**
 **Gas Zone**
 **Cemented (Calcified) Zone**

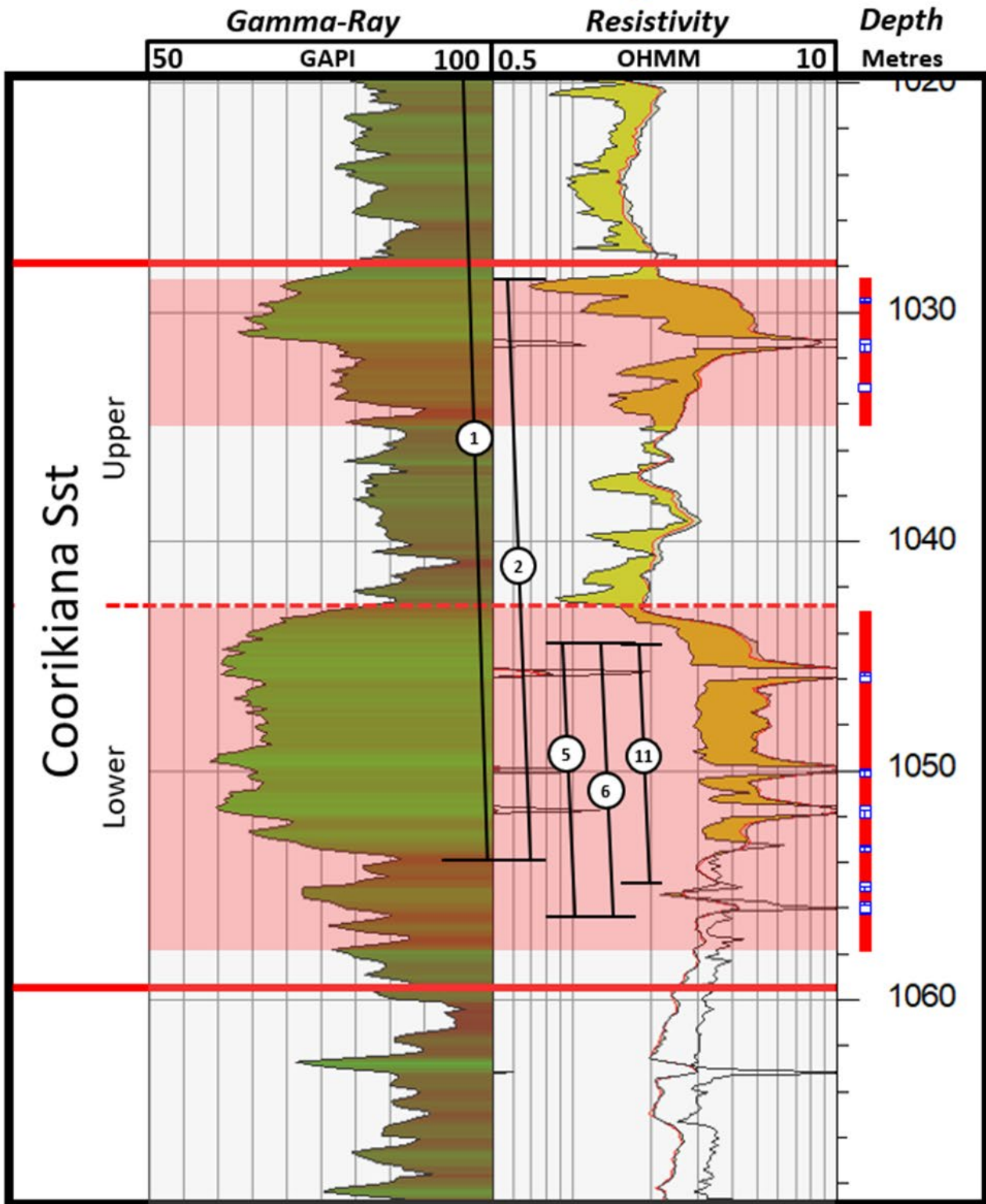
 **Full Hole Core Recovered**

N.B: 6.05m (19' 10") of core 1 recovered in core 2

Carmine Grasso

Figure 19. Coorikiana Sandstone wire-line log response in Marabooka 4 highlighting cored intervals.

MARABOOKA 4



DST # 1/#2: Lost Packer Seat. Recovery; 1004' mud & 1024' mud, respectively
DST # 5/#6: Unable to Inflate Packers.
DST # 11: Packer did not seat

-  Gas Zone
-  Cemented (Calcified) Zone

Carmine Grasso

Figure 20. Coorikiana Sandstone wire-line log response in Marabooka 4 highlighting the attempted drill stem test intervals.

Marabooka 7, a gas development well drilled in 2002, successfully cut a 30 ft full hole core but recovered essentially the marine shale section of the upper Coorikiana Sandstone cycle. The wire-line log section across the Coorikiana Sandstone in Figure 21 shows the section cored, whilst the two attempts made to individually DST the upper and lower cycles in the open hole are shown in Figure 22.

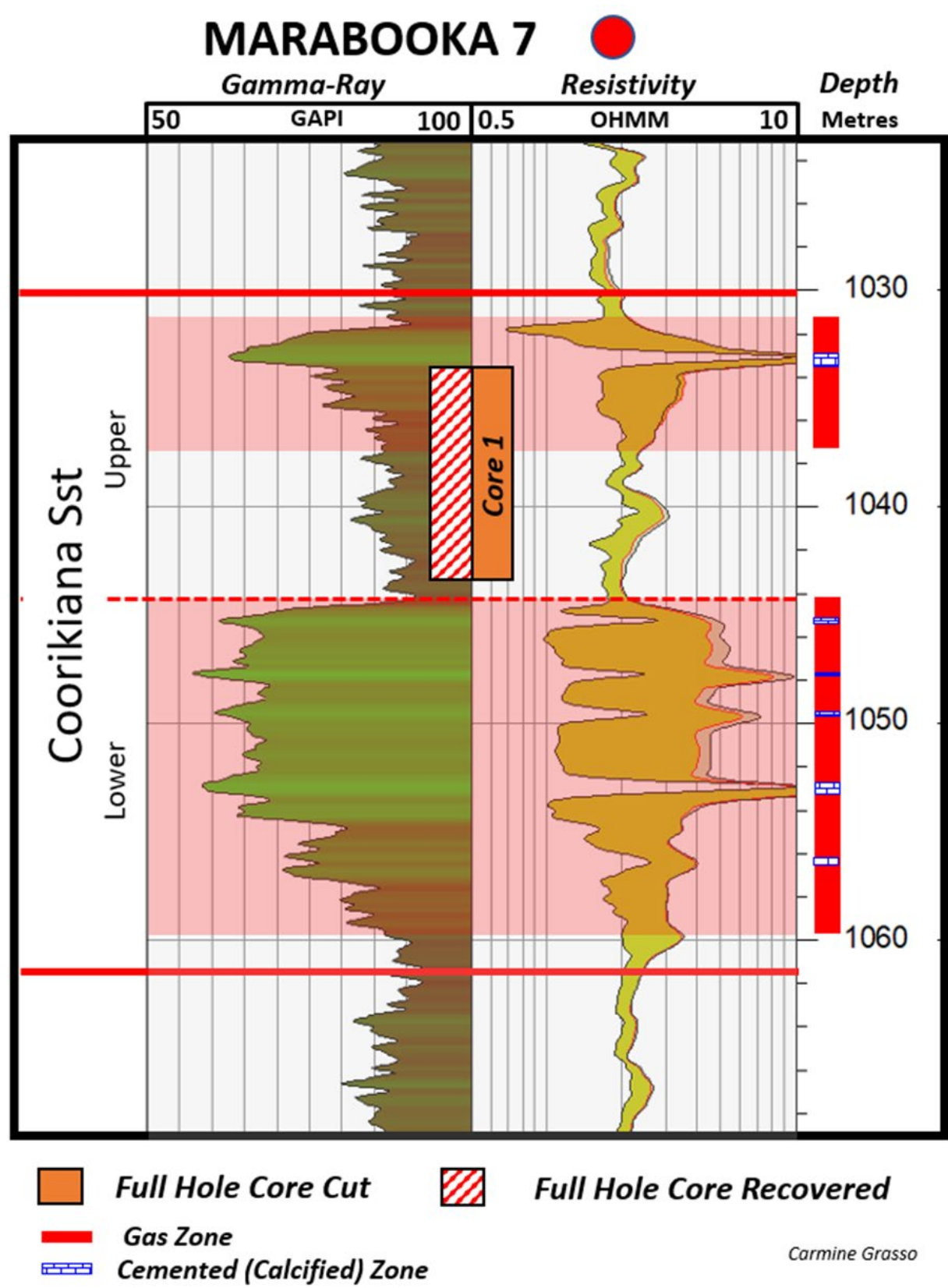
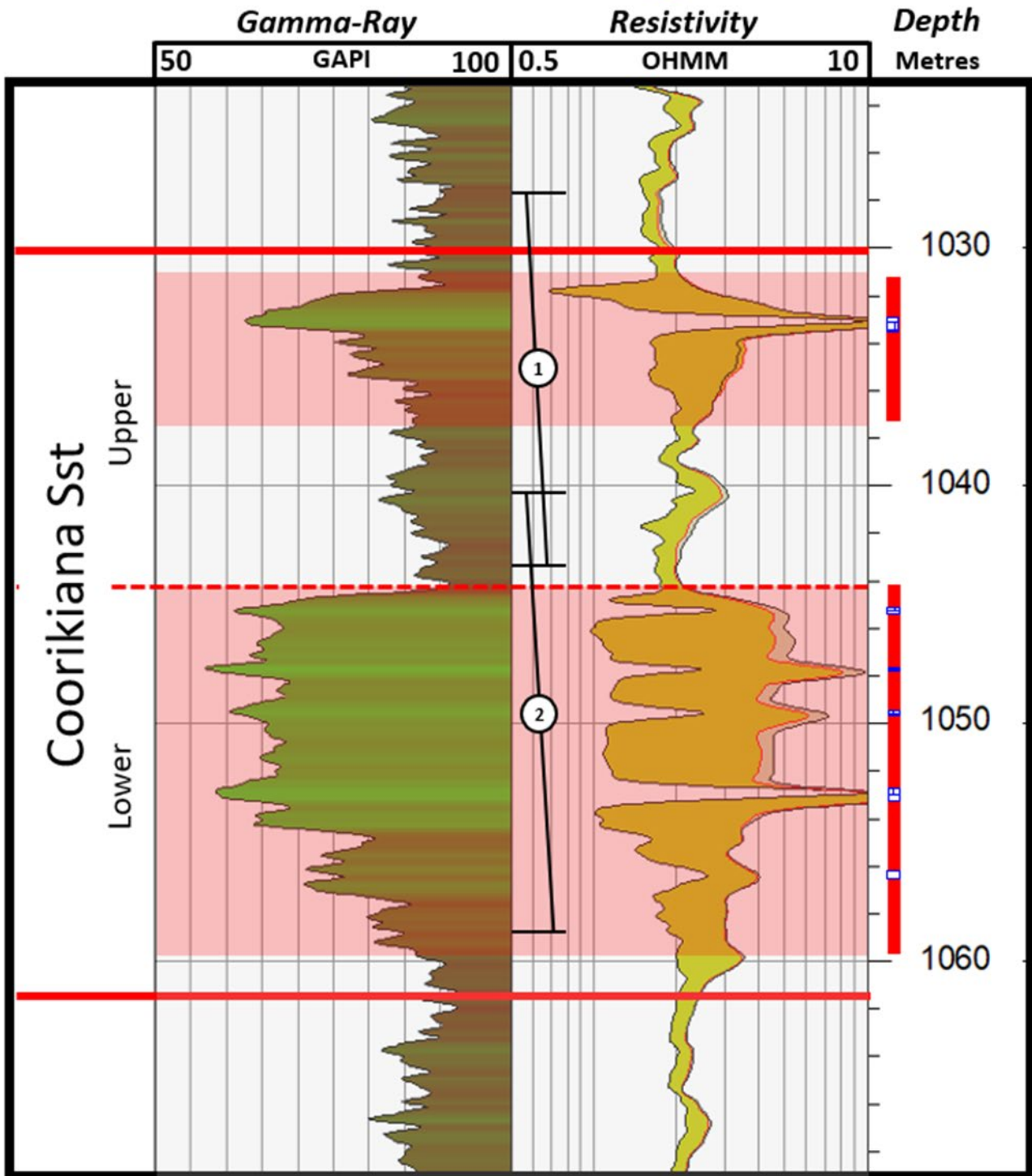


Figure 21. Coorikiana Sandstone wire-line log response in Marabooka 7 highlighting the attempted cored and recovered intervals.

MARABOOKA 7



DST # 1/#2: Packer seat failure.

- Gas Zone**
- Cemented (Calcified) Zone**

Carmine Grasso

Figure 22. Coorikiana Sandstone wire-line log response in Marabooka 7 highlighting the attempted drill stem test intervals.

The first attempt to cut a full hole core across the lowermost, thickest reservoir section in the Coorikiana Sandstone in an oil well occurred in Ulandi 15, an oil appraisal well drilled in 2007 and future producer, although only 18 ft of 54 ft cut was recovered, a total of 33% (Fig. 23).

From Santos Ulandi 15 well completion report: Figures 24, 25 and 26 cover core description, core gamma-ray vs wireline gamma-ray and core porosity, permeability and grain density information; and Figures 27 and 28 highlight in the slabbed full hole core key sedimentary features representing the regressive marine, nearshore, shallow shelf environment that is typical for a major portion of the Coorikiana Sandstone within the study area.

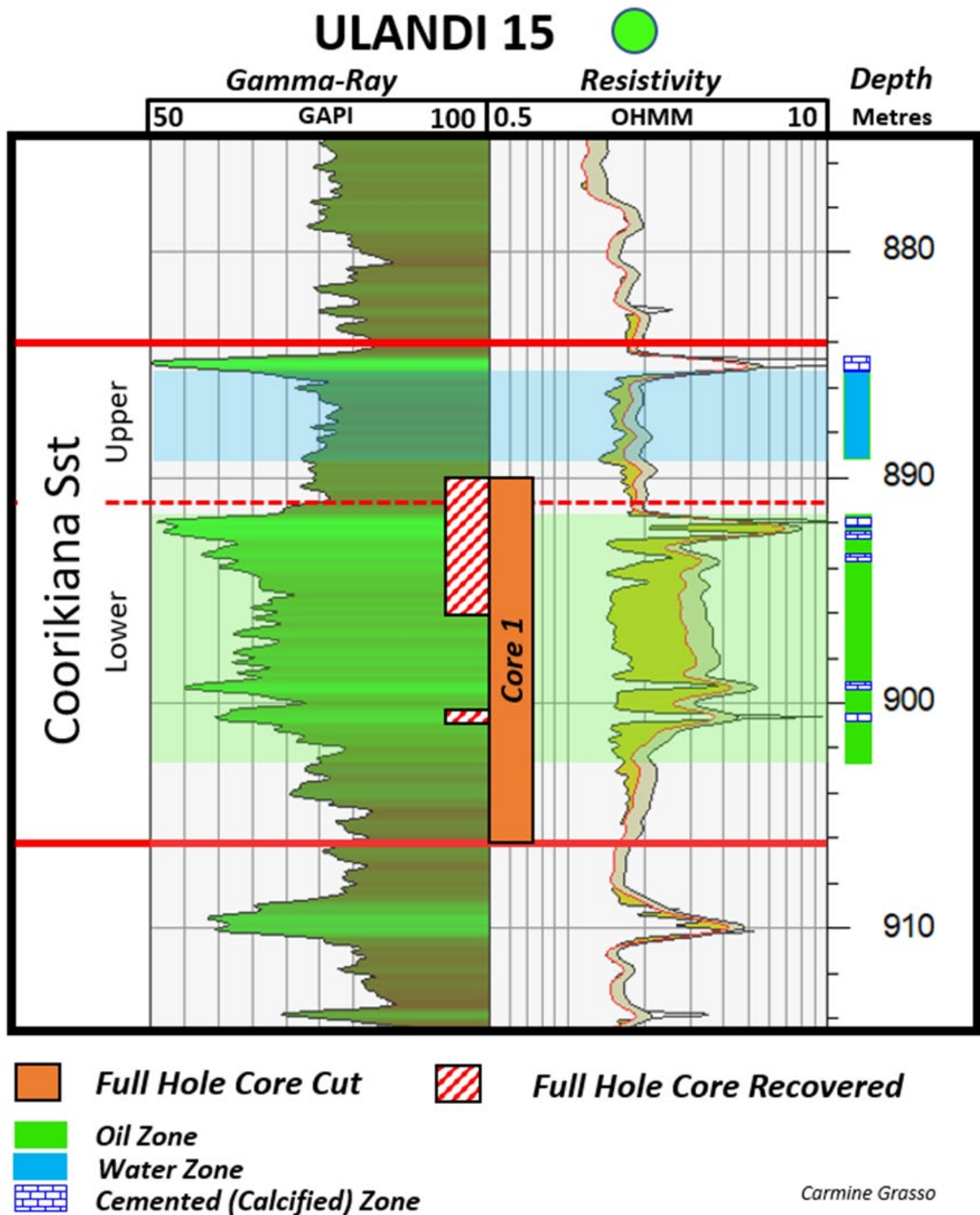


Figure 23. Coorikiana Sandstone wire-line log response in Ulandi 15 highlighting the attempted cored and recovered intervals.

CORE DESCRIPTION

Date November 2006

Page 1 of 1

Well Name Ulandi 15

CORE No. 1

Location: Latitude Longitude

Interval Cut 60 feet
Recovery 18 Feet 30 %

Elevation: GL RT

Formation Coorikiana Sandstone

Geologist Nick Lemon

Age Cretaceous - Albian

DEPTH feet	Graphic Sedimentological Log			LITHOFACIES CODES	DESCRIPTION
	Mud	Sand	Gravel		
	Top of Core 2920 feet				
2920				Fb	Bioturbated, dark grey mudstone, glaucony pellets in burrows
				Ss	Hiatus between sand and shale, heavily burrowed surface, pyrite and mud-filled burrows
				Ss	Apparent low angle cross beds – actually HCS. Cemented band
				Ss	Uncemented layer
				Ss	Cemented layer. All sands are green, massive to laminated glauconitic arenites
2924				Ss	Uncemented greensands with low angle cross beds – Hummocky cross stratification
					Bedding shown by alternating light and dark laminations
2928				Ss	Silty top to storm bed
2932				Ss	
2936				Ss	Core loss zone
2948				Ss	1' of tightly cemented core in the catcher placed at 2949 – 50' (drillers depth) by comparison with MSFL log. Layer of cone-in-cone calcite cement and thin (2cm) graded storm-generated ?turbidite? beds
2952					Core became wedged in the barrel and developed spiral fracture set making drilling of intact RCA plugs very difficult. After 17' entered the barrel, most of the cored interval was ground away in front of the bit. One foot of a hard layer was forced into the barrel before the rest of the core was ground away

Oil stained

Figure 24. Coorikiana Sandstone core description in Ulandi 15. Santos Ulandi 15 well completion report, 2007.

CORE DATA

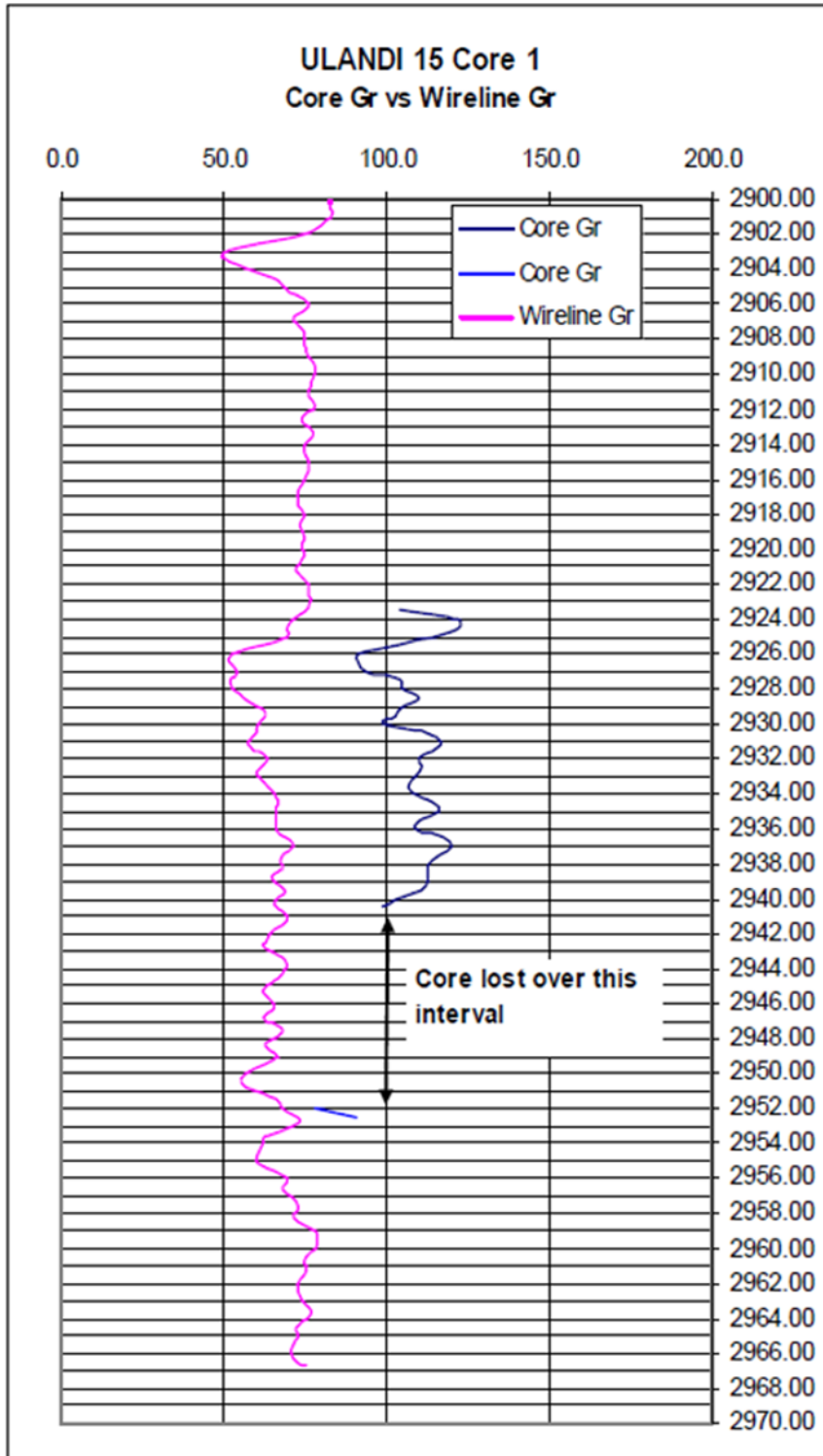
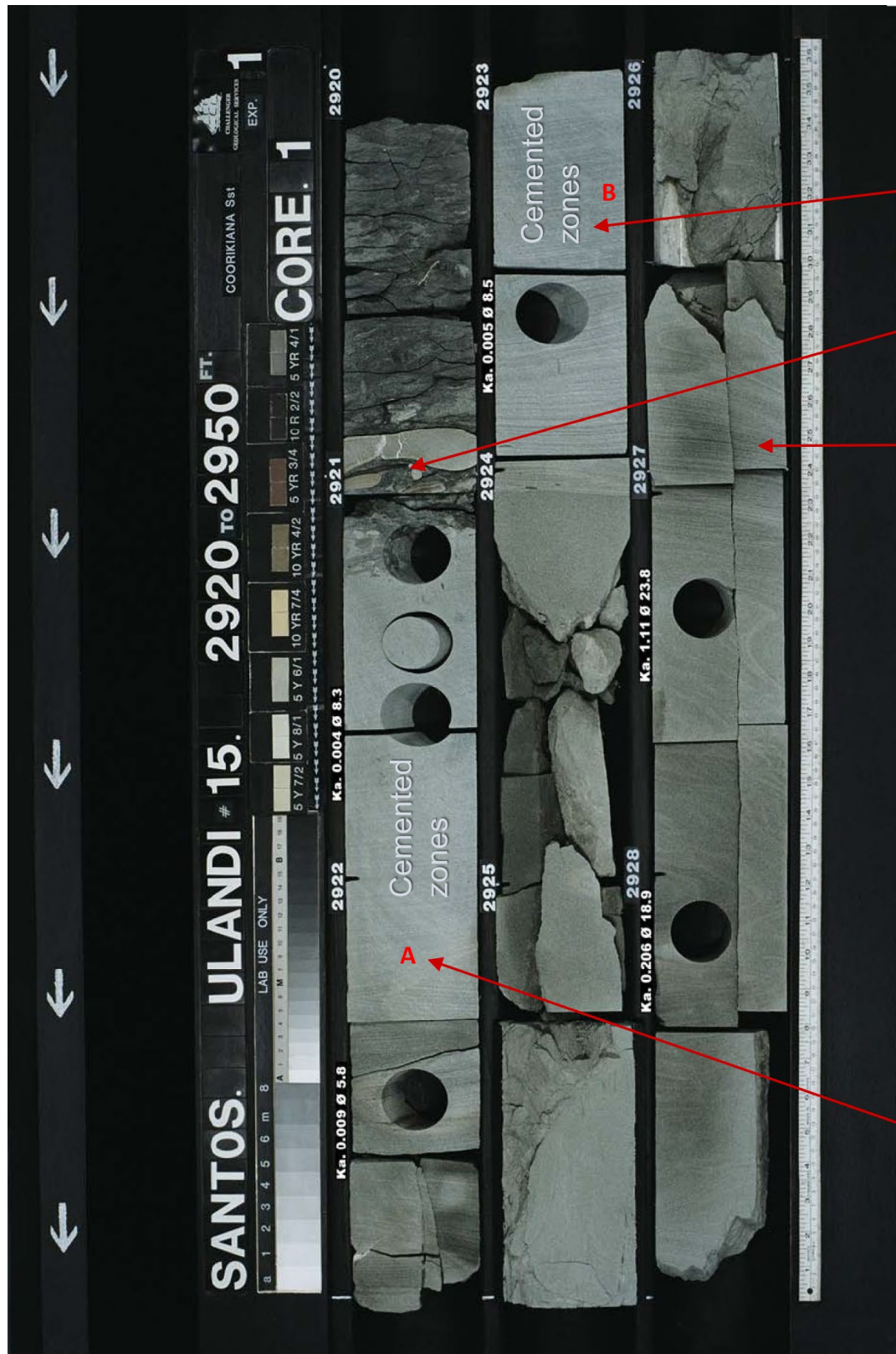


Figure 25. Coorikiana Sandstone core gamma-ray vs wire-line gamma-ray over the lower recovery from core 1 in Ulandi 15. Santos Ulandi 15 well completion report, 2007.

POROSITY, PERMEABILITY AND GRAIN DENSITY

SAMPLE NUMBER	DEPTH (ft)	CMS CONFINING STRESS 800psi.			GRAIN DENSITY (g/cc)	COMMENTS
		PERMEABILITY		POROSITY (%)		
		Kinf (md)	Kair (md)			
1	2921.50	0.001	0.004	8.3	2.582	
2	2922.50	0.005	0.009	5.8	2.717	
3	2923.66	0.002	0.005	8.5	2.672	
4	2927.33	0.782	1.11	23.8	2.675	
5	2928.08	0.135	0.206	18.9	2.681	
6	2931.33	0.264	0.393	26.5	2.669	
7	2733.66	7.48	9.09	27.9	2.639	

Figure 26. Coorikiana Sandstone core porosity, permeability, and grain density data in Ulandi 15. Position of core plugs taken are shown in Appendix 3. Santos Ulandi 15 well completion report, 2007.

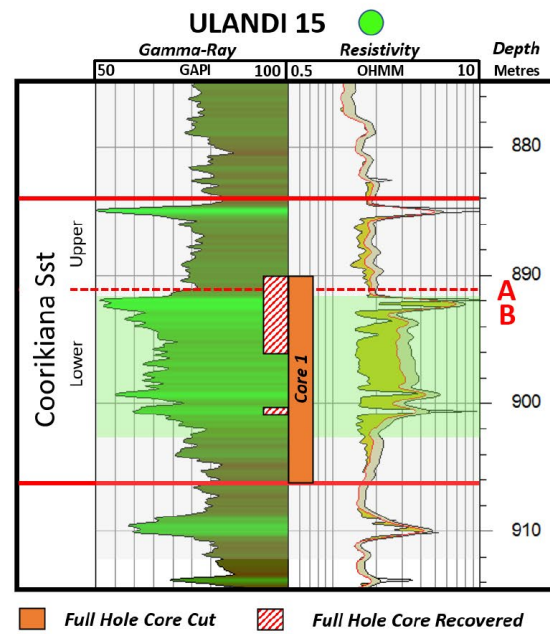


Regressive marine, nearshore, shallow shelf environment.

Cemented zone – ties with higher resistivity response

burrowed surface

hummocky cross beds



Cemented zone – ties with higher resistivity response



Figure 27. Coorikiana Sandstone slabbed full hole core from 2920–2929 ft (drillers depth) in Ulandi 15 highlighting key sedimentary features. Note the high fluorescence indicating the presence of oil in highly permeable sandstone, whereas the cemented zones show no fluorescence. Core photos and sedimentary labels (Fig. 24) from Santos Ulandi 15 well completion report, 2007.

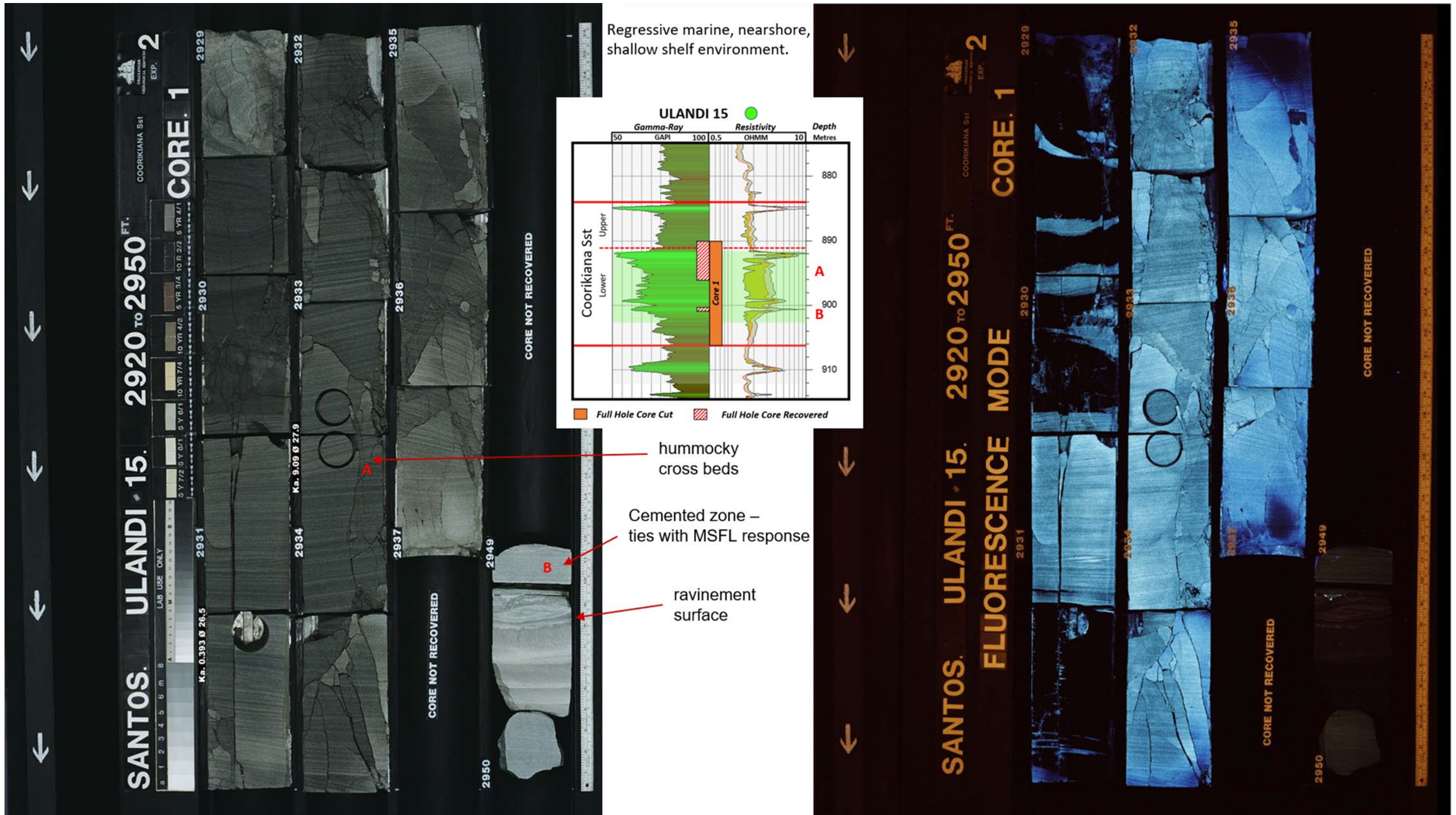


Figure 28. Coorikiana Sandstone slabbed full hole core from 2929–2937 ft and 2949–2950 ft (drillers depth) in Ulandi 15 highlighting key sedimentary features. Note the high fluorescence indicating the presence of oil in highly permeable sandstone, whereas the cemented zones show no fluorescence. Core photos and sedimentary labels (Fig. 24) from Santos Ulandi 15 well completion report, 2007.

4.4.3. Mudlog/Wireline log response

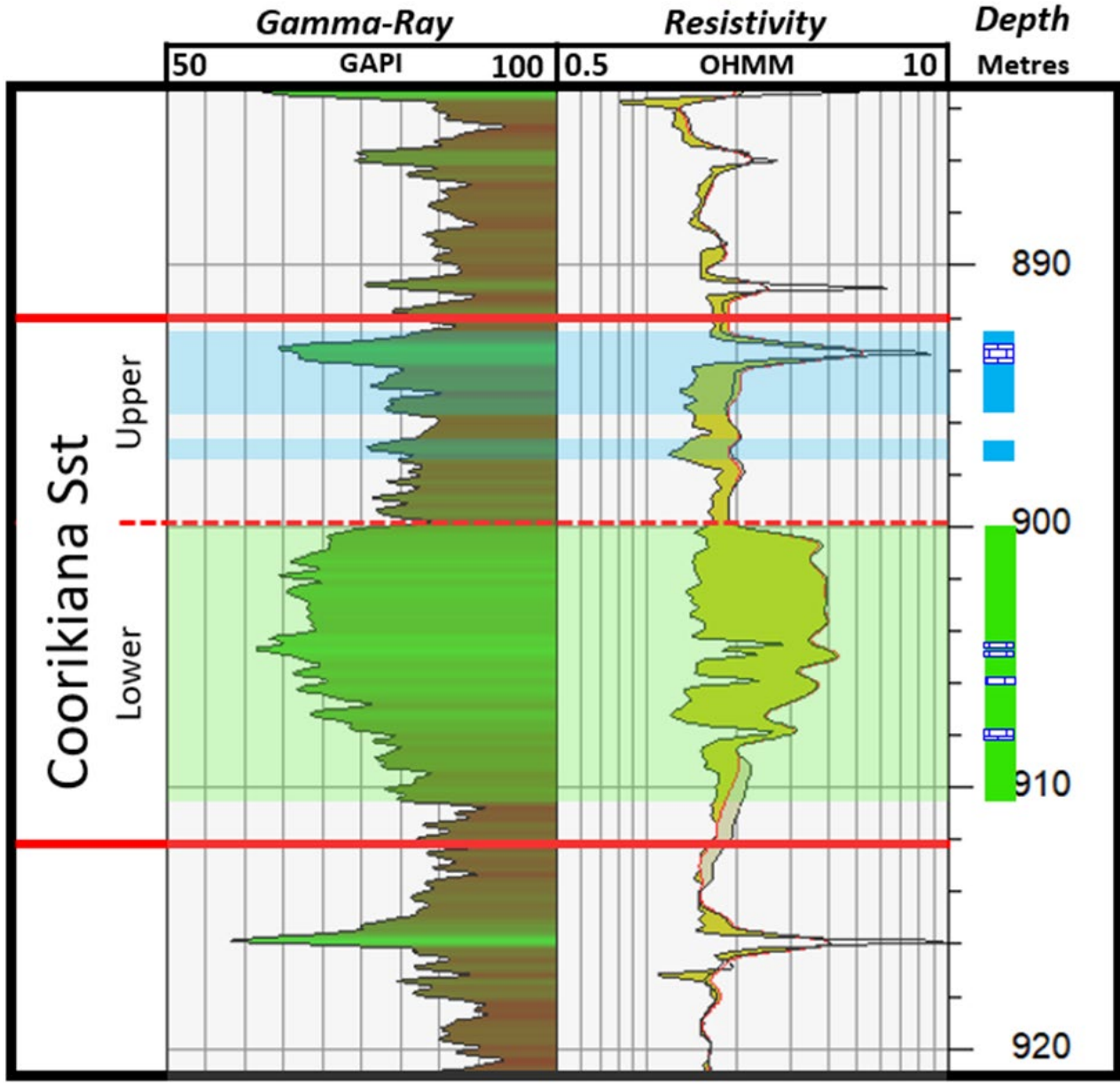
Within the area of study, the Coorikiana Sandstone is a lithologically complex reservoir system with overall low resistivity contrast between productive and non-productive hydrocarbon zones. This is further exacerbated by the fact that often there is little resistivity (intermediate to deep) contrast between a hydrocarbon zone or water wet zone, based on conductive mineralogy, viz. pyrite and clay content (high bound water), coupled with generally the freshwater nature (based on limited water analyses) inherent in these aquifers of the Eromanga Basin. Across the oil producing area of the JALBU Complex (Fig. 4), oil resistivity ranges from 3 to 4+ Ohm-m and water resistivities range from 2 to 3 Ohm-m. To demonstrate these features better it is important to adapt the minimum and maximum scales on wire-line logs as opposed to using the standard industry minimum/maximum scales of 0 to 200 GAPI for gamma-ray log and 0.2 to 2000 ohm-m for resistivity logs; Figures 29 and 30 aptly illustrate this point for the oil well Ulandi 12 and the nearby water well Ulandi 11 respectively with GR plotted on a scale of 50 to 100 GR units and resistivity plotted on a scale of 0.5 to 10 ohm-m. Figure 31, Bugito-Seccante-Ulandi field area Coorikiana Sandstone depth map showing locations for Ulandi 11 and 12.

Formation evaluation is vitally important in understanding reservoir petrophysics and identification of hydrocarbons on both mud and wireline logs. This places a much greater emphasis when characterising the Coorikiana reservoir that mudlog, wireline log, core (both full-hole and sidewall), pressure data and production profiles are taken into consideration.

Control and/or fixed rate drilling is designed to allow gathering of better and more frequent samples (drill cuttings) across a prospective zone to obtain an improved quality reservoir description. This also allows for the recording of more accurate gas/oil shows across a potential hydrocarbon zone. Two excellent examples on the JALBU Complex (Fig. 31) show how slowing the drill rate led to a significantly more accurate representation of future oil producing zones that may have otherwise been abandoned:

- The first example compares Ulandi 13 and Ulandi 10, drilled back-to-back in 2003 and in the same Coorikiana fault block, although both were drilled for Murta and McKinlay primary targets. The Ulandi 13 Coorikiana Sandstone interval was drilled at an average rate of approximately 250 ft/hr, described as only having 10% oil fluorescence (poor) and total gas composition breakdown percentage for the light hydrocarbons, C1/C2/C3/C4, of 71/3/11/15 (Fig. 32). With the encouraging total gas peak profile and subsequent reading of 60/6 units the next well in the drilling sequence, Ulandi 10, was drilled at a much slower rate across the prospective Coorikiana Sandstone interval. This well had the Coorikiana Sandstone interval drilled at an average rate of approximately 30ft/hr, however this well was described as having up to 60% oil fluorescence (very good) and total gas composition breakdown percentage for the light hydrocarbons, C1/C2/C3/C4, of 58/2/17/23 which indicates more heavier hydrocarbon components indicative of an oil zone (Fig. 33). Both wells are Coorikiana oil producers.
- The second example is between Bugito 1 and Bugito 2 drilled in the same Coorikiana fault block, but unlike the previous example these two wells were drilled two years apart. The Bugito 1 Coorikiana Sandstone interval was drilled at an average rate of approximately 250ft/hr, described as only having trace oil fluorescence (very poor) and with no real total gas peak (11/6 units) and a corresponding breakdown percentage for the light hydrocarbons, C1/C2/C3/C4, of 87/6/4/3 which is generally not indicative of a producible oil zone (Fig. 34). Fortunately for Bugito 1, Ulandi 12 had earlier been converted to a Coorikiana Sandstone oil producer and on subsequent review of the wire-line log response, Bugito 1 was completed as a Coorikiana oil producer (Fig. 35). The Bugito 2 Coorikiana interval was drilled at an average rate of approximately 30 ft/hr, described as only having 50–100% oil fluorescence (excellent) and with total gas peak (82/15 units) and a corresponding breakdown percentage for the light hydrocarbons, C1/C2/C3/C4/C5, of which 61/3/9/16/10% is indicative of a producible oil zone (Fig. 36). Unfortunately, Bugito 2 was subsequent abandoned due to the economic conditions at the time of drilling (Fig. 37).

ULANDI 12

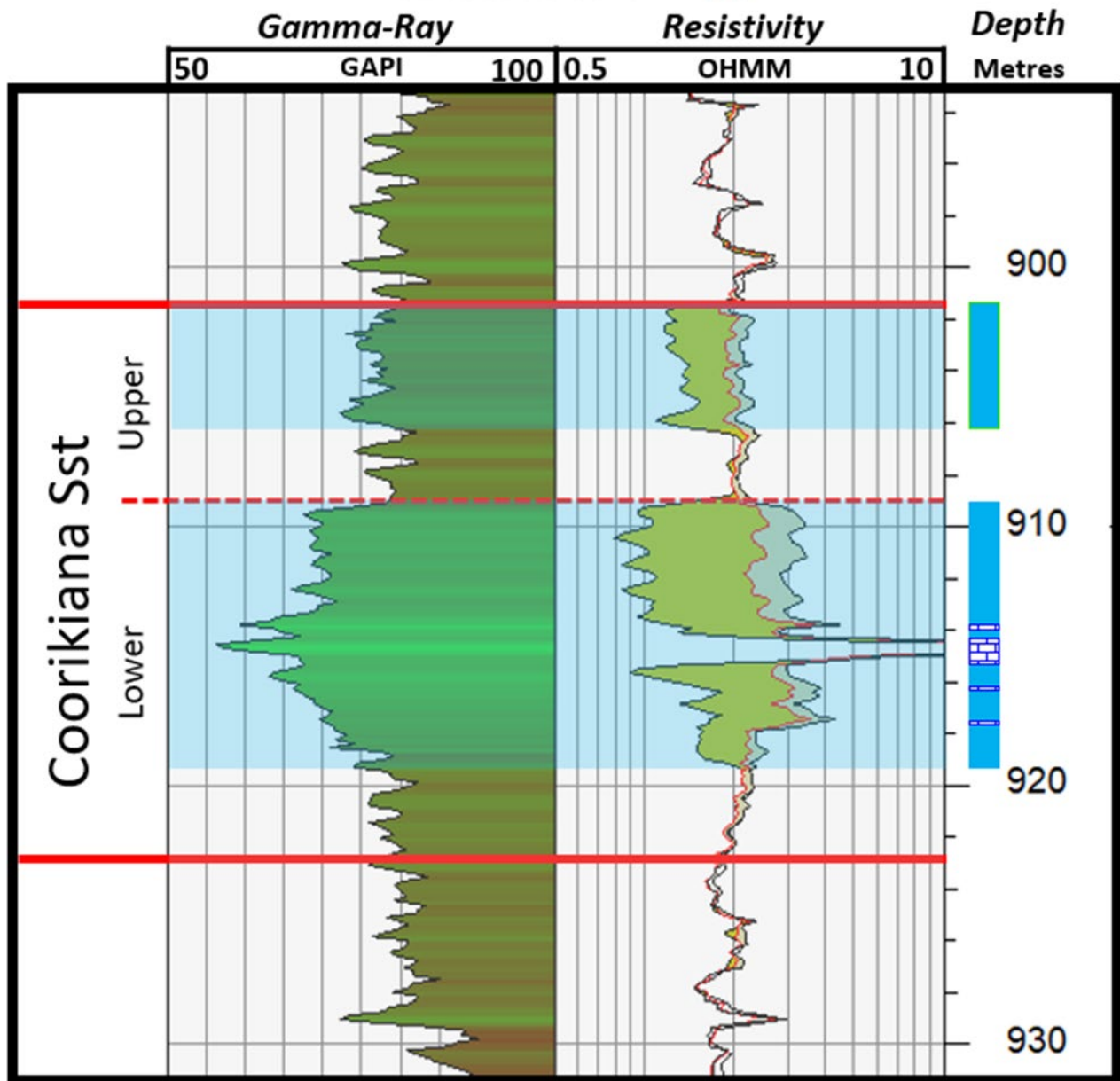




- Oil Zone
- Water Zone
- Cemented (Calcified) Zone

Carmine Grasso

Figure 29. Coorikiana Sandstone wire-line log response in Ulandi 12, highlighting the 3-4+ ohm-m resistivity oil zone.

ULANDI 11



 **Water Zone**
 **Cemented (Calcified) Zone**

Carmine Grasso

Figure 30. Coorikiana Sandstone wire-line log response in Ulandi 11 highlighting the 2-3 ohm-m resistivity water zone.

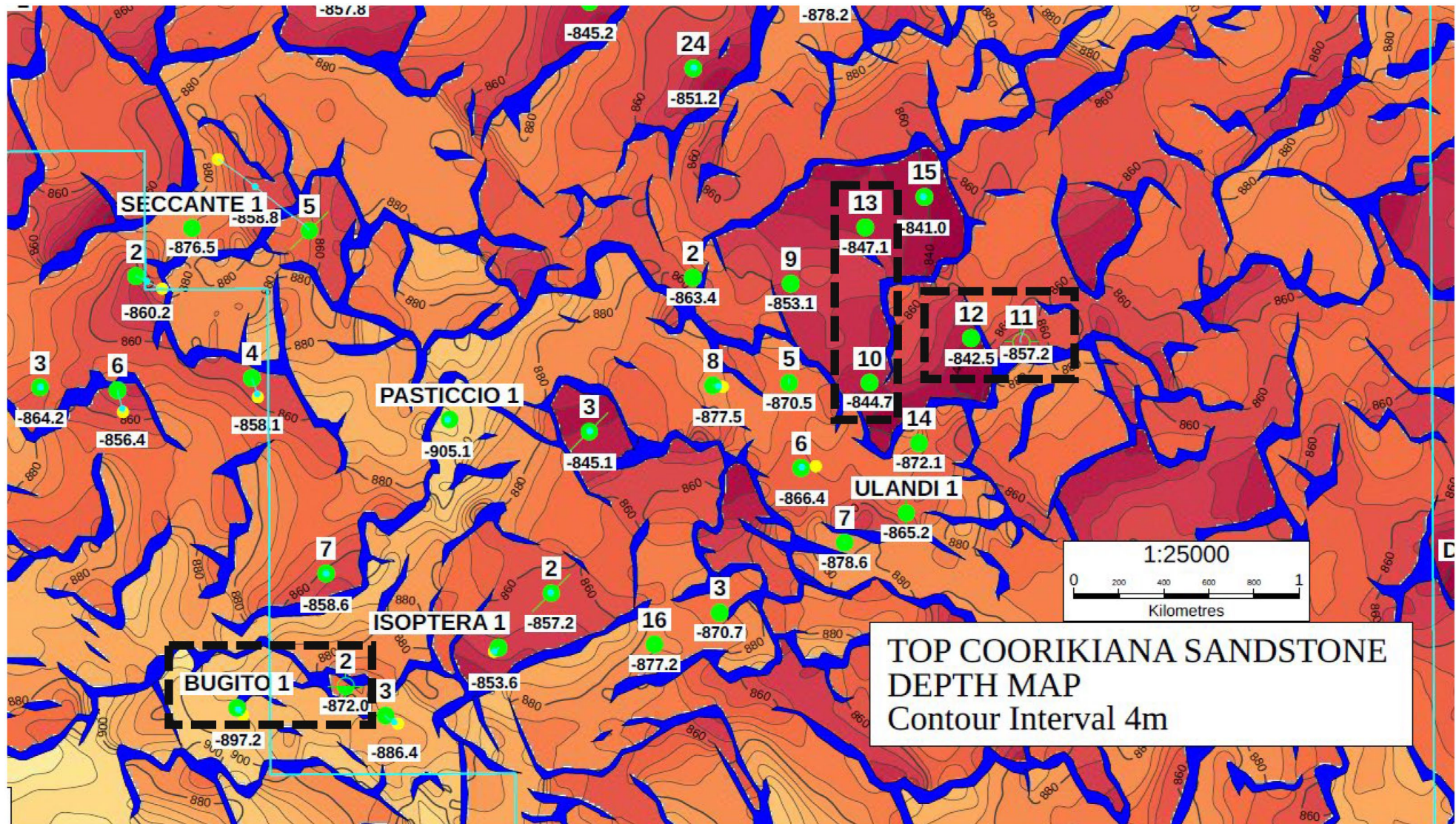


Figure 31. Top Coorikiana depth map, JALBU Complex, highlighting Ulandi 11 & 12, Ulandi 10 & 13, and Bugito 1 & 2. Santos Ulandi 11 Well Completion Report August 2020.

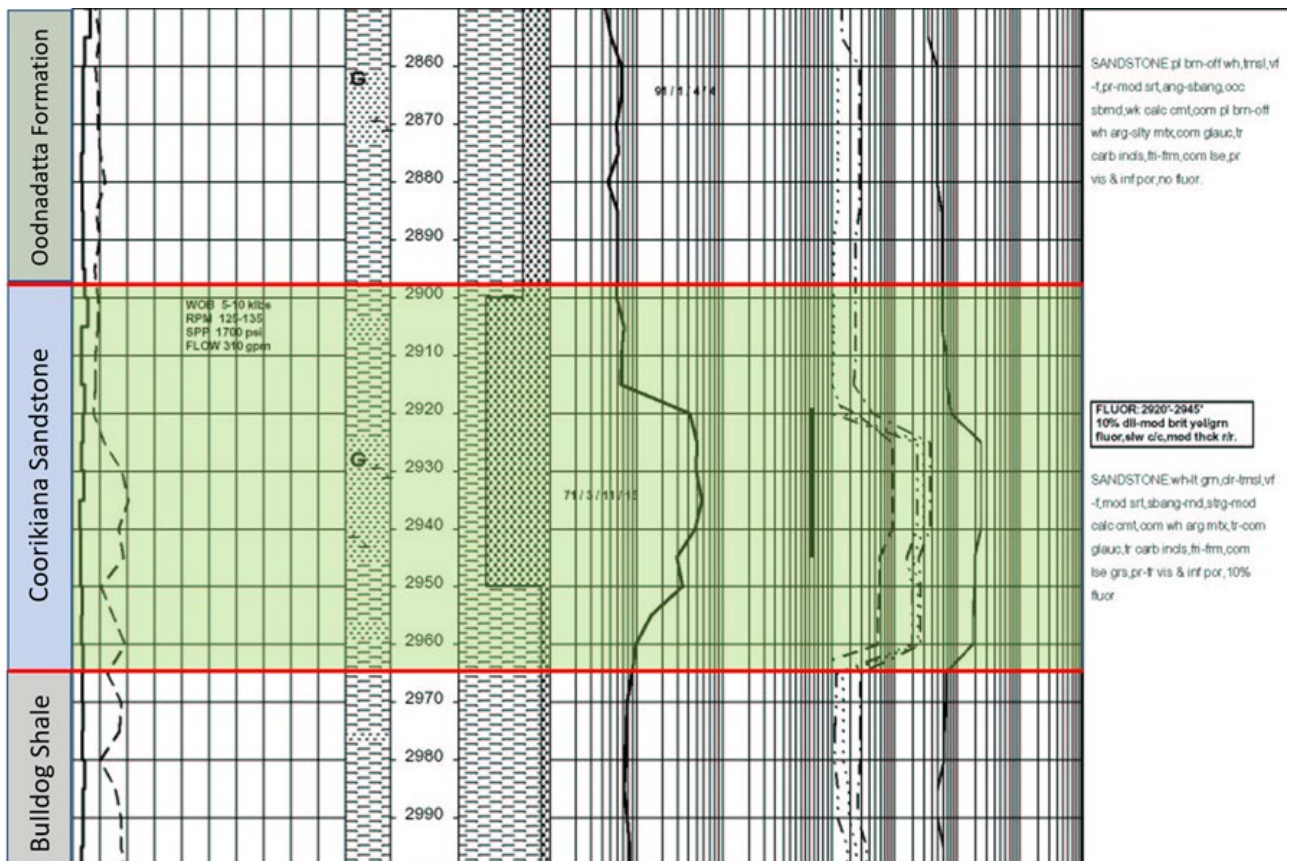


Figure 32. Coorikiana Sandstone mudlog for Ulandi 13, drilled at approximately 250 ft/hr with corresponding poor oil show. Subsequently completed as a Coorikiana oil producer.

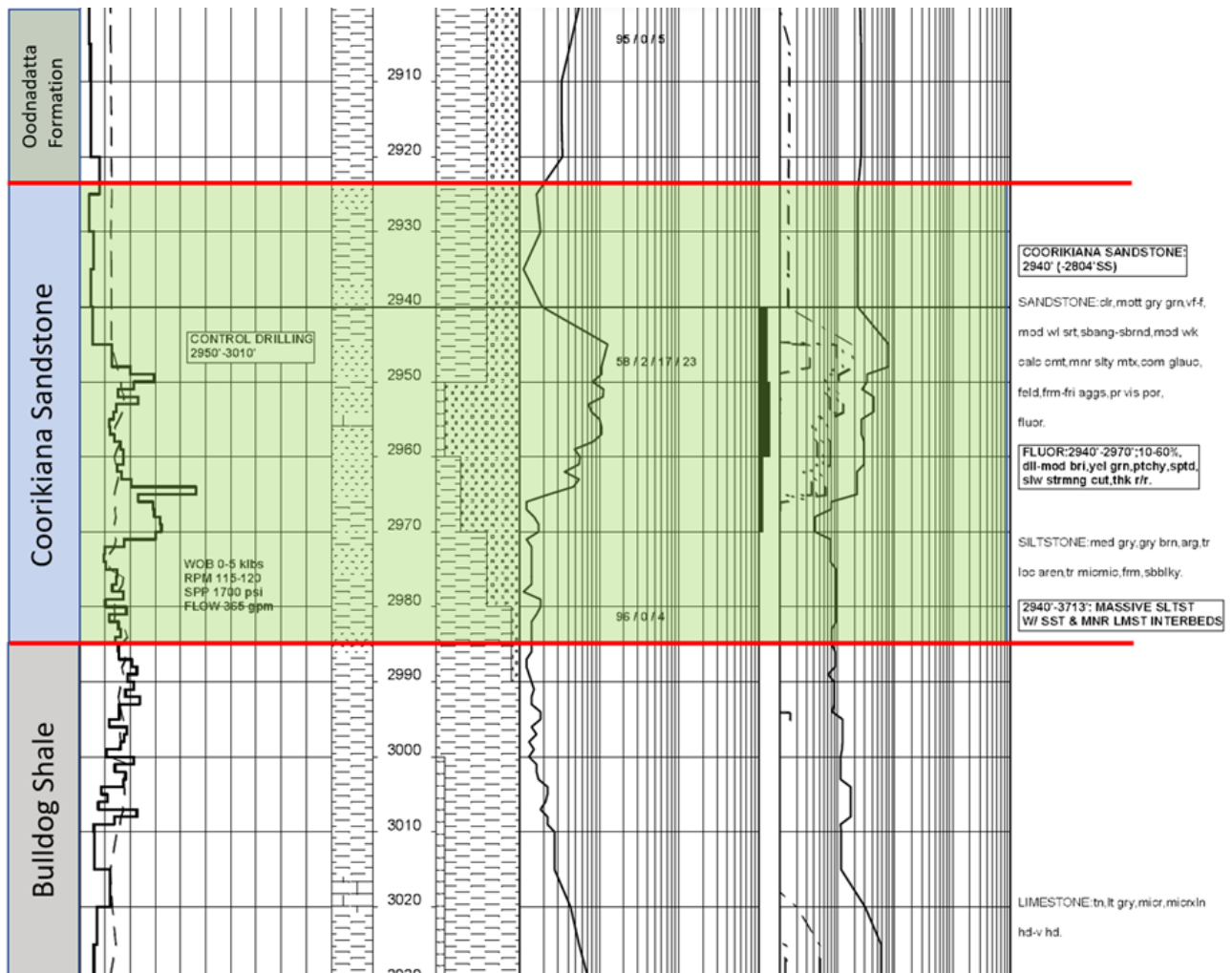


Figure 33. Coorikiana Sandstone mudlog for Ulandi 10, drilled at approximately 30 ft/hr with corresponding very good oil show. Subsequently completed as a Coorikiana oil producer.

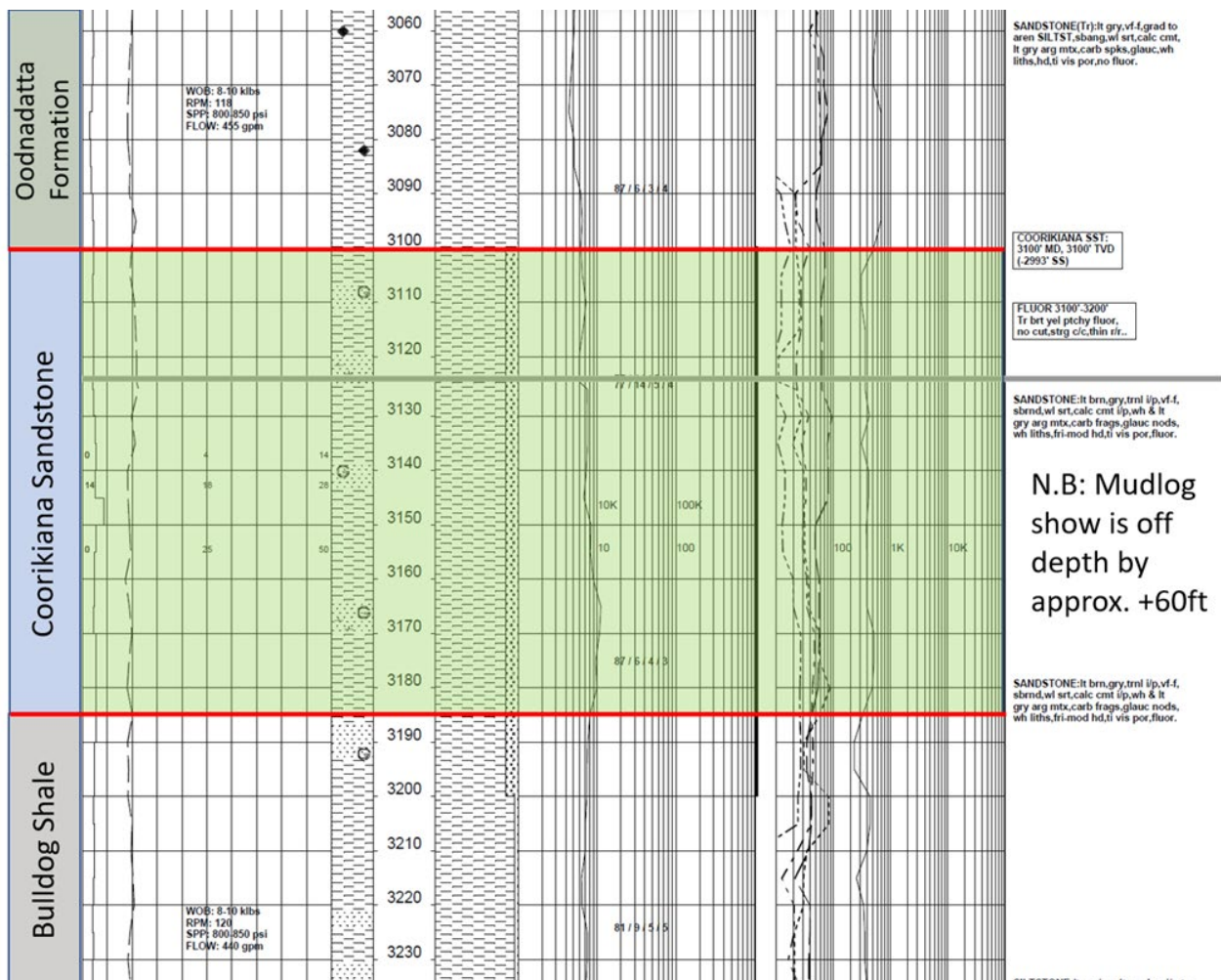


Figure 34. Coorikiana Sandstone mudlog for Bugito 1 drilled at approximately 250 ft/hr with corresponding very poor gas and oil show. Subsequently completed as a Coorikiana oil producer. Note: Mudlog show and lithology description at 3100–3200 ft (945–975 m) is off depth by approximately 60 ft (18 m) when compared to wire-line log response in Fig. 35.

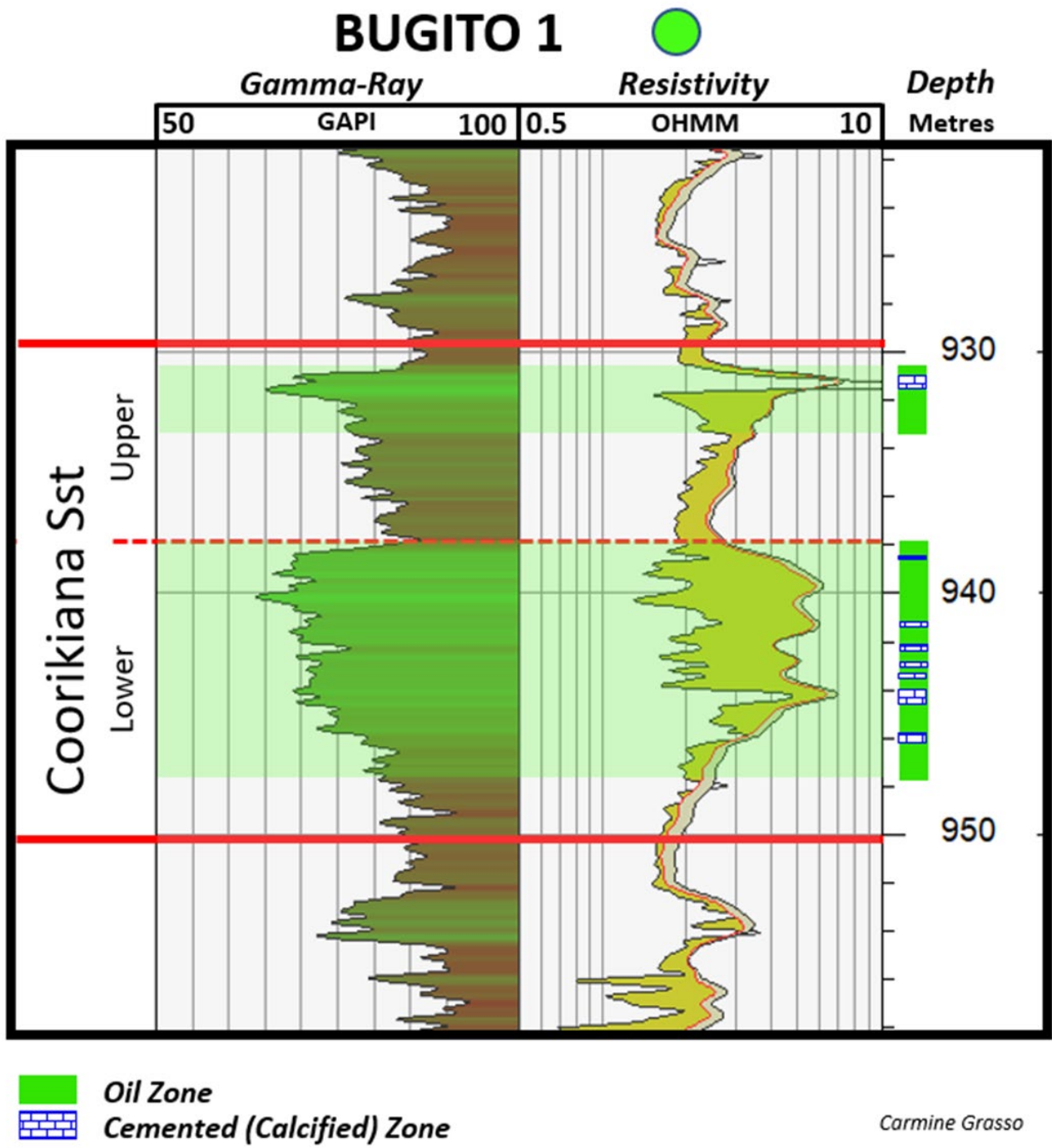


Figure 35. Coorikiana Sandstone wire-line log response in Bugito 1. Subsequently completed as a Coorikiana oil producer.

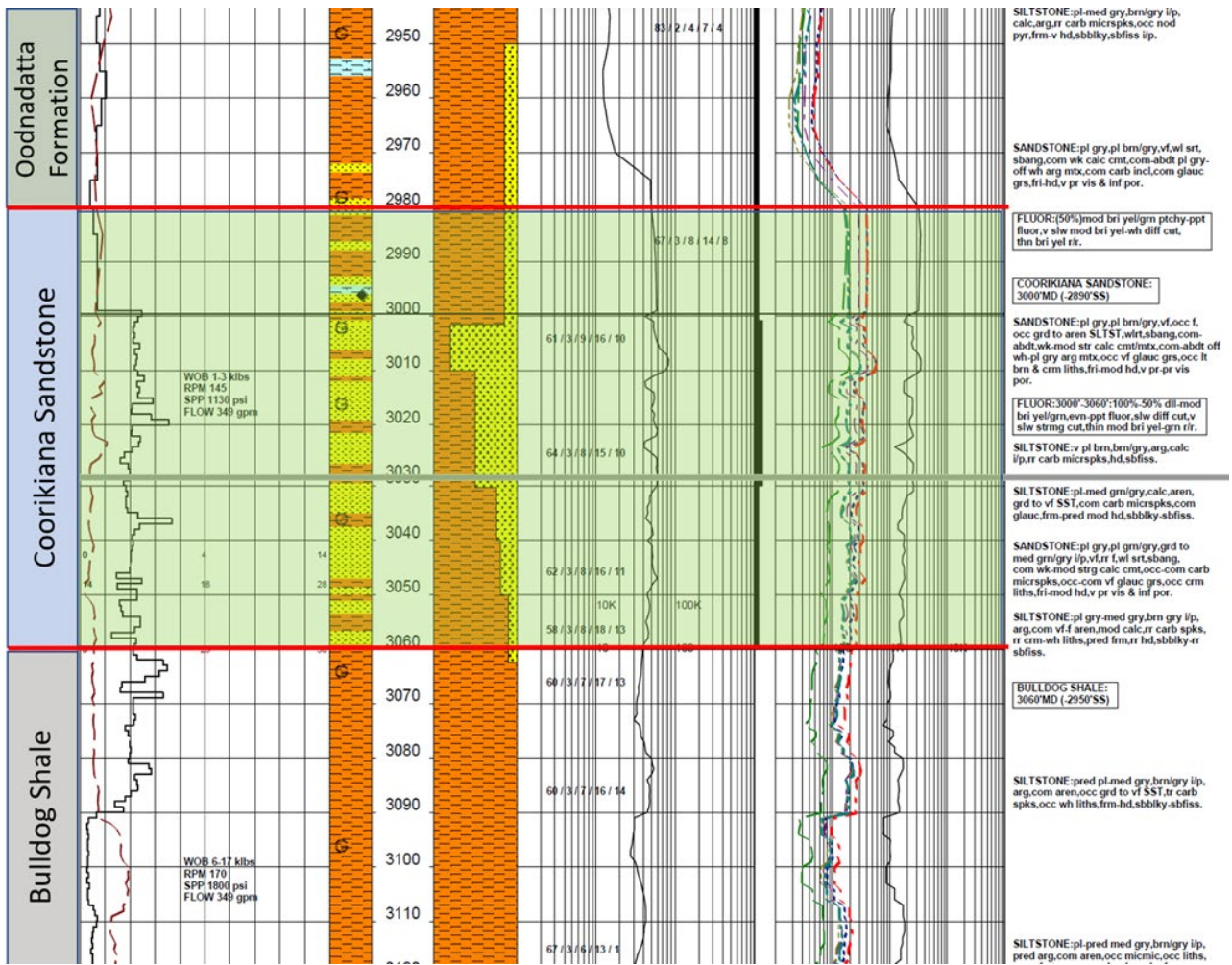
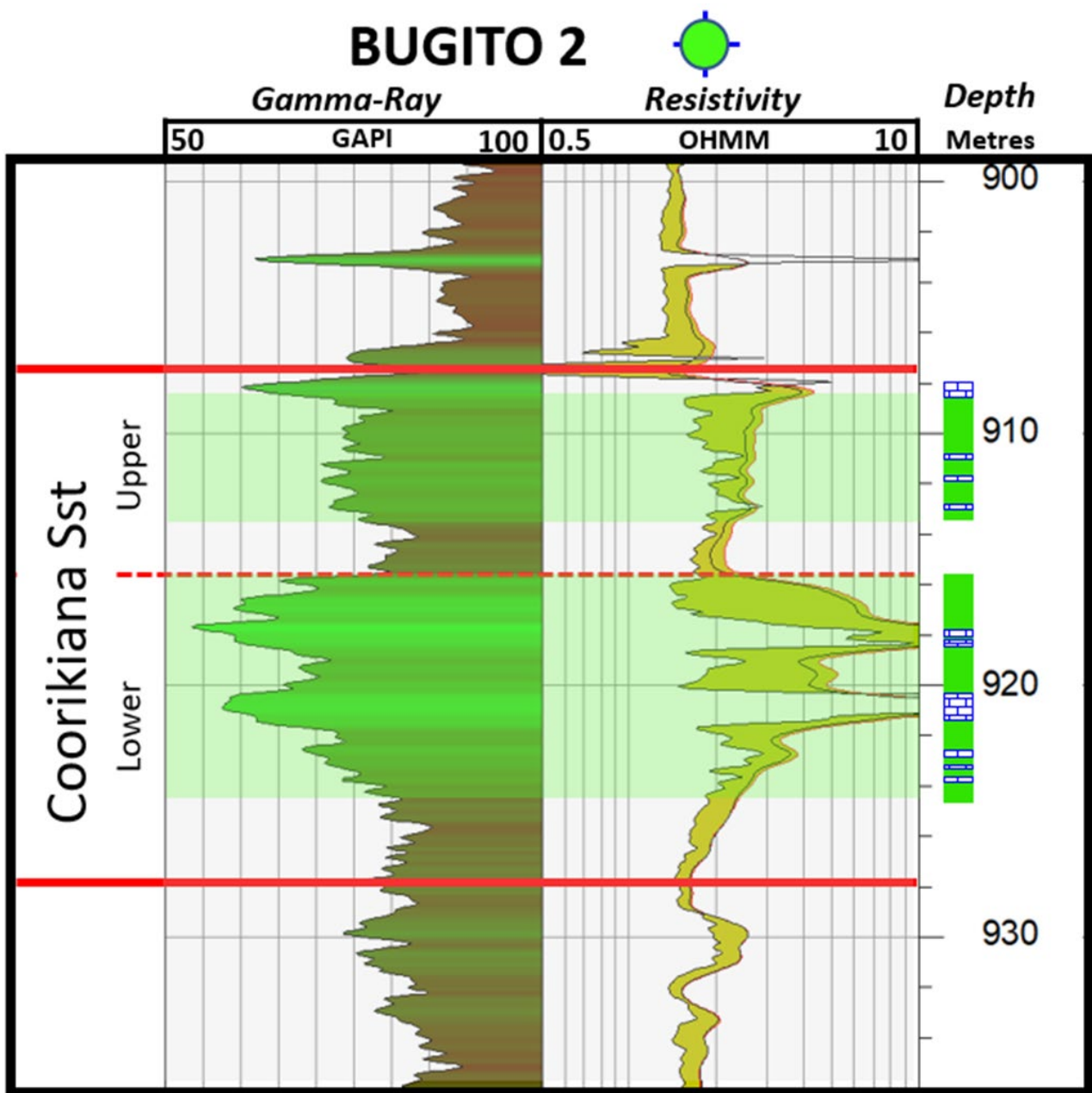


Figure 36. Coorikiana Sandstone mudlog for Bugito 2, drilled at approximately 30 ft/hr with corresponding good gas and excellent oil show.



- Oil Zone
- Cemented (Calcified) Zone

Carmine Grasso

Figure 37. Coorikiana Sandstone wire-line log response in Bugito 2, deemed uneconomic at time of drilling (2007).

4.5. SOURCE ROCKS

Previous geochemical and basin modelling studies across the study area, in and around where the Coorikiana Sandstone is present, suggest that the potential source rocks of the marine section encompassing the Coorikiana Sandstone facies (Fig. 3) are immature and hence have not generated and released enough hydrocarbons to form commercial accumulations of oil or gas.

When examining the gas chromatography plot of the oil recovered from drill stem tests or produced from the Coorikiana Sandstone and comparing the overall shape and oil composition with gas chromatography plots of oil reservoired deeper in older horizons, viz. the Murta Formation, there is very little differentiation between the two. On the JALBU Complex (Fig. 38), where Coorikiana Sandstone oil has been discovered and produced, a comparison is made of the oil characteristics from these two formations:

- Figure 39 is an example of a gas chromatography plot for an oil sample on the JALBU Complex, showing a typical curve for hydrocarbons from C6 to C30. The light hydrocarbons have been essentially removed by dissolution in water sweeping through the reservoir. Key peaks have been highlighted for comparison purposes, viz. C15 and C25 (red) and C17 (green) between Murta Formation and Coorikiana Sandstone gas chromatograph plots.
- Three well bores that produce from the deeper Murta Formation have been selected that are in or around where the Coorikiana Sandstone produces oil. These Murta Formation oil analyses have been selected from oil recovered on drill stem tests.
- In addition, three Coorikiana Sandstone oil samples taken from drill stem tests and from produced oil have also been analysed and displayed in Figure 40.
- Figure 40 shows a comparison of the 3 Murta wells with the 3 Coorikiana wells, aligned based on the C15 to C25 peaks (red dashed lines) with the basic oil properties posted on the right-hand side.
- When comparing the gas chromatography plots and basic oil properties of the two formations, it clearly implies that the oil reservoired in the Coorikiana Sandstone has at least come from the much deeper Murta Formation reservoir. This is important when considering migration pathways of the deeper source (oil pools) into the shallower overlying Coorikiana Sandstone. Although McKinlay Member oil pool gas chromatographs on the JALBU Complex have not been shown here, they are almost identical to the adjacent overlying Murta Formation oil pools gas chromatograph plots.

The conclusion from this is that the oil produced from the Coorikiana appears to have been sourced from the oil reservoired in the deeper Murta Formation and/or McKinlay Member oil pools.

Similar mechanism is invoked for the gas reservoired in the Coorikiana Sandstone on the NMMS trend of gas fields. But in addition, Figures 42 and 45 show that for the Namur Gas Field, Coorikiana Sandstone gas pools can potentially also be sourced directly from the much deeper Permo-Triassic Cooper Basin source rocks.

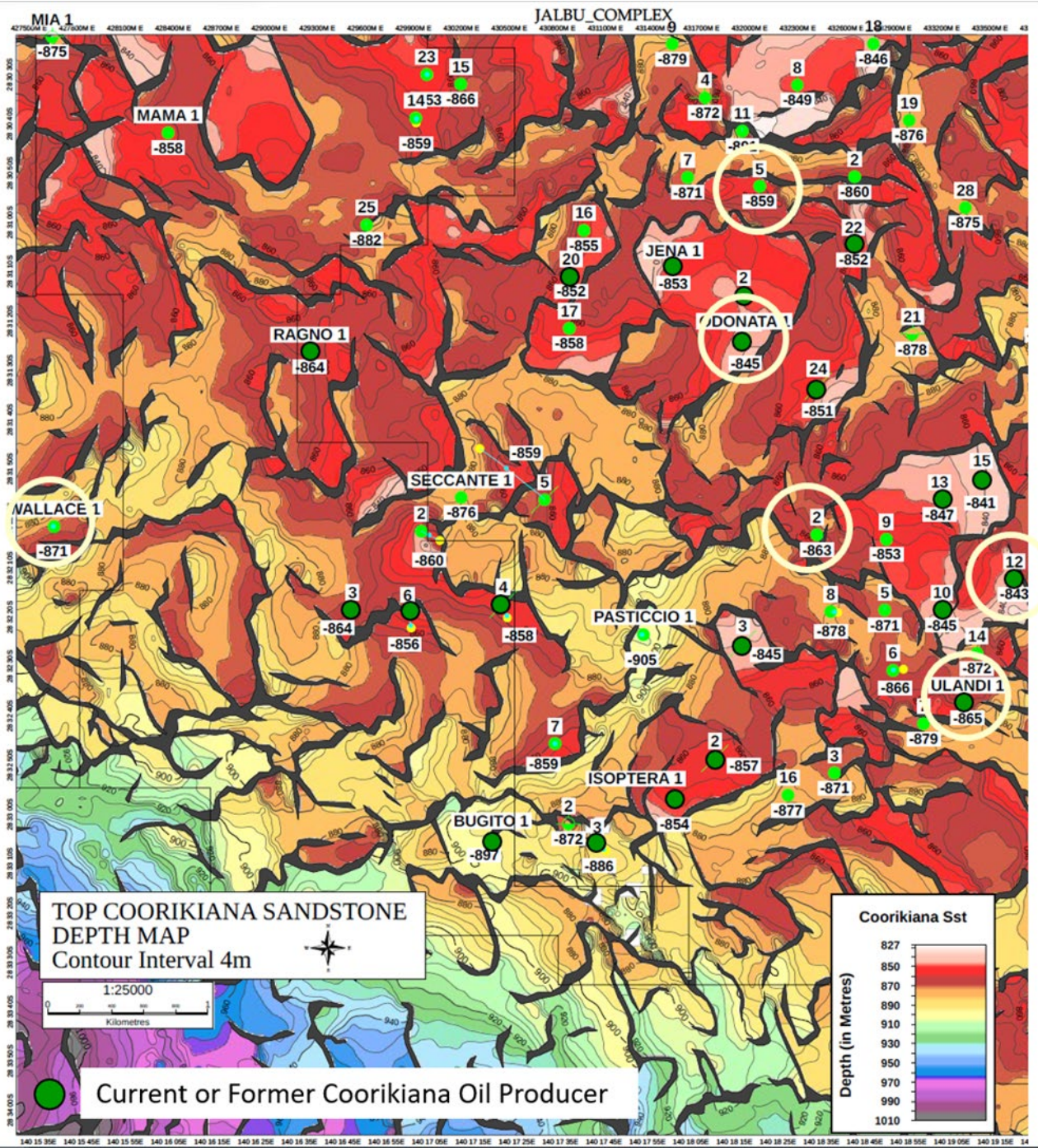


Figure 38. Location of wells for gas chromatography plots in Figure 40, circled.

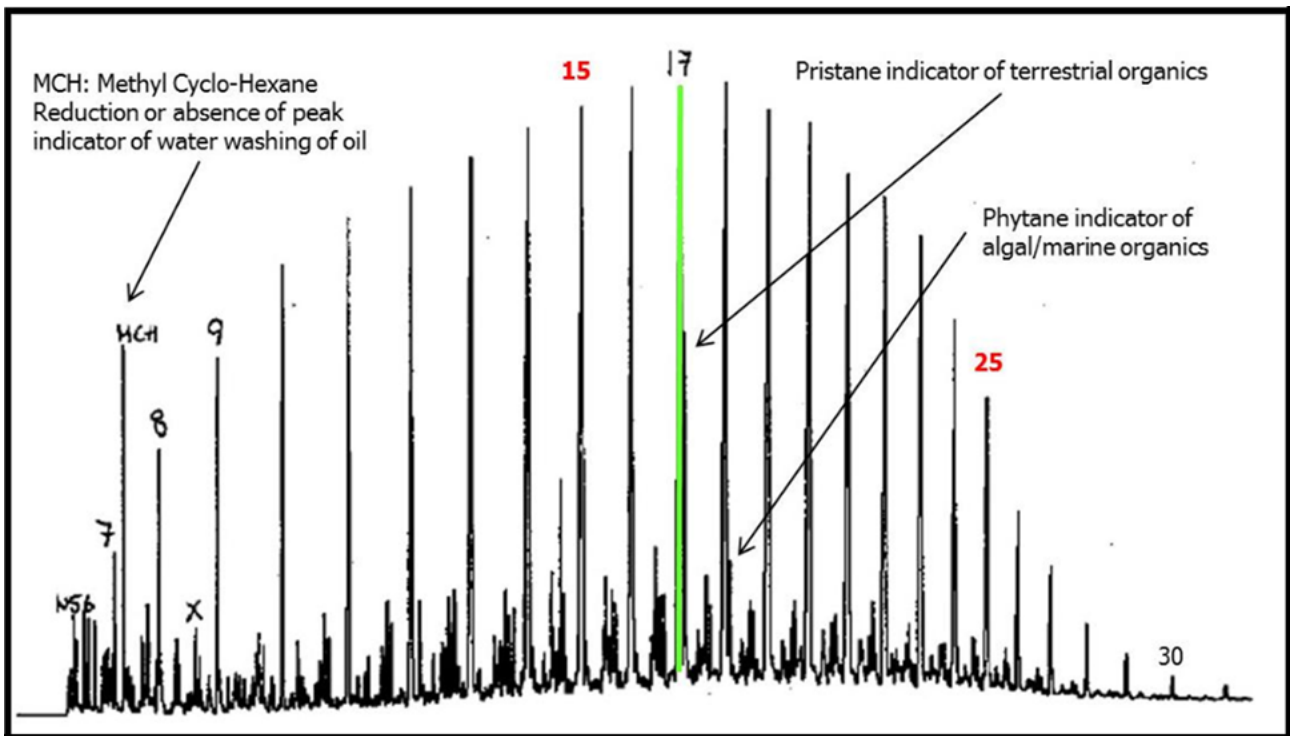


Figure 39. Example gas chromatography plot for an oil sample highlighting key peaks for comparison purposes.

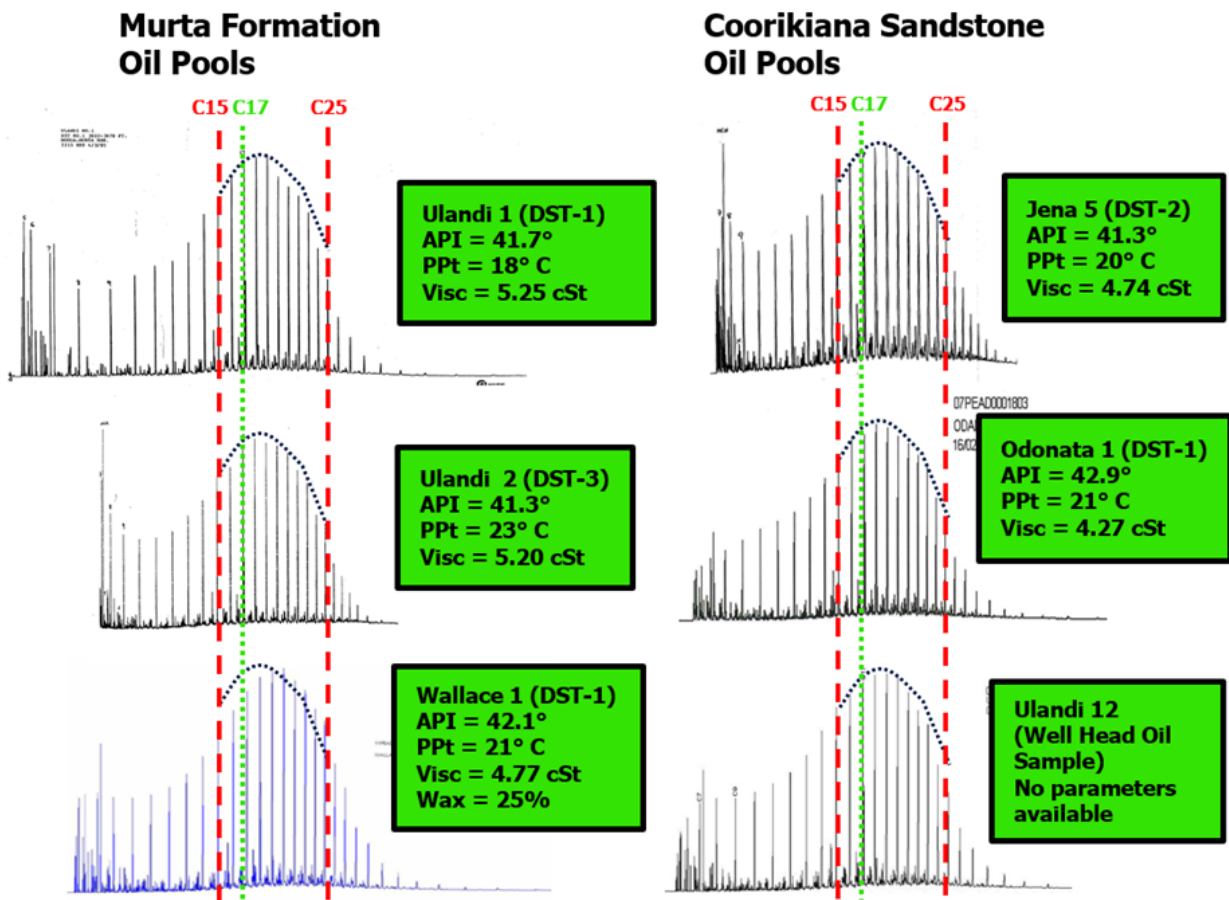


Figure 40. Murta Formation and Coorikiana Sandstone oil gas chromatography plots for key wells in the JALBU Complex. For location of samples see Figure 39. Santos Ulandi 1 (1985), Ulandi 2 (1989), Jena 5 (1990), Ulandi 12 (2003), Odonata 1 (2007), Wallace 1 (2012) well completion reports.

4.6. MIGRATION PATHWAYS

Migration of oil and gas into the shallow horizon of the Coorikiana Sandstone of the Eromanga Basin is shown in Figure 41. These hydrocarbon traps are shown as the shallowest tilted fault blocks.

The model for successful migration of hydrocarbons, one oil and one gas, into the Coorikiana Sandstone will be discussed herein. The oil example is taken from the discoveries of Coorikiana Sandstone oil pools on the JALBU Complex (Fig. 11), specifically examining the migration of oil into the Bugito to Seccante region (traverse A-B, Fig. 12) and Bugito to Isoptera to Ulandi region (traverse C-D, Fig. 12). In Figure 12, the 3D seismic response for these two traverses, A-B and C-D, show the key seismic events and faults pivotal to the migration narrative. These key items have been captured in both Figures 42 and 43 highlighting the charge and migration of oil into the discovered and potentially yet to be discovered oil pools in the Coorikiana Sandstone in these areas. In Figures 42 and 43, the key fault conduit (in green) allows for the direct vertical migration of oil from the underlying Murta Formation and McKinlay Member/Namur Sandstone section. These deeper fault extensions into underlying hydrocarbon pools are pivotal in allowing hydrocarbon charge into Coorikiana Sandstone reservoirs. Once oil has first migrated into the Coorikiana Sandstone, further migration can then occur via fill and spill and/or via juxtaposition of reservoirs across faults into neighbouring fault blocks. This can lead to a more convoluted migration pathway once the oil has travelled up the primary fault conduit(s).

In the case for the proven gas-charged Coorikiana Sandstone of the Marabooka/Mudera/Namur/Strzelecki Complex (Fig. 4), the charge and migration model invoked is one of either direct migration from the key fault conduit (in red, Fig. 44) from the underlying Permian section of the Cooper Basin and/or direct vertical migration of gas from the underlying Murta Formation and McKinlay Member/Namur Sandstone section of the Eromanga Basin. Figure 44 is the proposed charge and migration model for the Namur Field Coorikiana Sandstone reservoir (field location Fig. 45). Like the proposed charge/migration model for the oil example above, once gas has first migrated into the Coorikiana Sandstone migration can then occur via fill and spill and/or via juxtaposition of reservoirs across faults into neighbouring fault blocks. This can lead to a more convoluted migration pathway once the gas has travelled up the primary fault conduit(s). Figure 46 is a 3D seismic traverse section on which the charge and migration model has been proposed in Figure 44.

Although lateral oil charge on the Jena-Alwyn-Limestone Creek-Biala-Ulandi Complex, based on current drill results, appears to have thus far travelled up to 3 km for the primary fault conduit, in the case for the Marabooka/Mudera/Namur/Strzelecki Complex, there is the potential that gas charge has migrated laterally by up to 10 km. It is for this reason that an arbitrary 10km limit has been shown on the Coorikiana Sandstone play extent map (Fig. 47), away from the Cooper Basin margin.

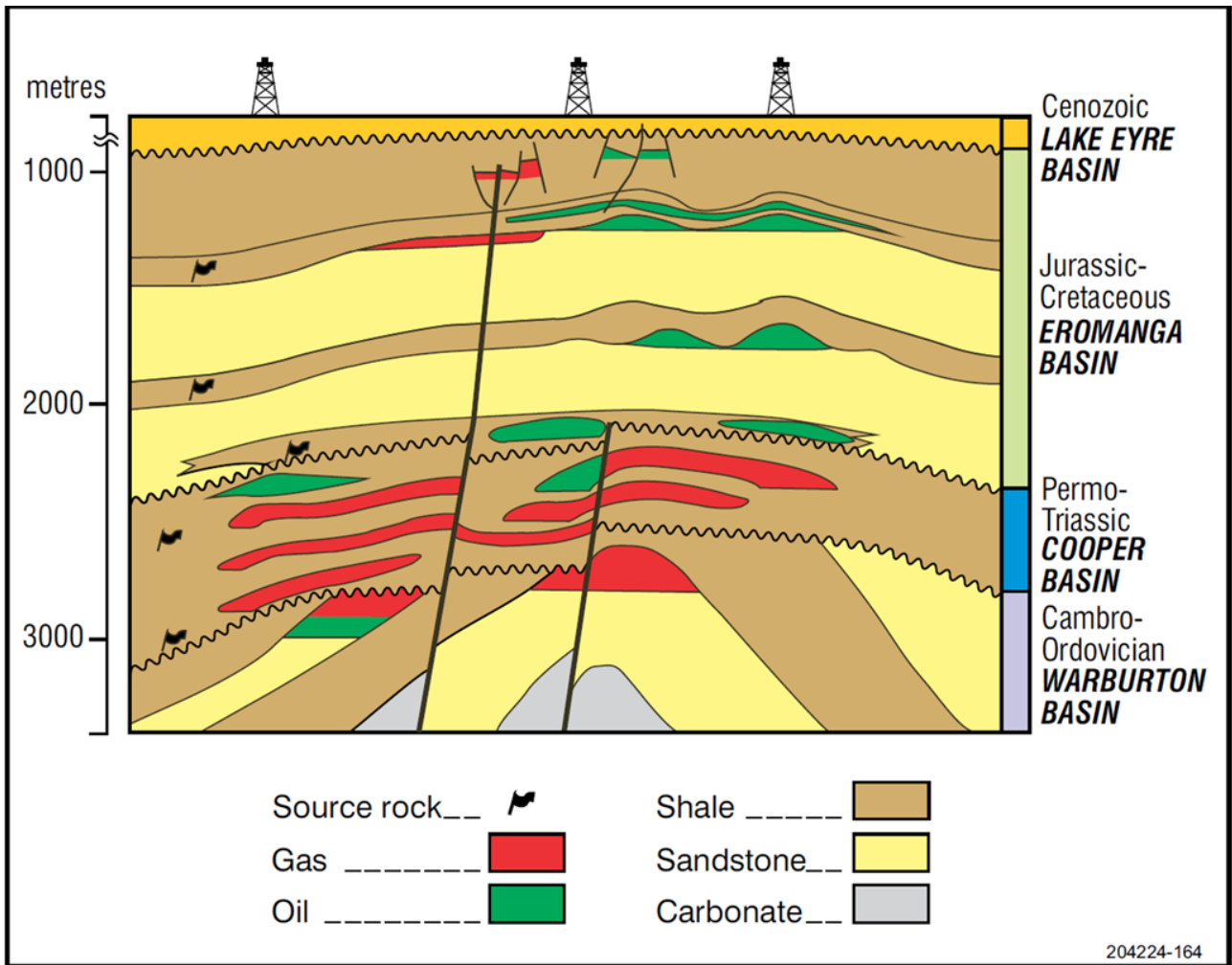


Figure 41. Schematic section showing typical petroleum traps in the Eromanga, Cooper and Warburton Basins.

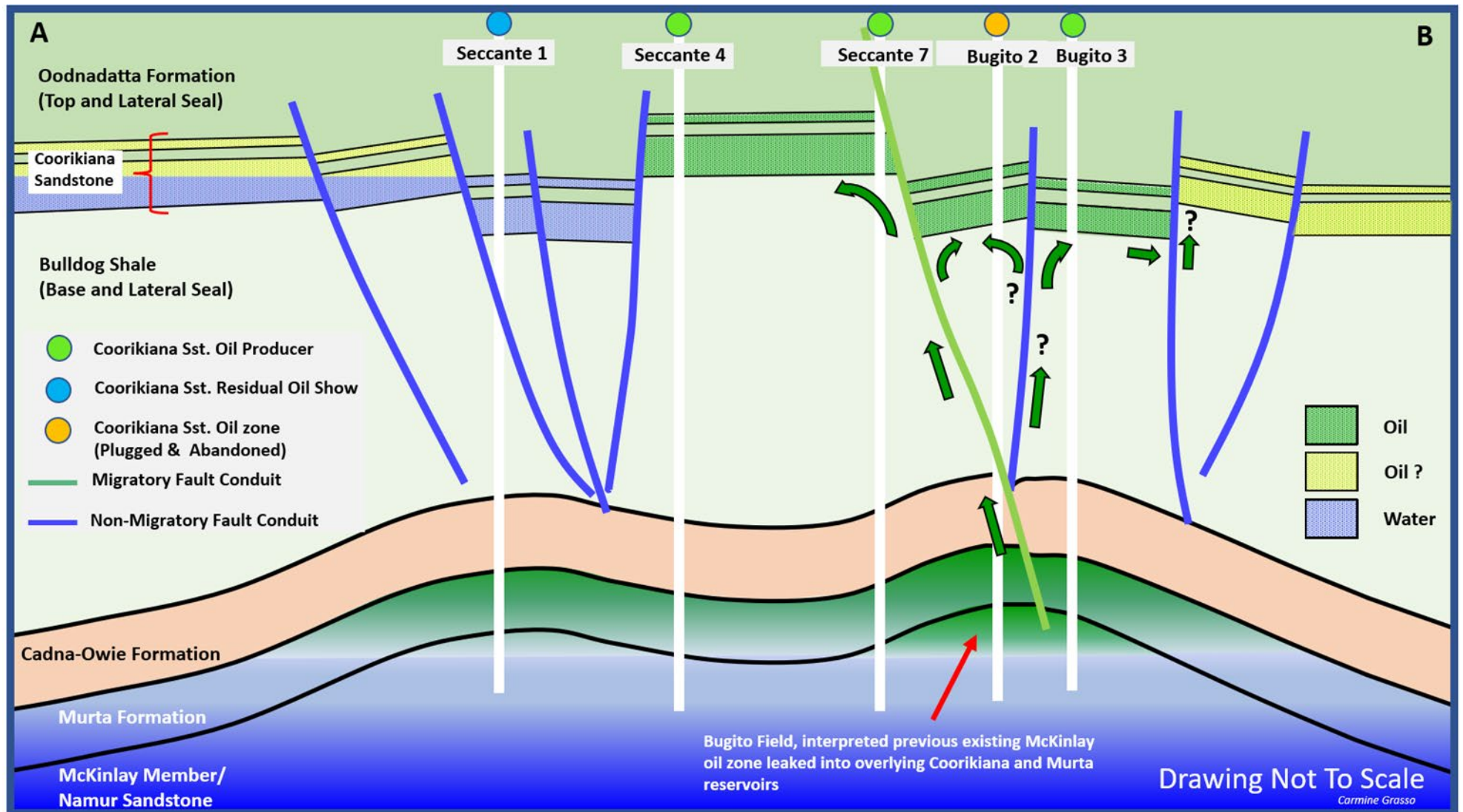


Figure 42. Oil charge and migration model into the Coorikiana Sandstone for the Bugito to Seccante region. See Figure 11 for location of traverse.

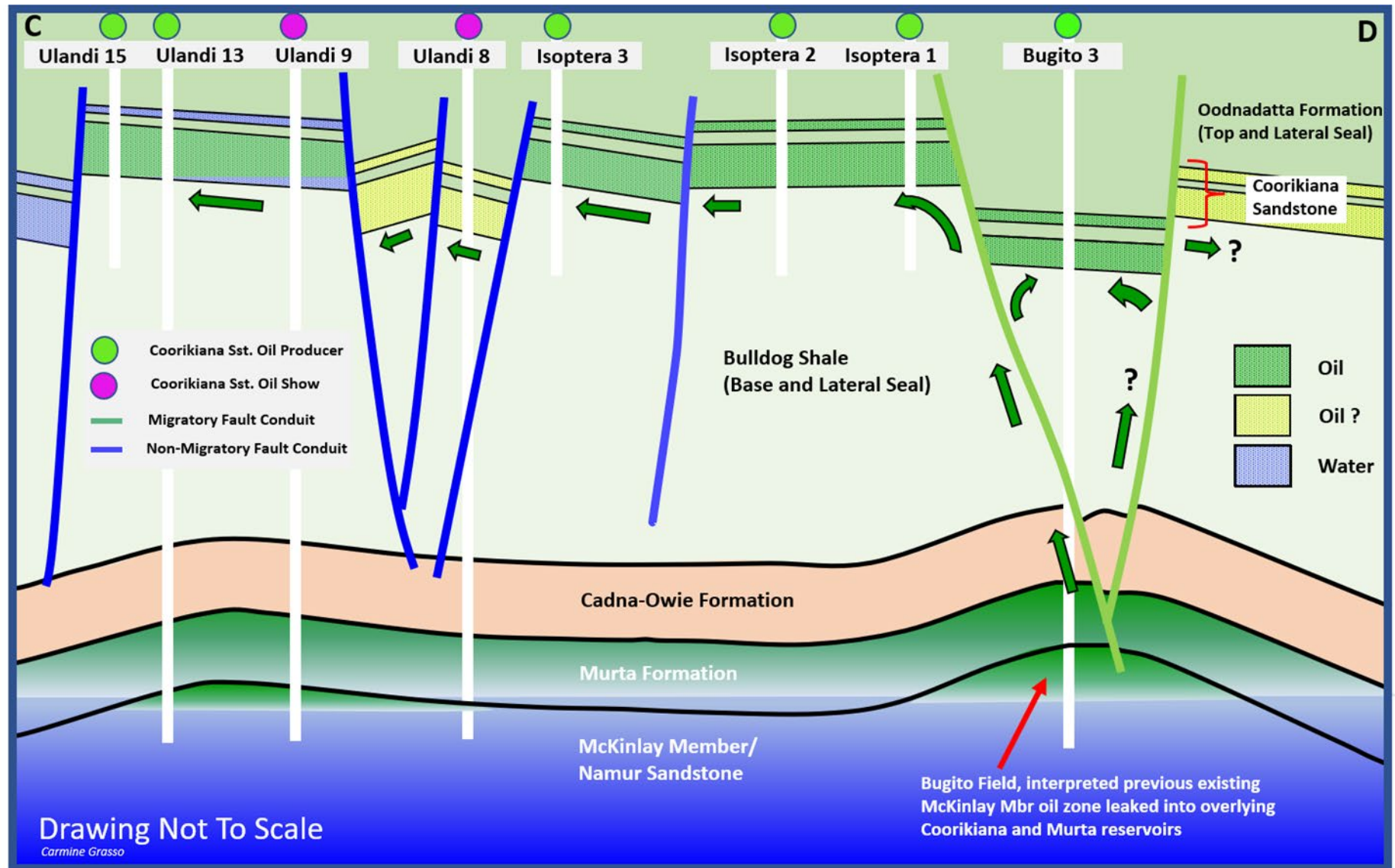


Figure 43. Oil charge and migration model into the Coorikiana Sandstone for the Bugito-Isoptera-Ulandi region. See Figure 11 for location of traverse.

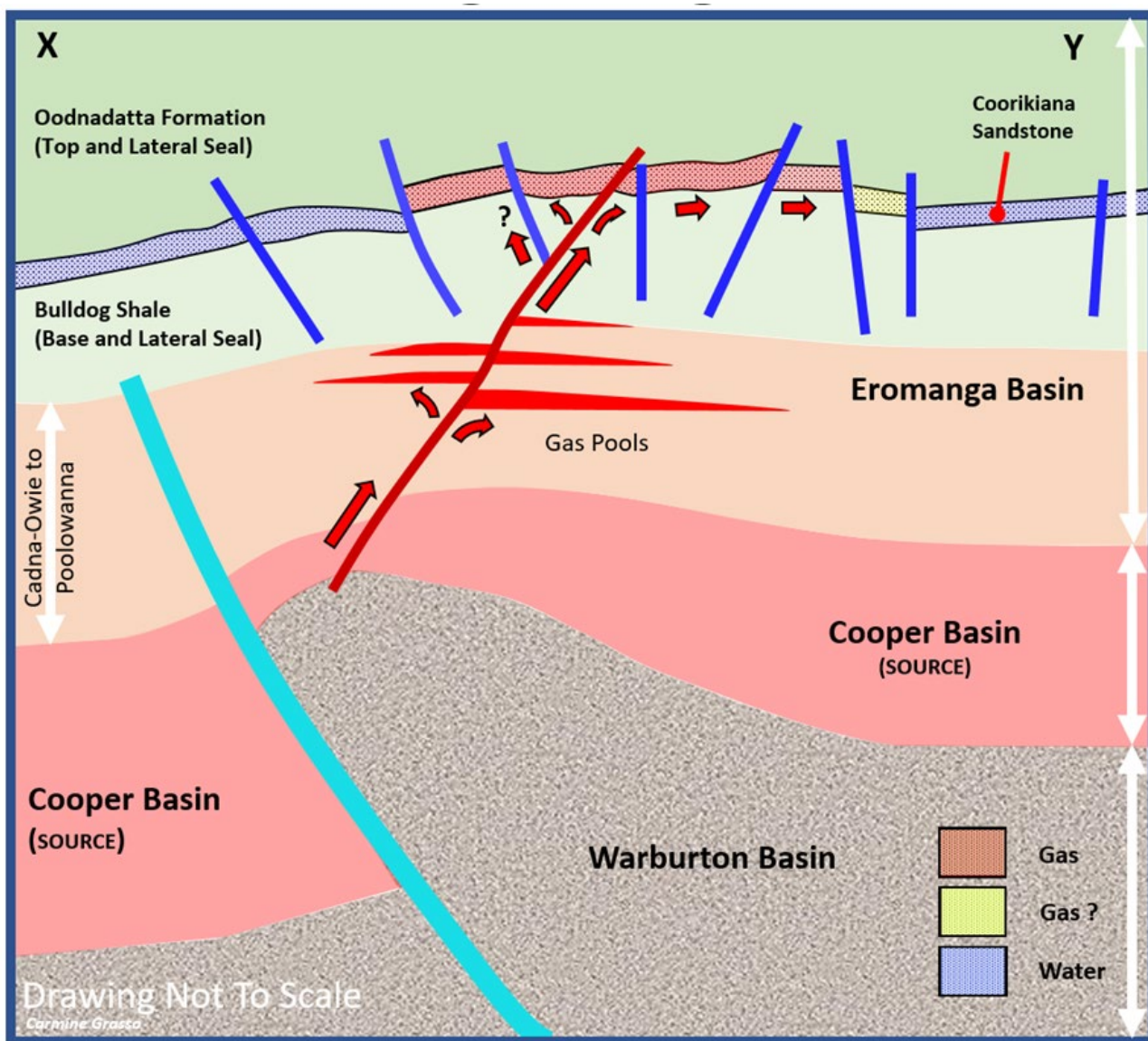


Figure 44. Gas charge and migration model into the Coorikiana Sandstone for the Namur Field.

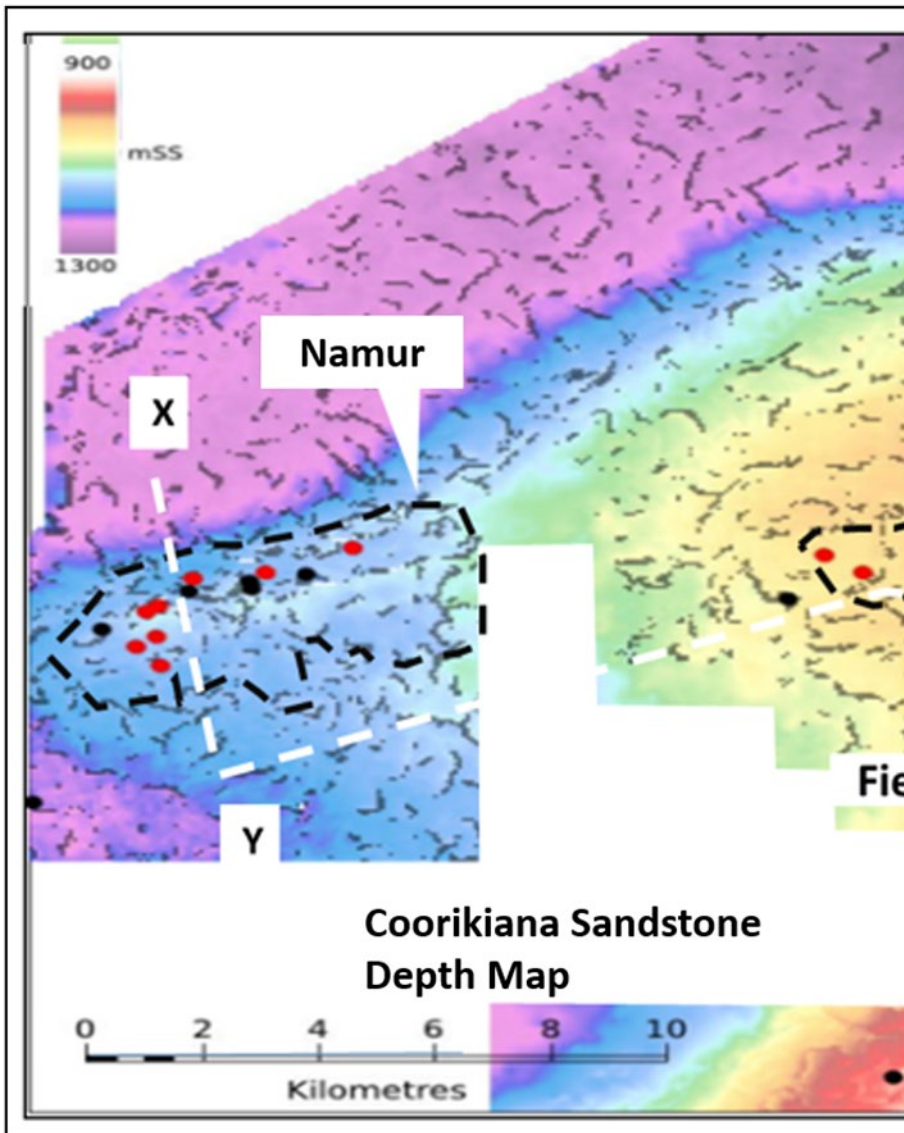


Figure 45. Namur Gas Field Top Coorikiana Sandstone depth map. Modified from Mishra et al. (2021).

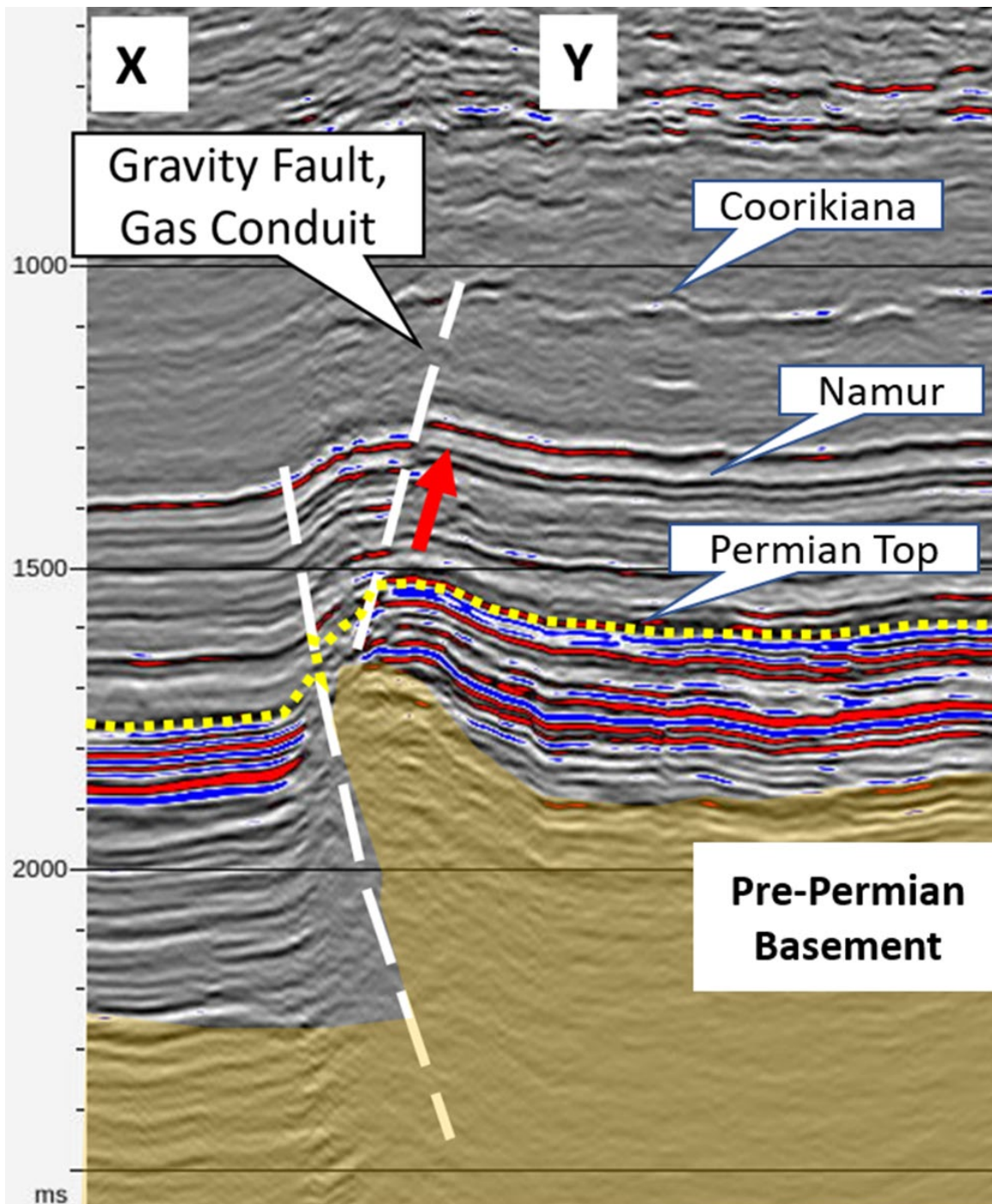
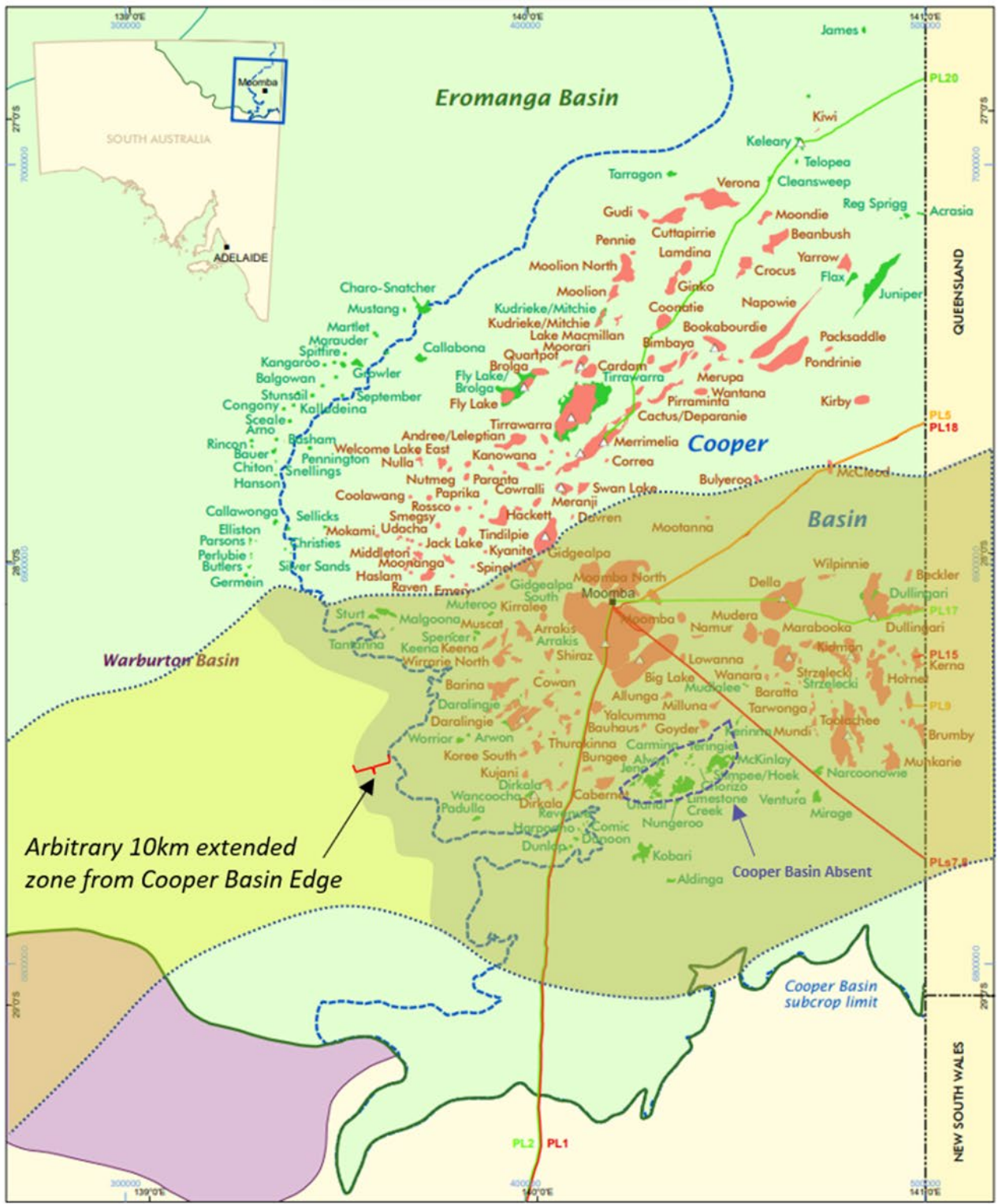


Figure 46. Seismic traverse over the Namur Gas Field. See Figure 45 for traverse location. Modified from Mishra et al (2021).

4.7. PLAY EXTENT

The Coorikiana Sandstone play exists in the Cooper Basin region of the study area of the Eromanga Basin, proven by oil and gas discovered and produced in several fields. Although these discoveries are located along major structural features related to the underlying older Warburton and Cooper basins (Fig. 4) there is potential for further discoveries if all the play elements are met. Figure 47 shows the approximate extent of the Coorikiana Sandstone play. The 10 km arbitrary zone allows for the potential for lateral migration of hydrocarbons to nearby fault blocks.

Figure 48 displays where oil shows, and current discovered oil fields are in the Coorikiana Sandstone as of August 2022. It is important to note that a discovered oil field may contain several connected or independent oil pools. Figure 49 displays the current gas fields discovered in the Coorikiana Sandstone as of August 2022.



Arbitrary 10km extended zone from Cooper Basin Edge

- Production facility
- Gas field
- Oil field
- Extent of Coorikiana Sandstone
- Play Extent of Coorikiana Sandstone

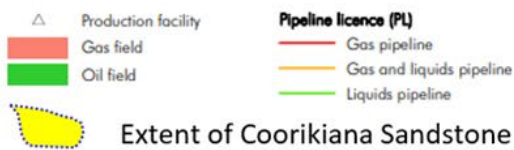
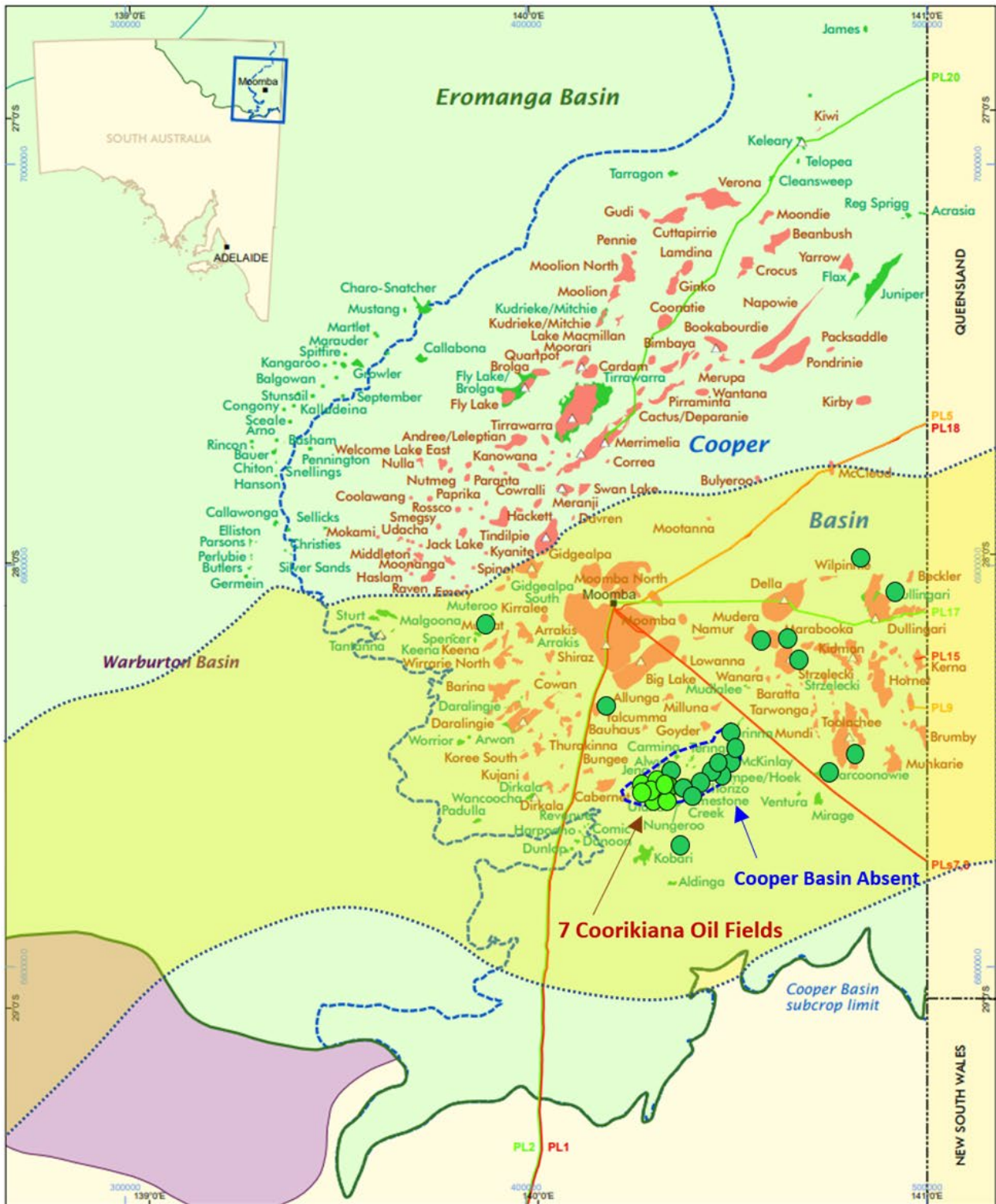
- Pipeline licence (PL)**
- Gas pipeline
- Gas and liquids pipeline
- Liquids pipeline

0 25 50 km
MGA Zone 54

Government of South Australia
Department for Energy and Mining

**Cooper and Eromanga basins
South Australia
OIL and GAS FIELDS**

Figure 47. Coorikiana Sandstone play extent within Cooper Basin region of the study area.
The 'Cooper Basin absent' polygon is an area often referred to as the Murteree Horst.



**Cooper and Eromanga basins
South Australia
OIL and GAS FIELDS**

ERD 204662-004

Figure 48. Coorikiana Sandstone play extent showing wells with oil shows (dark green) and producing fields (light green) as of August 2022.

5. COORIKIANA PRODUCTION HISTORY

The Coorikiana Sandstone play production history are summarised in Figure 50 for oil and Figure 51 for gas and Figure 52 for both oil and gas. These three graphs show rate and production with time annotated with significant events relating to this play. It is particularly evident with the prioritization of the Coorikiana Sandstone play on JALBU Complex in recent years, that there has been a significant uplift to both volumetric oil in place and reserves with a positive flow on effect to oil rate and production.

One major advance to both oil and gas rate has been successful fracture stimulation of the reservoir rock. In the oil sphere, non-fracture stimulated wells come online at between 10 to 70 bopd. With recent 2020 oil drilling campaign on the JALBU Complex, the Coorikiana Sandstone has been fracture stimulated post completion, delivering rates more than 100 bopd. Isoptera 1, drilled in 2017 was not fracture stimulated post-completion. However, a couple of years later, this well's monthly average oil rate had dropped to 25 bopd. But post-fracture stimulation, the rate increased 3-fold to a monthly average of 75 bopd demonstrating the economic value of fracture stimulation.

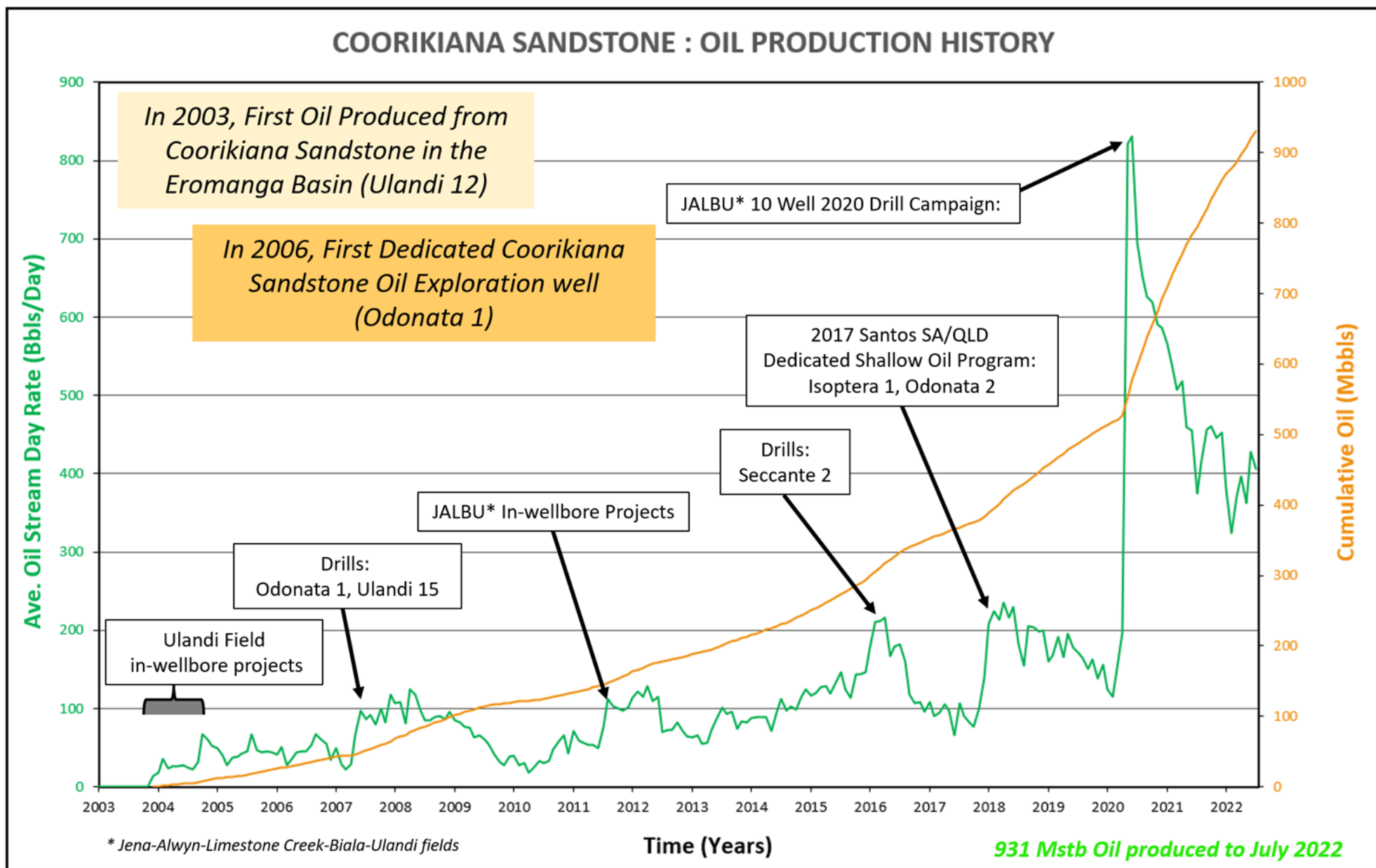


Figure 50. Coorikiana Sandstone showing oil production history and significant events as of July 2022.

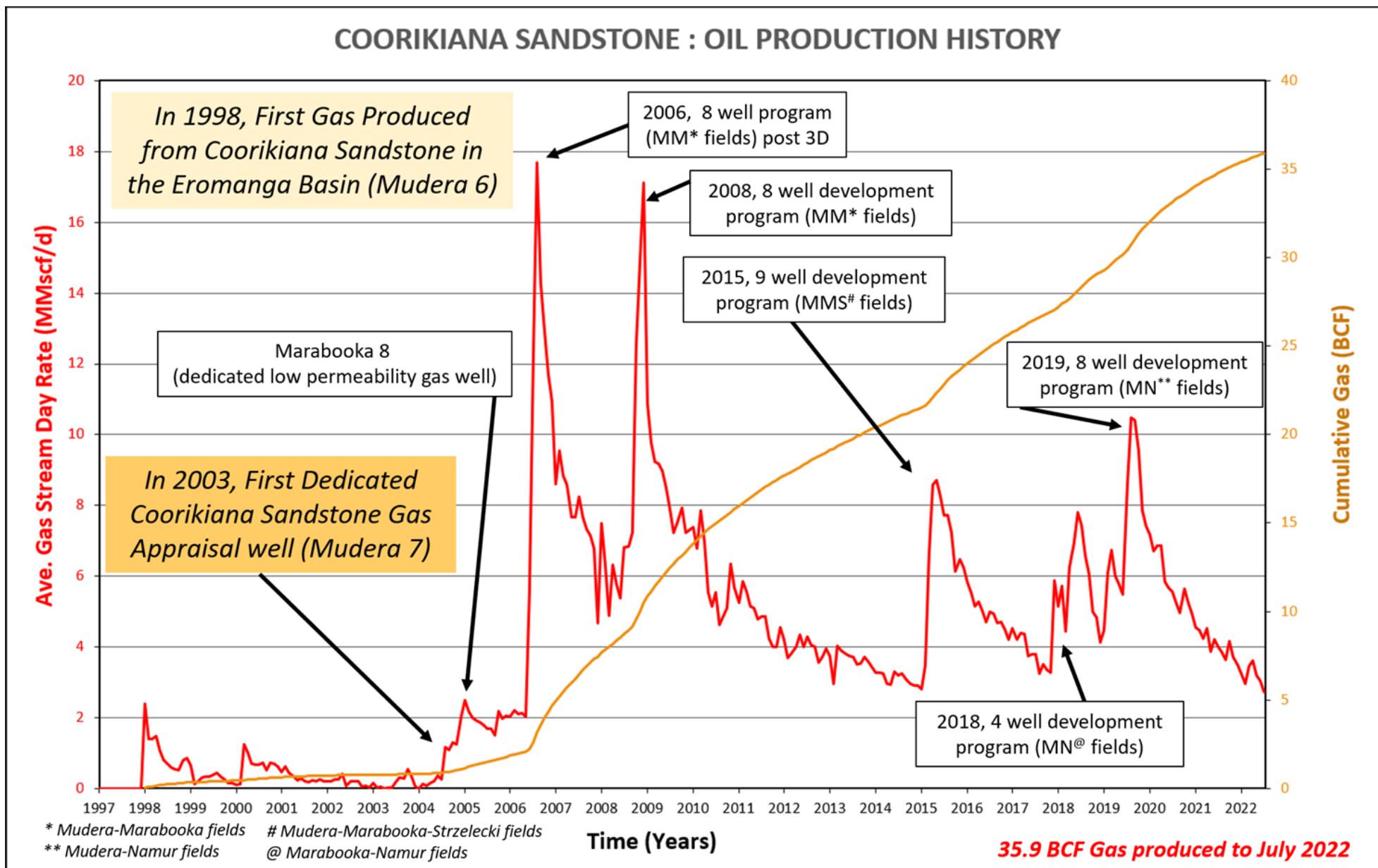


Figure 51. Coorikiana Sandstone showing gas production history and significant events as of July 2022.

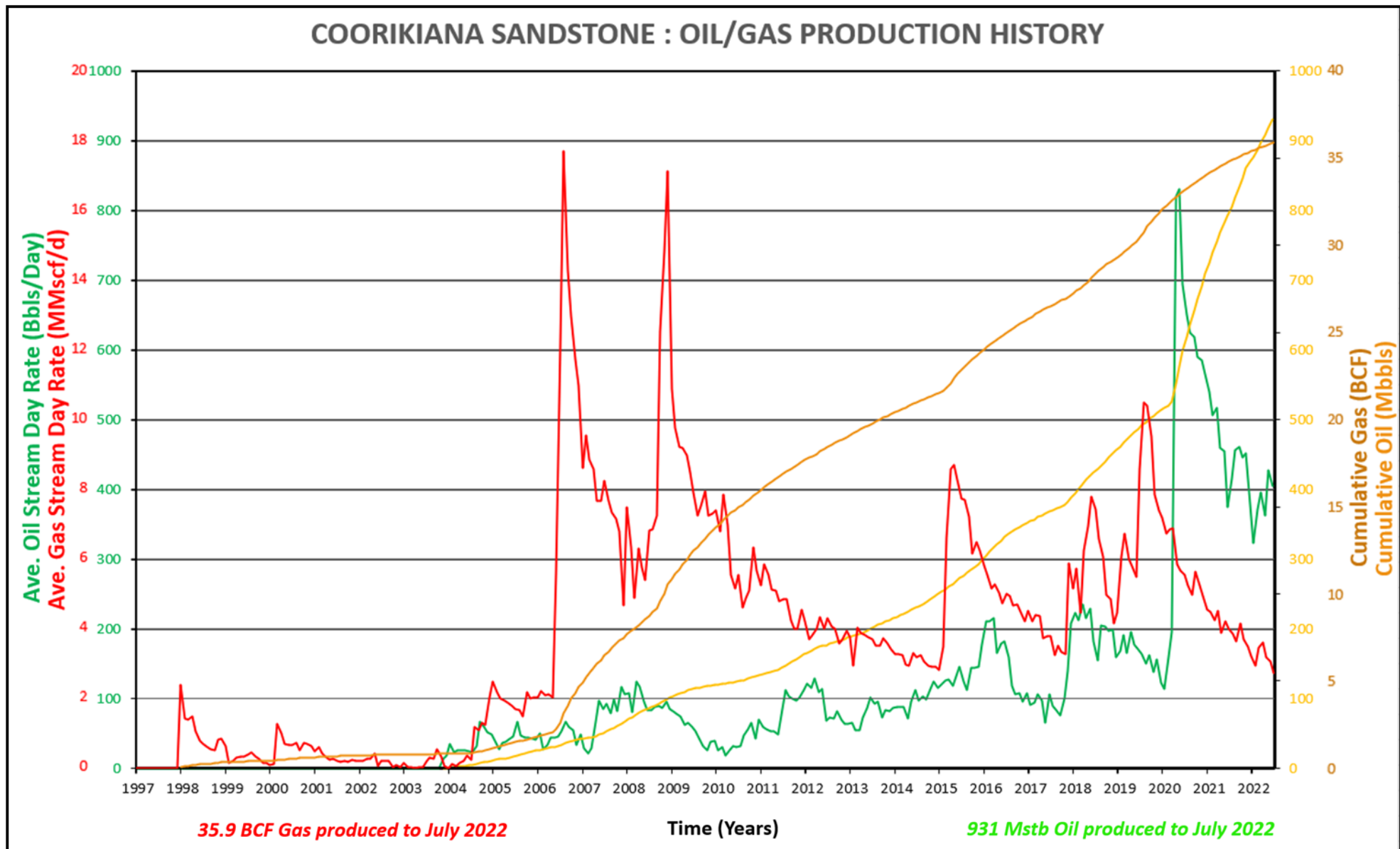


Figure 52. Coorikiana Sandstone showing oil and gas production history as of July 2022.

6. UNDISCOVERED POTENTIAL RESOURCES

Oil production from the Coorikiana Sandstone to the end of July 2022 was close to 1 MMstb from 7 fields, with further production likely to occur.

If 10 more fields were to be discovered it is not unreasonable to expect that there would be at least 10 MMstb of oil in place. Confidential information available to DEM suggests it is likely that the undiscovered oil potential for the Coorikiana Sandstone in South Australia could be significantly larger than this.

Gas production from the Coorikiana to the end of July 2022 was 35.9 BCF from 4 fields. A similar amount may be as yet undiscovered.

7. CONCLUSIONS

Petroleum exploration and development has historically been prioritised for the deeper gas reservoirs of the Cooper Basin, although the Jurassic and earliest Cretaceous reservoirs of the Eromanga Basin have also been targeted for oil reserves. However, it has only been in the last 20 years that consideration has been given to the shallowest reservoirs above the Cadna-owie Formation in the Eromanga Basin.

The Coorikiana Sandstone play in the South Australian Cooper Basin region can be a geologically complex section making identification of hydrocarbons challenging, particularly due to the low resistivity of any oil present. Typically, the structural configuration at the top Coorikiana Sandstone is independent of the older Eromanga Basin Cadna-owie Formation and deeper Cooper Basin structures.

Recent successful shallow drill campaigns that have specifically targeted the Coorikiana Sandstone have demonstrated that significant hydrocarbons can be discovered and produced for this previously overlooked zone.

The shallow Coorikiana Sandstone provides incumbent and future explorers and developers a genuine bona fide hydrocarbon target as a relatively low cost and shallow depth drilling opportunity in the Eromanga Basin section of the Cooper Basin in South Australia.

APPENDIXES

1. HYDROCARBON FLOW RATES AND KEY EVENTS IN SOUTH AUSTRALIAN WELLS FOR THE COORIKIANA SANDSTONE IN THE COOPER BASIN REGION OF THE EROMANGA BASIN

Well	Year	Activity	Hydrocarbon type	Shows (Mudlog)	Flow rate / Recovery
Strzelecki 4	1981 (January)	Exploration Well (Oil – targeted deeper reservoirs) Drill Stem Test (DST) in open drill hole	Gas	Gas show: [upper cycle] Total Gas (TG) peak of 32 units* over background of 1. Oil show: Nil. Gas show: [lower cycle] Total Gas (TG) peak of 262 units over background of 3. Oil show: Nil	DST 1: Gas to surface (GTS) at a rate too small to measure (RTSTM). Recovered: 214ft Gas-Cut Muddy Water <i>This gas show and DST is significant as possibly the shallowest formation in this part of the Eromanga Basin</i>
McKinlay 1	1981 (May)	Exploration Well (Oil) Full hole core (8 ½") <i>First successful full hole core cut across uppermost, thinnest reservoir section in the Coorikiana Sst</i>	Oil	Gas show: No increase in background gas Oil show: Trace, dull yellow patchy fluorescence with no cut.	No DST conducted <i>This oil show is significant as possibly the shallowest depth in this part of the Eromanga Basin</i>
Corkwood 1	1981 (July)	Exploration Well (Oil/Gas) DST in open drill hole	Oil	Gas show: Total Gas (TG) peak of 80 units over background of 10. Oil show: 20% very dull spotted fluorescence, with instant crush cut and thin ring residue.	DST 1: No Fluid to Surface (NFTS). Recovered: 120ft Mud with trace oil.
Marabooka 3	1984 (April)	Development Well (Gas – targeted deeper reservoirs) DST in open drill hole <i>First successful significant gas flow and indicator of reservoir productivity.</i>	Gas	Gas show: Total Gas (TG) peak of 1136 units over background of 10. Oil show: Nil	DST 1:GTS at a rate of 0.65 MMscf/d**. Recovered: 10ft of condensate-cut mud and 269ft of gas cut mud Zone fracture stimulated flowing 1.16 MMscf/d through a 24/64" choke. Zone was subsequently cemented off prior to completion across the deeper Namur Sandstone.
Mudera 2	1984 (September)	Exploration/App-raisal Well (Gas) DST in open drill hole across upper (1) and lower (8) reservoir cycles <i>First successful individual gas flows across upper and lower Coorikiana reservoir intervals.</i>	Gas	Gas show: [upper cycle] TG peak of 1742 units over background of 30. Oil show: Nil Gas show: [lower cycle] TG peak of 300 units over background of 40. Oil show: Nil	DST 1: GTS at a rate of 0.05 MMscf/d. Recovered: 110ft of mud DST 8: GTS at a rate of 0.09 MMscf/d. Recovered: 277ft of slightly gas-cut mud

Well	Year	Activity	Hydrocarbon type	Shows (Mudlog)	Flow rate / Recovery
Marabooka 4	1986 (February)	Development Well (Gas) Full hole core (8 ½") DST in open drill hole Full hole core (8 ½") First successful full hole core cut across lowermost, thickest gas-prone reservoir section in the Coorikiana Sst	Gas	Gas show: TG peak of 100 units over background of 2. Oil show: Nil	DST 1: Lost Packer. Recovered: 1004ft Mud
Jena 5	1989 (September)	Development Well (Oil – targeted deeper reservoirs) DST in open drill hole	Oil	Gas show: TG peak of 35 units over background of 3. Oil show: 80% patchy, moderately bright, yellow and yellow/white fluorescence with instant crush cut and thick ring residue.	DST 2: NFTS. Recovered: 30ft of oil, 200ft very muddy water and 550ft water. First measurable oil and indicator of reservoir productivity across a potential oil zone. This well tested an oil water contact (OWC).
Mudera 6	1998 (January) N.B: Drilled April 1997	Development Well (Gas – targeted deeper reservoirs) Completed across the Coorikiana reservoir sections	Gas	Gas show: TG peak of 1000 units over background of 80. <i>Excellent gas shows accompanied by the best wire-line log response seen in the Eromanga Basin</i> Oil show: Nil	On-line gas rate at 2.4 MMscf/d (first month average) First gas production from this zone in Eromanga Basin
Marabooka 7	2002 (October)	Development Well (Gas – targeted deeper reservoirs) Full hole core (8 ½") DST in open drill hole across upper (1) and lower (2) reservoir cycles Partial success of full hole core cut across uppermost reservoir section in Coorikiana Sst	Gas	Gas show: TG peak of 950 units over background of 5.	DST 1: Misrun – Packer Failure. DST 2: Misrun – Packer Failure.
Ulandi 12	2003 (December) N.B: Drilled August 2003	Development Well (Oil – targeted deeper reservoirs) Completed across the Coorikiana reservoir section Zone was not control drilled#	Oil	Gas show: TG peak of 70 units over background of 4. Oil show: 10% moderately bright greenish/yellow spotted to patchy fluorescence, with moderate to slow diffuse cut and thick ring residue.	On-line oil rate at 35 BOPD*** (first month average) First oil production from this zone in the Eromanga Basin
Ulandi 10	2003 (August)	Development Well (Oil – targeted deeper reservoirs) Completed across the Coorikiana reservoir section Zone was control drilled	Oil	Gas show: TG peak of 12 units over background of 2. Oil show: 10%-60% of dull to moderately bright greenish/yellow spotted to patchy fluorescence, with slow streaming cut, thick residual ring.	On-line oil rate at 30 BOPD (peak month average) Demonstrated the important value of control drilling, especially on the oil show description

Well	Year	Activity	Hydrocarbon type	Shows (Mudlog)	Flow rate / Recovery
Marabooka 8	2004 (July)	Development Well (Gas) Completed across the Coorikiana reservoir sections	Gas	Gas show: [upper cycle] TG peak of 1000 units over background of 30. Oil show: Trace to 10% dull orange patchy fluorescence, very slow blooming cut, moderate to strong yellow/green crush cut, thin ring residue. Gas show: [lower cycle] TG peak of 300 units over background of 40. Oil show: Nil	On-line gas rate at 2.0 MMscf/d (first month average) Part of the Advanced Technology Pilot Delineation Program targeting low permeability gas resources.
Bugito 1	2005 (August)	Exploration Well (Oil – targeting deeper reservoirs) Coorikiana reservoir interval not control drilled	Oil	Gas show: TG peak of 6 to 12 units over background of 4. Oil show: Trace bright yellow patchy fluorescence, no cut, strong crush cut, thin ring residue.	On-line oil rate at 15 BOPD (peak month average) Oil producing zone, despite zone not control drilled leading to a very poor oil and gas show on mudlog
Mudera 10	2006 (April)	Development Well (Gas) Completed across the Coorikiana reservoir sections	Gas	Gas show: [upper cycle] TG peak of 191 units over background of 15. Oil show: Nil Gas show: [lower cycle] TG peak of 182 units over background of 15. Oil show: Nil	On-line gas rate at 5.8 MMscf/d (first month average) This is highest recorded on-line gas rate from this zone in the Eromanga Basin
Ulandi 15	2006 (October)	Appraisal Well (Oil) Full hole core (8 ½") First successful full hole core cut across the lower most, thickest reservoir oil-prone section in the Coorikiana Sandstone albeit only 18ft of 54ft cut recovered (33%)	Oil	Gas show: [upper cycle] TG peak of 18 units over background of 8. Oil show: Trace (to rare specks) dull to moderately bright yellow green pin-point to occasional spotted fluorescence, no direct cut, very slow dull yellow crush cut, moderately thick yellow residue ring. Cored Interval Gas show: [lower cycle] TG peak of 24 units over background of 5. Oil show: 20-60% dull to moderately bright yellow green, yellow white patchy to even fluorescence, no direct cut, slow diffuse to streaming yellow crush cut, moderate to thin yellow white residue ring.	On-line oil rate at 33 BOPD (peak month average)
Odonata 1	2006 (November)	Exploration Well (Oil) DST in open drill hole across lower cycle First dedicated Coorikiana Sandstone oil exploration well in the Eromanga Basin	Oil	Gas show: TG peak of 58 units over background of 3. Oil show: 50-80% moderately bright green pinpoint, patchy, moderately rapid crush cut, thin pale yellow green film residue.	DST 1: NFTS. Recovery; 13 Bbls Oil, 1 Bbl Muddy Oil, 2 Bbls Muddy Water On-line oil rate at 45 BOPD (peak month average)

Well	Year	Activity	Hydrocarbon type	Shows (Mudlog)	Flow rate / Recovery
Bugito 2	2007 (November)	Appraisal Well (Oil – targeting deeper formations) Coorikiana reservoir interval control drilled	Oil	Gas show: TG peak of 50-80 units over background of 12. Oil show: 100% - 50% dull to moderately bright yellow – green even to patchy and pinpoint fluorescence, slow diffuse cut, very slow streaming cut in part, thin moderately bright yellow residue ring	Well Plugged and Abandoned due to economic conditions. <i>Demonstrated the important value of control drilling, especially on the oil show description when compared with nearby Bugito 1</i>
Isoptera 1	2017 (November)	Exploration Well (Oil) Completed across the Coorikiana reservoir sections in January 2018 Fracture stimulated 2 ½ years later <i>August 2020, first successful demonstration of the effectiveness of fracture stimulation on the Coorikiana oil reservoirs, increasing oil rate three-fold.</i>	Oil	Gas show: [upper cycle] TG peak of 73 units over background of 15. Oil show: 50-80% dull and bright yellow/green, patchy and solid, instant weak dispersive cut, strong crush cut, thick residue ring, moderate film residue. Gas show: [lower cycle] TG peak of 165 units over background of 50. Oil show: 50%, predominantly bright, occasionally dull yellow/green solid and occasionally patchy, weak instant cut, slow dispersive cut, strong crush cut, thick ring and moderate film residue.	On-line oil rate at 45 BOPD (peak month average). Rate declined to 23 BOPD (month average) 2 ½ years after initial completion. Zone fracture stimulated with peak oil rate at 75 BOPD (57 BOPD month average).
Isoptera 3	2020 (February)	Appraisal Well (Oil) Completed across the Coorikiana reservoir sections	Oil	Gas show: [upper cycle] TG peak of 145 units over background of 32. Oil show: 90-100% of sandstone, bright & occasionally dim yellow white, solid, occasionally patchy, weak instant cut, moderate dispersive/ blooming cut, slow streaming cut, strong crush cut, thick residue ring. Gas show: [lower cycle] TG peak of 280 units over background of 41. Oil show: 80-90% of sandstone, bright & dim yellow white, solid and patchy, weak instant cut, moderate blooming cut, moderate crush cut, thick residue ring, trace film.	On-line oil rate at 121 BOPD (peak month average) <i>This is highest recorded on-line oil rate from this zone in the Eromanga Basin</i>

2. MARABOOKA 4 FULL HOLE CORE DESCRIPTIONS AND CORE ANALYSIS RESULTS

WELL: MARABOOKA 4 **Ft. Cut:** 30'11" **Page:** 1 of 7
Core No.: 1 **Ft. Rec.:** 9'10" **Date:** 23/01/86
Interval: 3386'-3395'10" **Recovery %:** 31.8% **Core head:** CHRIST RC4 8½"
Formation: Early Cretaceous **Geologist:** R. Schlichting & A. Freeman

DEPTH	LITHOLOGY	sample	DESCRIPTION	O %	K(md)
3386 (9.0)	[Lithology: Siltstone with horizontal bedding]	SP1	3386'-3386'2" Siltstone grading to claystone. Siltstone: medium grey, soft to firm, slightly arenaceous.	7.9	0.003
3387 (1.2)					
3388 (4.5)	[Lithology: Sandstone with horizontal bedding]	SP2	3386'2"-3386'11½" Sandstone: light grey to grey green, moderate firm to friable, very fine to fine, poor to moderate sorting, subangular to subrounded, argillaceous matrix, micromicaceous in part, glauconitic, very poor porosity.	24.7	2.9
3389 (11.0)					
3390 (16.8)	[Lithology: Siltstone with horizontal bedding]	SP3	3386'1½"-3387'3" Siltstone grading in part to sandstone. Siltstone: light grey, firm to friable, abundant siltstone to very fine grain quartz, argillaceous matrix, micromicaceous in part, glauconitic in part.	23.1	0.050
3391 (12.5)					
3392 (7.2)	[Lithology: Sandstone with horizontal bedding]		3387'3"-3390' Sandstone interlaminated with siltstone. Also abundant cross laminations and slump structures. Sandstone: light grey to light green grey, firm to friable, very fine, moderate sorting, subangular to subrounded, argillaceous matrix, glauconitic, micromicaceous in part. Tight porosity. Siltstone: as above.		
3393 (13.5)					
3394 (11.2)	[Lithology: Interlaminated sandstone and siltstone]	SP4	3390'-3395'10" Interlaminated siltstone and sandstone containing abundant silty sandstone intraclasts and minor limestone inclusions. Also abundant slump structures. Sandstone: as above. Siltstone: as above.	21.8	0.44
3395 (14.8)					

Figure A2.1 Marabooka 4 core 1 description, interval 3386' – 3395' 10" (driller's depth).

WELL : MARABOOKA 4
 Core No. : 2
 Interval : 3395'10"-3405'

Ft. Cut : 40'1"
 Ft. Rec. : 58'6" (inc. C#1)
 38'7" (C#2 only)
 Recovery % : 96.3%
 Formation : Early Cretaceous

Page : 1 of 7
 Date : 24/01/86
 Core head : CHRIST CIRC4
 Geologist : R. Schlichting &
 A. Freeman

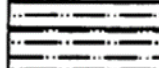
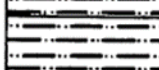
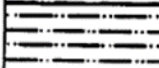
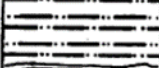
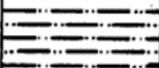
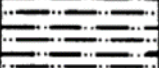
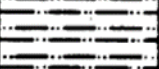
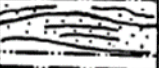
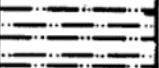
DEPTH	LITHOLOGY	sample	DESCRIPTION	O %	K(md)
3395'10"					
3396 (18.2)		3395'10"-3426'7"	Siltstone: light grey to medium grey, argillaceous matrix, minor carbonaceous fragments with trace very finely laminated silty sandstone.		
3397 (21.5)					
3398 (20.5)					
3399 (23.0)					
3400 (25.0)					
3401 (24.0)					
3402 (22.2)					
3403 (21.5)					
3404 (28.8)					

Figure A2.2 Marabooka 4 core 2 description, interval 3395' 10" – 3405' (driller's depth).

WELL : MARABOOKA 4
 Core No. : 2
 Interval : 3405' - 3415'

Ft. Cut : 40'1"
 Ft. Rec. : 58'6" (C#18 C#2)
 Recovery % : 38'7" (C#2)
 Formation : 96.3%
 Early Cretaceous

Page : 2 of 7
 Date : 24/01/86
 Core head : CHRIST C1 RC4
 Geologist : R. Schlitching
 A. Freeman

DEPTH	LITHOLOGY	sample	DESCRIPTION	O %	K(md)
3405 (25.8)	[Lithology pattern]				
3406 (27.5)	[Lithology pattern]				
3407 (21.0)	[Lithology pattern]				
3408 (19.1)	[Lithology pattern]				
3409 (18.5)	[Lithology pattern]				
3410 (19.5)	[Lithology pattern]				
3411 (19.8)	[Lithology pattern]				
3412 (23.2)	[Lithology pattern]				
3413 (20.3)	[Lithology pattern]				
3414 (27.0)	[Lithology pattern]				

Figure A2.3 Marabooka 4 core 2 description, interval 3405' - 3515' (driller's depth).

WELL : MARABOOKA 4
 Core No. : 2
 Interval : 3415'-3425'

Fl. Cut : 40'1"
 Fl. Rec. : 58'6" (C#1:8.2)
 Recovery % : 38'7" (C#2)
 Formation : Early Cretaceous

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 Date : 24/01/86
 Core head : CHRIST C1 RC4
 Geologist : R. Schlitching &
 A. Freeman

DEPTH	LITHOLOGY	sample	DESCRIPTION	O %	K(md)
3415 (23.8)	[Lithology pattern]				●
3416 (10.0)	[Lithology pattern]				
3417 (10.0)	[Lithology pattern]				
3418 (14.0)	[Lithology pattern]				
3419 (24.0)	[Lithology pattern]				●
3420 (35.0)	[Lithology pattern]				
3421 (28.5)	[Lithology pattern]				
3422 (29.5)	[Lithology pattern]				
3423 (29.0)	[Lithology pattern]				
3424 (29.0)	[Lithology pattern]				●
3425	[Lithology pattern]				

Figure A2.4 Marabooka 4 core 2 description, interval 3415' – 3525' (driller's depth).

WELL : MARABOOKA 4
 Core No.: 2
 Interval: 3425'-3435'

Ft. Cut : 40'1"
 Ft. Rec. : 58'6" (C#1 82)
 Recovery % : 38'7" (C#2 only)
 Formation : 96.3%
 Early Cretaceous

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 Date : 24/01/86
 Core head : CHRIST C1 RC4
 Geologist : R. Schlichting & A. Freeman

DEPTH	LITHOLOGY	sample	DESCRIPTION	O %	K(md)
3425 (29.5)					
3426 (25.0)					
3427 (12.5)			Sandstone: light to medium grey, to green grey, friable to moderately, very friable in part, very fine to fine, moderately well to occasionally well sorted, subangular to subrounded calcareous matrix, abundant glauconite with trace pyrite, lithic fragments and carbonaceous flecks, dominately poor to occasionally fair visual porosity, trace silty laminations.	27.6	6.7
3428 (4.5)		SP5		28.8	2.8
3429 (3.5)		SP6		27.7	2.1
3430 (3.5)			Homogeneous sandstone.		
3431 (5.0)		SP7		26.1	1.8
3432 (5.2)				24.7	5.1
3433 (6.0)		SP8		7.3	0.002
		SP9		5.4	0.003
3434 (7.5)		SP10		25.5	0.007

Figure A2.5 Marabooka 4 core 2 description, interval 3425' – 3535' (driller's depth).

WELL : MARABOOKA 4
 Core No. : 2
 Interval : 3435'-3445'

Ft. Cut : 40'1"
 Ft. Rec. : 58'6" (C #1 & 2)
 Recovery % : 96.3%
 Formation : Early Cretaceous

Page : 5 of 6
 Date : 24/01/86
 Core head : CHRIST C1 RC4
 Geologist : R. Schlitching &
 A. Freeman

DEPTH	LITHOLOGY	sample	DESCRIPTION	O %	K(md)
3435 (6.0)	[Dotted Lithology]	SP11		25.7	0.61
3436 (5.0)		SP12		24.9	0.60
3437 (5.5)		SP13		29.1	0.009
3438 (5.5)		SP14		25.1	0.30
3439 (5.0)		SP15		24.9	1.1
3440 (5.1)		SP16		22.6	1.2
3441 (6.0)		SP17		13.6	0.006
3442 (6.5)		SP18		22.5	0.67
3443 (6.0)		SP19		24.7	0.76
3444 (5.5)		SP20		23.8	1.0
3445		SP21		22.5	1.2

Figure A2.6 Marabooka 4 core 2 description, interval 3435' – 3545' (driller's depth).

WELL : MARABOOKA 4
 Core No. : 2
 Interval : 3445'-3455'

Ft. Cut : 40'1"
 FL Rec. : 58'6" (C #1 & 2)
 38'7" (C #2 only)
 Recovery % : 96.3%
 Formation : Early Cretaceous

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 Date : 24/01/86
 Core head : CHRIST C1 RC4
 Geologist : R. Schlitching &
 A. Freeman

DEPTH	LITHOLOGY	sample	DESCRIPTION	O %	K(md)
3445 (4.8)		SP22		23.3	0.58
3446 (5.8)		SP23		14.1	0.12
3447 (2.5)		SP24		23.0	1.1
		SP25		6.9	0.004
3448 (1.0)		SP26		22.3	3.2
3449 (1.0)		SP27		21.8	2.0
3450 (0.8)		SP28		24.4	2.1
3451 (1.0)		SP29		23.3	1.2
3452 (0.8)		SP30		22.3	0.36
3453 (1.0)		SP31		8.1	0.004
3454 (2.5)		SP32	3454'4"-3457" No recovery.	12.0	0.008

Figure A2.7 Marabooka 4 core 2 description, interval 3445' – 3555' (driller's depth).

CORE ANALYSIS RESULTS

Company SANTOS LIMITED Formation COORIKIANA SANDSTONE File CD-SA-192
 Well MARABOOKA NO. 4 Date Report 5 FEB 86
 Field MARABOOKA Analysts DS
 Country AUSTRALIA State SOUTH AUSTRALIA Location COOPER BASIN

Lithological Abbreviations

SAND - SD DOLOMITE - DOL ANHYDRITE - ANHY SANDY - SDY FINE - FN CRYSTALLINE - XLM BROWN - BRN FRACTURED - FRAC SLIGHTLY - S
 SHALE - SH CHERT - CH CONGLOMERATE - CONG SNALY - SNY MEDIUM - MED GRAIN - GRN GRAY - GRV LAMINATION - LAM VERY - VI
 LIME - LM GYPSUM - GYP FOSSILIFEROUS - FOSS LIMY - LMY COARSE - CSE GRANULAR - GRNL VUGGY - VGV STYLOLITIC - STY WITH - WI

SAMPLE No.	DEPTH	Permeability's Millidarcys K.A.	Porosity %		Residual Saturation % Pore		GRAIN DENSITY	VERT PERM	SAMPLE DESCRIPTIONS AND REMARKS
			SUM	HE	OIL	Total Water			
1	3386'7½"	0.003	7.9	4.1	0.0	91.4	2.65		SST:clr-lt gy,vf-f grn,v hd,mod sort, calc mtx,sil cmtd,abunt glauconite & wht specks (cly),common lithics & vf pyrite.
2	3387'10"	2.9	24.7	23.9	0.0	64.0	2.72		SST:clr-lt gy,dm f-occ vf grn,firm, mod-well sort,calc cly mtx,occ sil cmtd,subang-subrnd,common gy siltstone lenses,common carb,glauc & pyrite, lithics.
3	3389'9"	0.050	23.1	22.4	0.0	71.0	2.70		SST:wht-lt gy,vf grn,firm,mod sort,cly mtx,decreasing calc cmtd,subang-subrnd, scat vf carb,glauc & gy silty incs,vf pyrite.
4	3393'7½"	0.44	21.8	23.1	0.0	79.4	2.71		SST:as above and decreasing silty content.
5	3427'7"	6.7	27.6	29.3	0.0	52.3	2.75	3.9	SST:wht-gy,vf-occ f grn,firm,mod-well sort,cly mtx,v sl calc cmtd,abunt glauc & vf mica,vf carb & lithics,occ gy silty mudstone inclusions.
6	3428'7"	2.8	28.8	28.4	0.0	68.9	2.73		SST: as above.
7	3429'1"	2.1	27.7	28.3	0.0	68.9	2.73		SST:as above.
8	3431'1"	1.8	26.1	25.4	0.0	59.5	2.72		SST:as above.
9	3432'7"	5.1	24.7	27.2	0.0	69.3	2.74		SST:as above.
10	3433'2½"	0.002	7.3	2.8	0.0	91.3	2.64		SST:clr-v pl brn,vf-f grn,v hd,mod sort,calc cmt,common rnd grns glauc, abunt lithics & mica.
11	3433'7"	0.003	5.4	4.8	0.0	90.8	2.63	0.002	SST:as above,vf grn.
12	3434'7"	0.007	25.5	8.3	0.0	60.8	2.66		SST:as above,vf grn.
13	3435'6"	0.61	25.7	24.8	0.0	65.1	2.74		SST:clr-v lt gy,vf grn,firm,mod-well sort,cly mtx,sl calc in pt,common glauc,f mica,carb & lithics.
14	3436'3"	0.60	24.9	24.1	0.0	75.4	2.72		SST:as above.
15	3437'7½"	0.009	29.1	15.6	0.0	64.6	2.70	0.003	SST:as above,mod calc.
16	3438'5½"	0.30	25.1	23.5	0.0	61.7	2.72		SST:clr-v lt gy,vf-occ f grn,firm, mod-well sort,cly mtx,tr sl calc cmtd, common f glauc,carb & lithics,mica & occ vf silty particles.
17	3439'8½"	1.1	24.9	24.8	0.0	61.6	2.72		SST:as above.
18	3440'7½"	1.2	22.6	24.7	0.0	54.1	2.73		SST:as above.
19	3441'2½"	0.006	13.6	16.0	0.0	91.2	2.70		SST:as above,v calc cmtd.
20	3442'0½"	0.67	22.5	24.0	0.0	61.6	2.71	0.016	SST:as above,tr calc cmtd.

Figure A2.8 Coorikiana Sandstone, core plugs 1 to 20, core porosity, permeability, and grain density data in Marabooka 4 (Santos Marabooka 4 well completion report, 1986). Position of core plugs taken are shown on the core description images above.

CORE ANALYSIS RESULTS

Company SANTOS LIMITED Formation COORIKIANA SANDSTONE File CD-SA-192
 Well MARABOOKA NO. 4 Date Report 5 FEB 86
 Field MARABOOKA Analysts DS
 Country AUSTRALIA State SOUTH AUSTRALIA Location COOPER BASIN

Lithological Abbreviations

SD - DOLOMITE - DOL ANHYDRITE - ANHY SANDY - SDY FINE - FN CRYSTALLINE - XLN BROWN - BRN FRACTURED - FRAC SLIGHTLY -
 SH - CHERT - CH CONGLOMERATE - CONG SHALY - SHY MEDIUM - MED GRAIN - GRN GRAY - GY LAMINATION - LAM VERY - VI
 LM - GYPSUM - GYP FOSSILIFEROUS - FOSS LIMY - LMV COARSE - CSE GRANULAR - GRNL VUGGY - VGY STYLOLITIC - STY WITH - WI

Core No.	DEPTH	Permeability's Millidarcys K.A.	Porosity % HE		Residual Saturation % Pore		GRAIN DENSITY	VERT PERM	SAMPLE DESCRIPTIONS AND REMARKS
			SUM	HE	OIL	Total Water			
1	3443' 4"	0.76	24.7	24.1	0.0	65.6	2.72	SST:as above, tr sl calc cmtd.	
2	3443' 8 1/2"	1.0	23.8	23.0	0.0	72.8	2.71	SST:clr-v lt gy, vf-occ f grn, firm, mod-well sort, cly mtx, tr sl calc cmtd, abunt f glauc, mica, carb, lithics & occ vf mudstone (gy) particles.	
3	3444' 5 1/2"	1.2	22.5	23.2	0.0	58.5	2.71	SST:as above.	
4	3445' 3 3/4"	0.58	23.3	23.3	0.0	64.8	2.71	SST:as above.	
5	3446' 2 3/4"	0.12	14.1	19.7	0.0	91.9	2.71	0.023 SST:as above, increasing in calc content.	
6	3447' 0"	1.1	23.0	22.6	0.0	72.7	2.72	SST:as above, tr sl calc cmtd.	
7	3447' 4 3/4"	0.004	6.9	3.7	0.0	88.5	2.64	SST:clr-v pl brn, vf grn, v hd, mod-well sort, cly mtx, mod calc cmtd, common vf glauc, carb, mica & lithics.	
3	3448' 5"	3.2	22.3	24.2	0.0	67.3	2.73	SST:clr-lt gy, vf-occ f grn, firm, mod-well sort, cly mtx, tr sl calc cmtd, abunt glauc, mica, vf carb & lithics, occ gy claystone fragments.	
9	3449' 5 1/2"	2.0	21.8	24.4	0.0	54.1	2.73	SST:as above.	
0	3450' 6"	2.1	24.4	24.2	0.0	62.2	2.72	0.96 SST:as above, and rare pyrite.	
1	3451' 3 1/2"	1.2	23.3	23.9	0.0	70.3	2.73	SST:as above.	
2	3452' 4 3/4"	0.36	22.3	24.0	0.0	66.0	2.73	SST:as above.	
3	3453' 5"	0.004	8.1	3.8	0.0	93.3	2.64	SST:clr-v pl brn, vf grn, v hd, well sort, cly mtx, mod calc cmtd, common vf glauc, carb, mica, lithics, & soft gy claystone inclusions.	
4	3453' 10 1/2"	0.008	12.0	6.1	0.0	94.5	2.64	SST:as above & rare claystone incs.	

Figure A2.9 Coorikiana Sandstone, core plugs 21 to 34, core porosity, permeability, and grain density data in Marabooka 4 (Santos Marabooka 4 well completion report, 1986). Position of core plugs taken are shown on the core description images above.

3. MARABOOKA 4 CORE PHOTOGRAPHS FOR CORES 1 AND 2

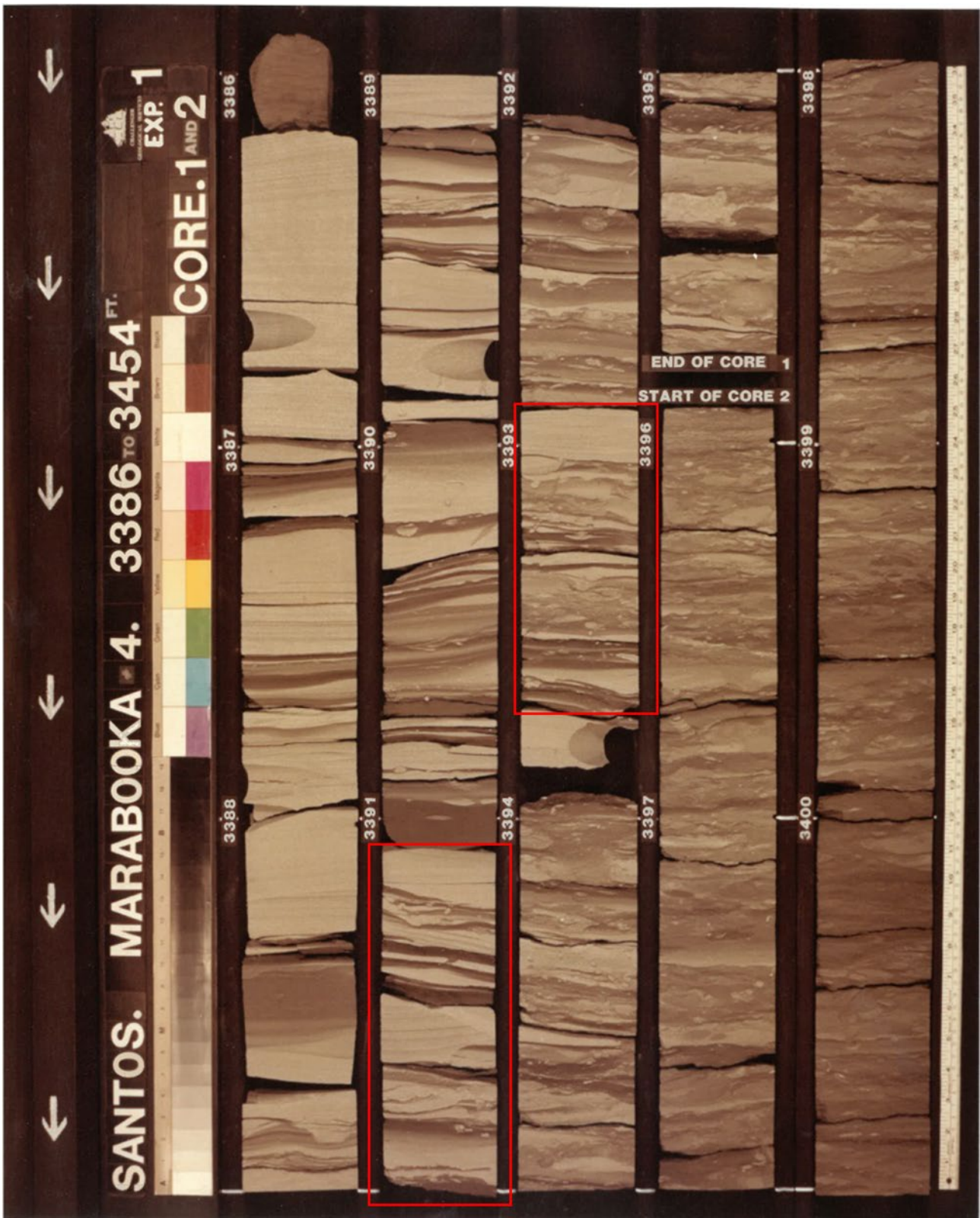


Figure A3.1 Coorikiana Sandstone slabbed full hole core 1 (upper cycle), from 3386–3396 ft (drillers depth) and core 2 (lower cycle), from 3396–3401 ft (driller's depth) in Marabooka 4. Zone highlighted in red boxes shown in a larger scale in the next two images.



Figure A3.2 Coorikiana Sandstone upper cycle slabbed full hole core 1, 3391' 1" – 3392' (driller's depth).

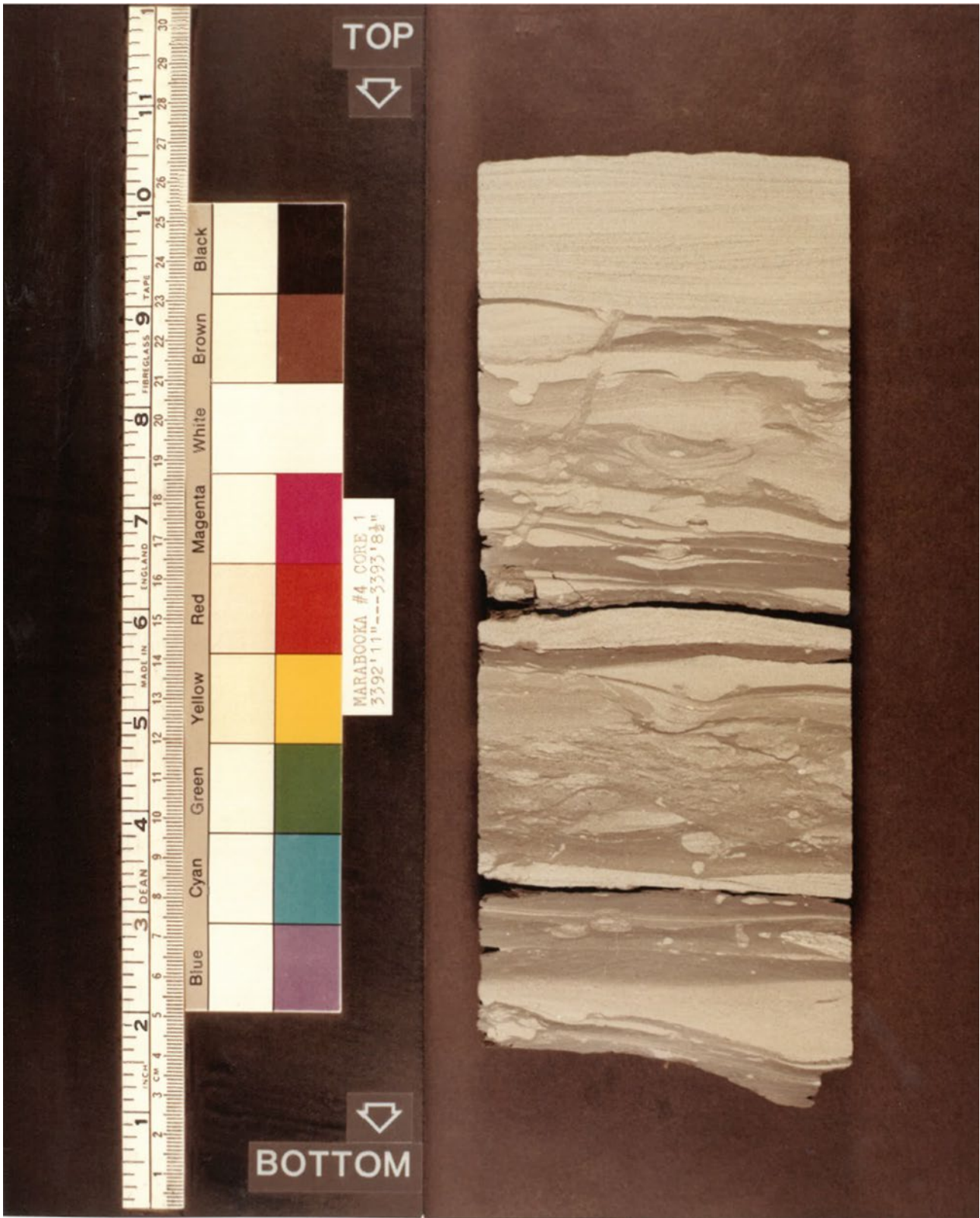


Figure A3.3 Coorikiana Sandstone upper cycle slabbed full hole core 1, 3392' 11" – 3393' 8½" (driller's depth).

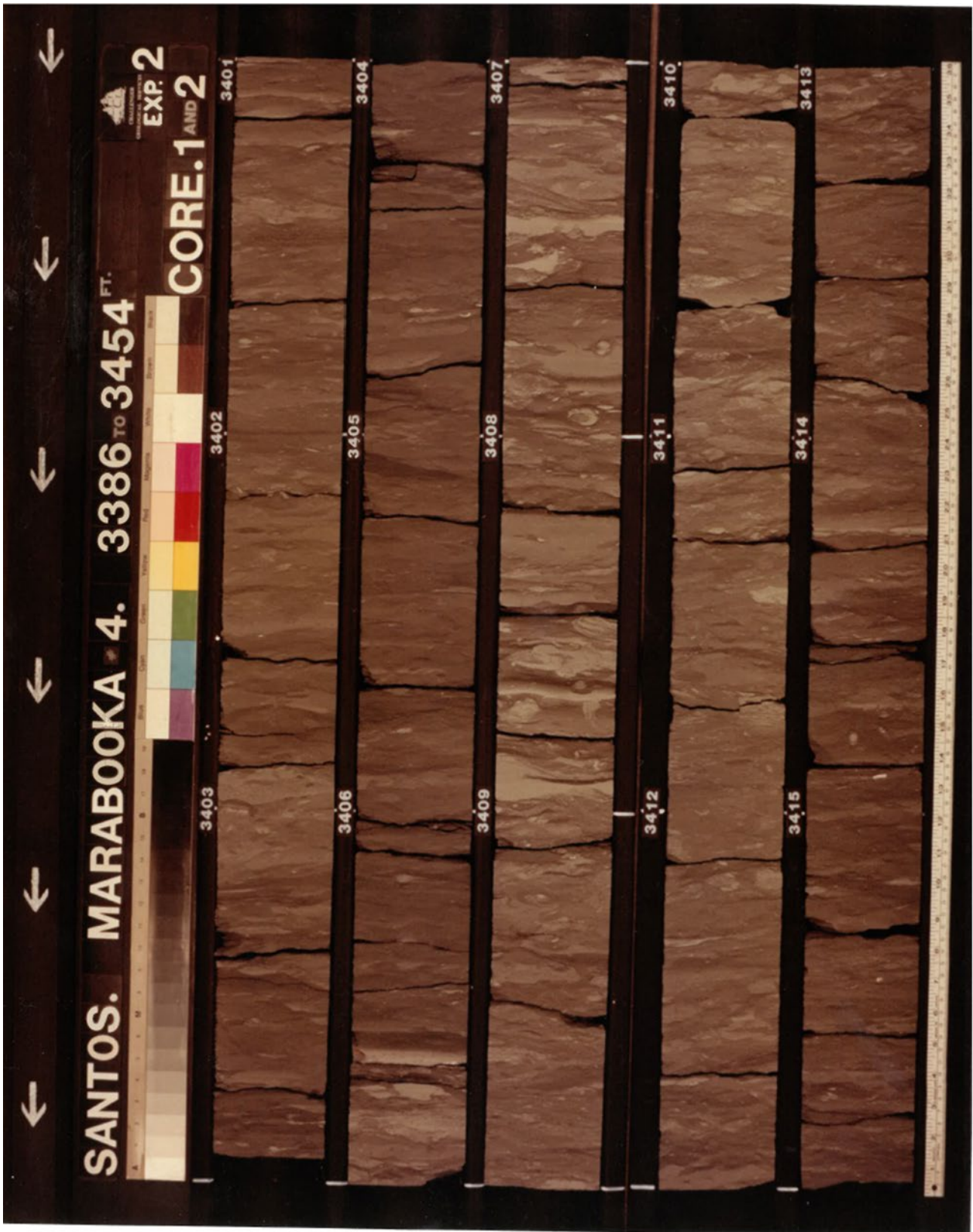


Figure A3.4 Coorikiana Sandstone upper cycle slabbed full hole core 2, 3401 – 3416 ft (driller's depth) in Marabooka 4.

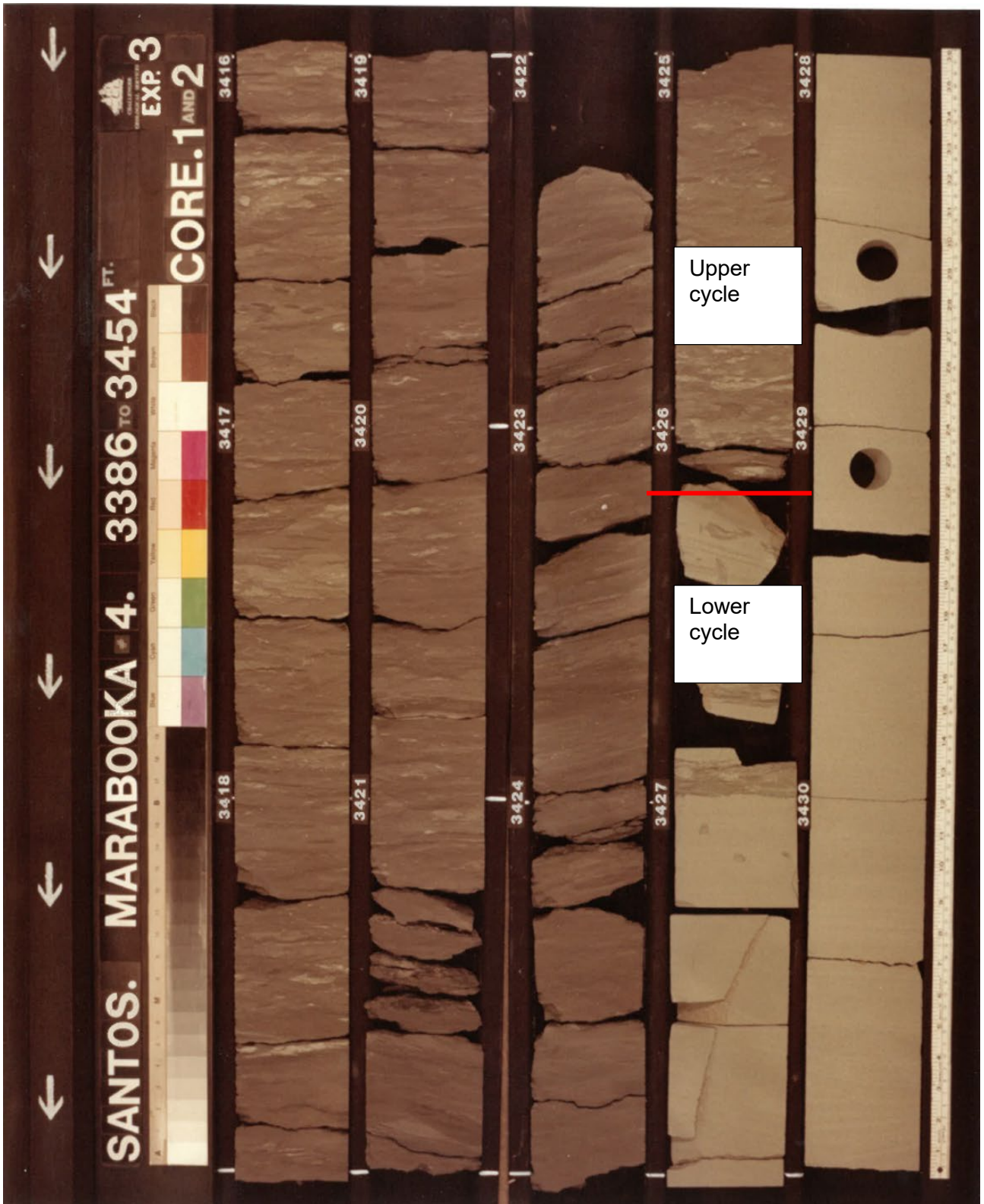


Figure A3.5 Coorikiana Sandstone upper/lower cycle slabbed full hole core 2, 3416 – 3431 ft (driller’s depth) in Marabooka 4.

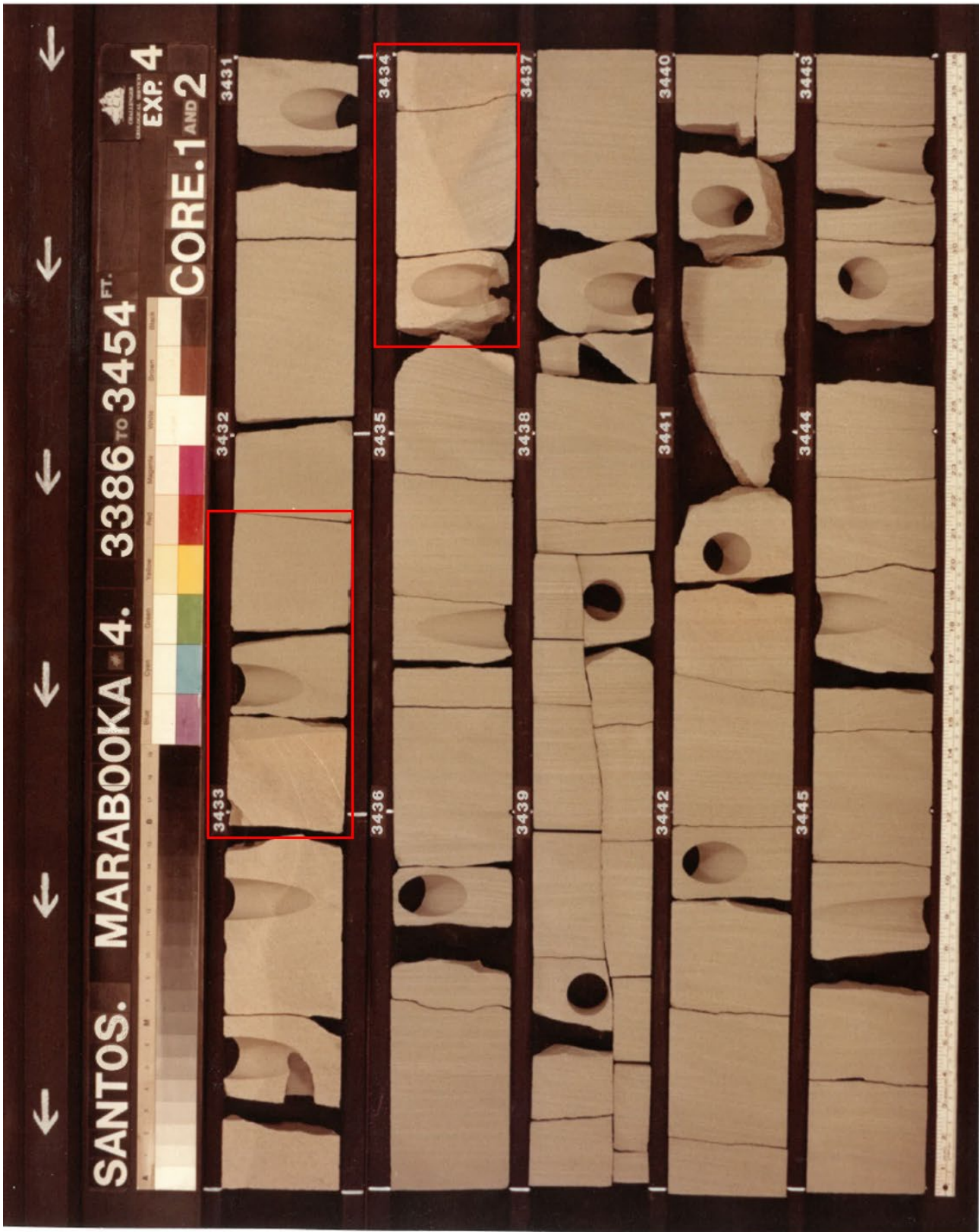


Figure A3.6 Coorikiana Sandstone lower cycle slatted full hole core 2, 3431 – 3446 ft (driller's depth) in Marabooka 4. Zone highlighted in red boxes shown in Figures A3.7 and A3.8.



Figure A3.7 Coorikiana Sandstone lower cycle slabbed full hole core 2, 3432' 3" – 3433' 1" (driller's depth).



Figure A3.8 Coorikiana Sandstone lower cycle slabbed full hole core 2, 3434' – 3434' 9" (driller's depth).

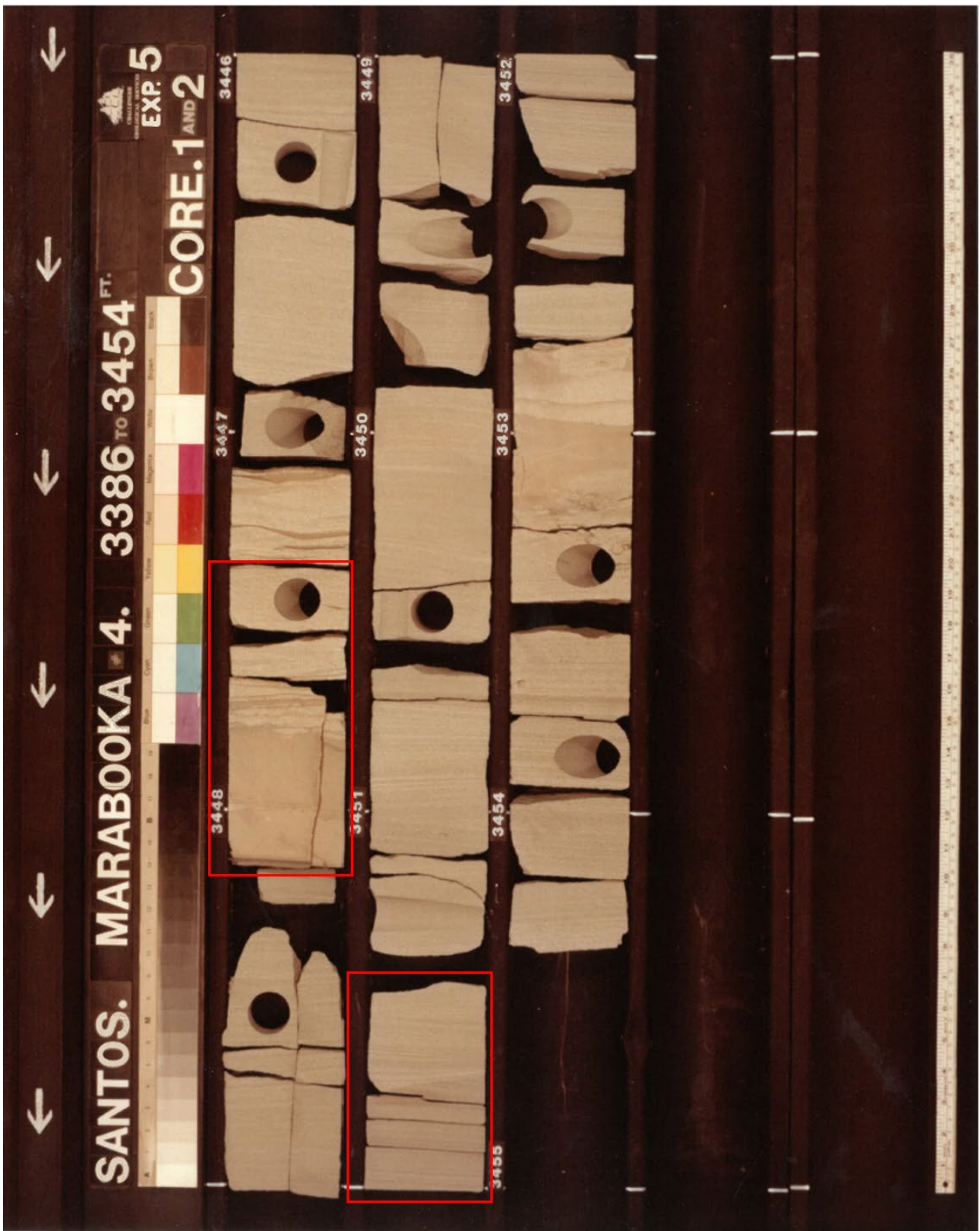


Figure A3.9 Coorikiana Sandstone lower cycle slabbed full hole core 2, 3446 – 3454 ft 4 (driller's depth) in Marabooka 4. Zone highlighted in red boxes shown in a larger scale in Figures A3.10 and A3.11.



Figure A3.10 Coorikiana Sandstone lower cycle slabbed full hole from core 2, 3447' 4" – 3448' 1 1/2" (driller's depth).



Figure A3.11 Coorikiana Sandstone lower cycle slabbed full hole from core 2, 3451' 5 1/2'' – 3452' (driller's depth).

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The author of this report brings a wealth of knowledge and over 30 years' experience as a highly skilled and well-respected geoscientist. The author has specifically worked within this region of one of Australia's most prolific hydrocarbon provinces. This report provides Australia's foremost expertise on the Coorikiana Sandstone.

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