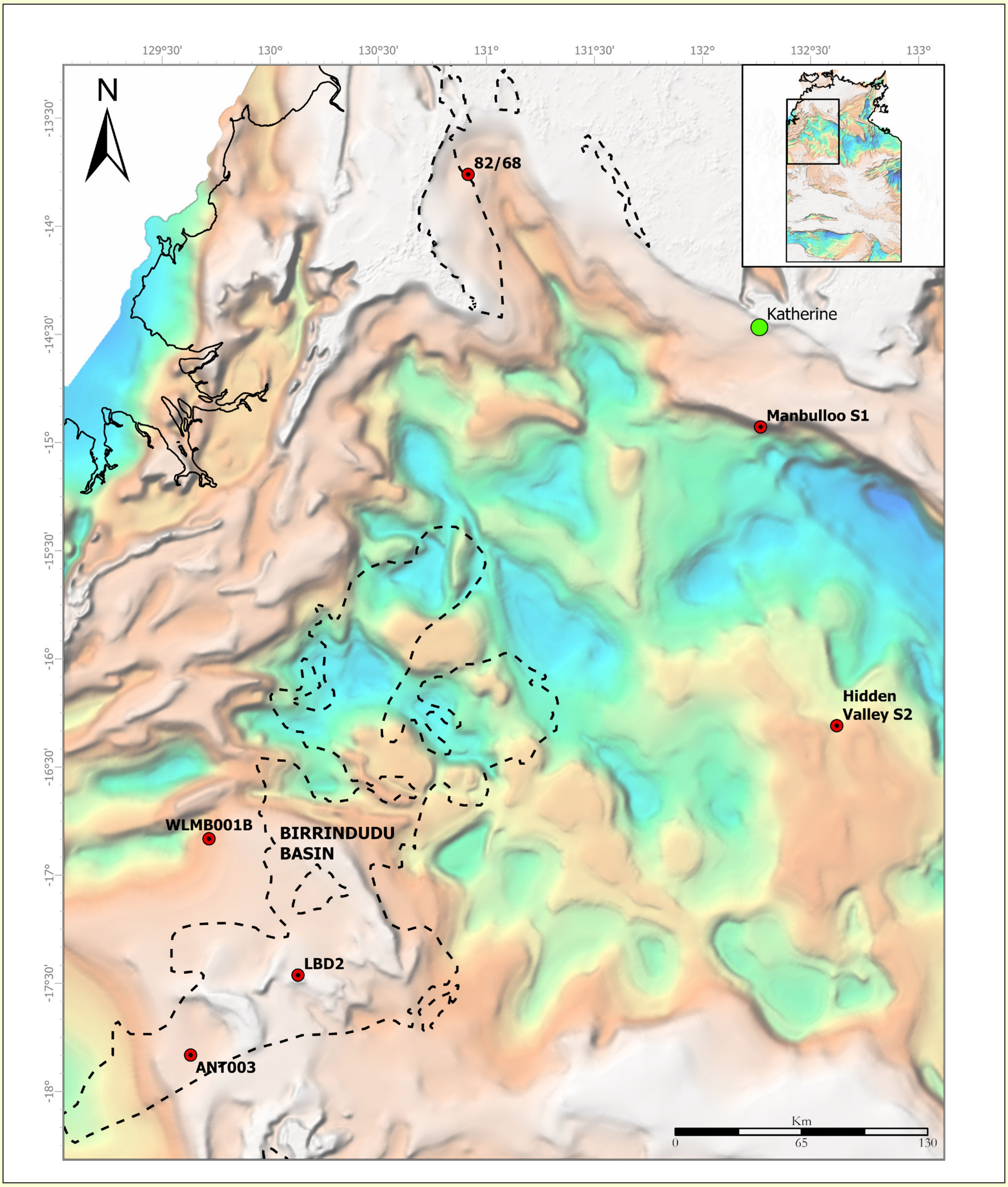
NORTHERN TERRITORY GEOLOGICAL SURVEY

NTGS RECORD 2023-008

Sedimentological and petrophysical characterisation of the Birrindudu Basin, Northern Territory



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and K Fenselau

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Cover image: NTGS SEEBASE® Depth to Basement image displaying the surface outcrop extent of the Birrindudu Basin and the locations of drillholes referred to in this Record.

Sedimentological and petrophysical characterisation of the Birrindudu Basin, Northern Territory

by

V Crombez, S Schmid and K Fenselau

SUMMARY

The Birrindudu Basin is located in the north-western Northern Territory and comprises sedimentary successions of Palaeoproterozoic to Mesoproterozoic age. To date, there has not been a consistent sedimentological and stratigraphic framework developed to investigate the evolution of the Birrindudu Basin and its sedimentary fill, nor has there been a thorough assessment of its sediment-hosted mineral potential. This is due in part to the remote and isolated location of this frontier basin and the paucity of subsurface geoscientific data available.

A collaborative study commissioned by the Northern Territory Geological Survey (NTGS) under its Resourcing the Territory program and being undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) seeks to address these gaps in our knowledge. This Record represents the findings of Module 1 of this study; namely the systematic characterisation of the sedimentary facies and petrophysical signature of the Birrindudu Basin succession. Establishing a sequence stratigraphic framework of the Birrindudu Basin and conducting a detailed assessment of its sediment-hosted mineral potential will form the crux of future Module 2 of this study.

Petrophysical data acquisition (handheld gamma, sonic velocity and pXRF) and detailed sedimentary logging and facies analysis were undertaken on core from six diamond drillholes from across the Birrindudu Basin: WLMB001B, LBD2, ANT003, Hidden Valley S2, Manbulloo S1, and NTGS 82/68. The attached appendices contain the following data for each drillhole:

- DataSummary.pdf
- FaciesAssociations_Codes.xlsx
- FaciesAssociations_Depths.xlsx
- GammaRay.xlsx
- GammaRay.las
- Lithofacies_Depths.xlsx
- PwaveVelocity.xlsx
- PwaveVelocity.las
- pXRF_uncalibrated.xlsx
- SedimentaryLog.pdf

This Record details 32 distinct sedimentary lithofacies that have been grouped into nine discrete sedimentary facies associations, in addition to a downhole synthesis of petrophysical data across the six drillholes. Furthermore, this Record also illustrates preliminary interpretations of the palaeogeographic evolution of the Birrindudu Basin. Investigations of intrabasinal stratigraphic correlations and the sequence stratigraphic framework of the Birrindudu Basin, in addition to discussion regarding its sediment-hosted mineral potential, will be detailed in Module 2.

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Australia's National
Science Agency

CuBAS – NTGS Birrindudu Basin sedimentology and mineral potential

Module 1 delivery

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June 30th, 2023

Outline

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1 Introduction

The Birrindudu Basin is located in the north-western Northern Territory and comprises sedimentary successions of Palaeo-to Mesoproterozoic ages (Dunster and Ahmad, 2013). Despite ongoing data acquisition by industry, government bodies (Northern Territory Geological Survey/NTGS) and Geoscience Australia (GA), and universities (e.g. University of Adelaide – ARC Linkage Program), a consistent sedimentological and stratigraphic framework to investigate the evolution of the Birrindudu Basin has not yet been established and requires further data acquisition and integration. The aim of this work is therefore to study the sedimentary successions present in the Birrindudu Basin through the acquisition of petrophysical data and through the sedimentary logging of six drill cores: WLMB001B, LBD2, ANT003, Hidden Valley S2, Manbulloo S1, NTGS 82/68.

This report follows the completion of the first module of this project and the description of the sedimentary successions presented on six drill cores from the Birrindudu Basin. This report details the different sedimentary facies present on the six drill cores together with sedimentary environments interpretations.

2 List of deliverables

The deliverables of this project's first module were described in the initial project proposal and are summarised in Table 1. The complete sedimentary logs for the different drill cores are available in Appendix 1-6, together with a short PowerPoint presentation that summarises the collected data. A description of the workflow used to log the drill cores and acquire the petrophysical data is outlined in section 3.1 and 3.2 of this document. The facies described in the core logging are presented in Table 2. The facies associations interpreted into sedimentary environments, are presented in Table 3 and illustrated in Figure 2. Lastly, the vertical evolution of the sedimentary environments on the six drill cores is presented in Figure 3. A description of the workflow used to interpret sedimentary environments from the described sedimentary facies is presented in section 3.3.

Table 1: Package 1 deliverables list

DELIVERABLES AND MILESTONES	
Module 1 – Facies Analysis	
Delivery of digitised graphic logs (pdf), digital data tables of all petrophysical data (in xlsx and LAS formats) and plots for each drill core.	Appendix 1 to 6
Summary descriptive report as PowerPoint presentation for each drill core, including basic interpretations and integrating the lithological logs, petrophysical data, and facies table.	Appendix 1 to 6
Final report with interpretation of depositional environment, detailing the sedimentological, stratigraphic and petrophysical frameworks of the Birrindudu Basin.	Figure 2 Figure 3

3 Module 1

The aim of module 1 is to generate sedimentary description for 6 drill cores located in the Birrindudu Basin. This is completed by the acquisition of a petrophysical dataset that will ultimately help the mineral resources exploration in the basin.

3.1 Sedimentological logging

Sedimentary descriptions for the present work were conducted using Figure 1 as a logging sheet. Descriptions were carried out in the NTGS core library in Darwin.

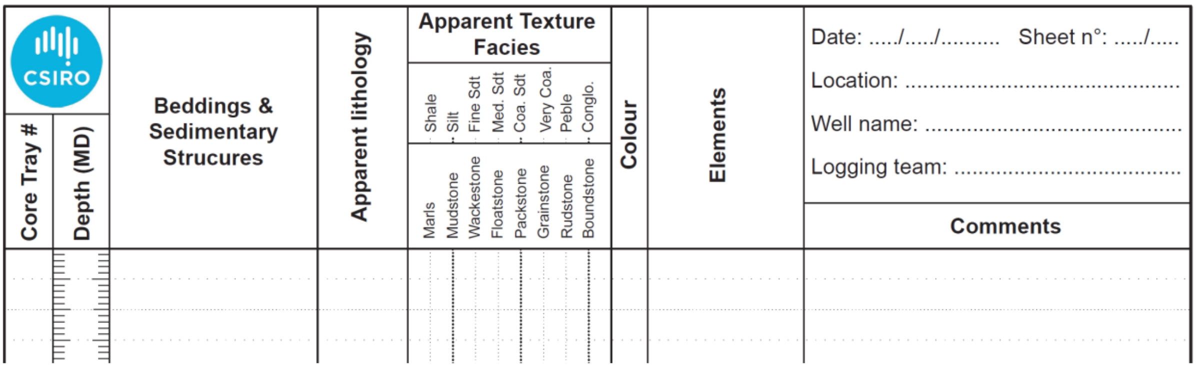

Figure 1: Logging sheet used to describe the drill cores located in the Birrindudu.

Sedimentary descriptions in the present work were conducted at 1:200-scale (or 1cm = 2m), which implies that some sedimentary details (e.g., fine facies changes) may not be captured in the descriptions. For this work, the logging team aimed at representing intervals >25cm thick and focussed on identifying the bedding type (e.g., planar-, wavy-, chaotic-) of each interval together with their apparent lithology and texture (e.g., siltstone, sandstone, shale, carbonate) and sedimentary structures (e.g., fining- or coarsening-upward trends, synaeresis marks, current ripples, reworked elements). In addition to the sedimentary structures, structural elements (e.g., fractures, faulting) and diagenetic elements are also recorded in the descriptions. The result of the sedimentary logging is presented in Appendix 1 to 6, and covers the following depths:

- WLMB001B: 793.7m to 48m,
- LBD2: 345.7m to 16.7m,
- ANT003: 342.7m to 104.7m,
- Hidden Valley S2: 1744.1m to 782.2m,
- Manbulloo S1: 1236.2m to 422.6m,
- NTGS 82/68: 509.7m to 4.7m.

3.2 Petrophysical data collection

In addition to sedimentary logging, handheld gamma ray and Pwave velocity were collected together with handheld XRF. The methods for the collection of each dataset is presented below.

3.2.1 Handheld gamma ray

Gamma radiation was measured directly on core at 50 cm resolution using a Radiation Solutions RS-230 handheld gamma ray scintillometer. Individual measurements were automatically averaged over a 10 second interval.

3.2.2 Handheld P-wave velocity

P-wave velocity was measured directly on core at 50 cm resolution using an ACS UK1401 Surfer handheld ultrasonic tester. Due to the distance between the transducers, measurements were only possible on continuous piece of core with a length exceeding 15 cm.

3.2.3 Handheld XRF

Portable XRF analysis was carried out directly on core at 4 m resolution using an Olympus Vanta handheld XRF analyser. The measurements were carried out using Geochem(3), a three-beam mode with 20 sec measure time for each beam. Instrument performance was monitored by routinely measuring standards (SiO_2 blank, NIST 88b, NIST 1b, NIST 2781, NIST 2710a, NIST 2711a).

3.3 Lithofacies table and facies associations

3.3.1 Facies table

Based on the sedimentary descriptions, lithofacies are defined for intervals with similar apparent lithology and texture and presenting the same sedimentary structures. They are presented in Table 2 which is organised by facies and bedding. A total of 32 lithofacies were identified: 2 conglomerates, 2 breccias, 4 coarse-grained sandstones, 4 sandstones, 4 siltstones, 7 shales, 7 carbonate rocks, one evaporitic facies and 2 volcanic/magmatic facies. In this table it is important to note that some lithofacies could be split in several lithofacies to generate a more accurate representation of the distribution of certain sedimentary features, however the aim of the present exercise was to build a table with a reasonable number of lithofacies.

Table 2: Lithofacies list for the Birrindudu Basin.

Code	Facies description	Colour, lithology and granulometry	Bedding style	Sedimentary structure *Common*	*Occasional*	*Rare*	Major processes
			Pebbles / Conglomerates / Breccia				
Co01	Massive to planar-bedded pebbles and conglomerates	Beige to grey pebbles and conglomerate	Massive to planar-bedded	Erosive surfaces Lags and reworked elements	Rip-up clasts		tractive currents
Co02	Carbonate-rich massive to planar-bedded pebbles and conglomerates	Beige to grey pebbles and conglomerate	Massive to planar-bedded	Erosive surfaces Lags and reworked elements (Carbonate-rich)	Fining-upward trends Rip-up clasts	Reworked stromatolites	tractive currents
Co03	Massive to planar-bedded pebbles and conglomerates	Brown to yellow pebbles and conglomerate	Matrix supported, planar-bedded	Erosive surfaces Lags and reworked elements		Hematite nodules / elements	tractive currents
Br01	Breccia	Grey to beige Breccia	Brecciated	Reworked elements			N-A
Br02	Carbonate-rich breccia	Grey to beige Breccia	Brecciated	Reworked elements (Carbonate-rich)		Anhydrite in matrix	N-A
			Coarse- to Very coarse-grained Sandstones				
CoSd01	Sub-massive coarse-grained sandstone	Beige coarse- to very coarse-grained sandstone	Sub-massive to planar bedded	Erosive surfaces Fining-upward trend	Lags and coarse-grained intervals Rip-up clasts Mud drapes	Shale-rich layers and synaeresis marks Load casts	unidirectional currents *tidal currents*
CoSd02	Fining-upward very coarse- to coarse-grained sandstone	Beige coarse- to very coarse-grained sandstone	Finning upward Sub-massive to planar bedded	Cross-bedding Lags and reworked elements			unidirectional currents
			Fine- to Medium-grained Sandstones				
Sd01	Sub-massive to cross-bedded fine- to medium-grained sandstone	Beige to grey fine- to medium-grained sandstone	Sub-massive to cross-bedded	Cross-bedding and tangential cross-bedding Erosive surfaces Lags and reworked elements Shale-to silt-rich layers Fining-upward trends Rip-up clasts	Mud drapes	m-size fining-upward trends on top of beds Synaeresis marks Diagenetic stains Wave ripples Desiccation marks Unidirectional current ripples	unidirectional & tidal currents
Sd02	Sub-massive fine- to medium-grained sandstone	Beige to grey fine- to medium-grained sandstone	Sub-massive (to sub-planar-bedded)	Erosive surfaces Lags and reworked elements Shale- to silt-rich layers Fining-upward trends Rip-up clasts	Mud drapes m-size fining-upward trends	Load casts Slumps Flaser bedding Synaeresis marks Diagenetic stains Desiccation marks	unidirectional & tidal currents
Sd03	Wavy- to planar-bedded fine- to medium-grained sandstone	Beige to grey fine- to medium-grained sandstone	Wavy- to planar-bedded	Lags and reworked elements Erosive surfaces Rip-up clasts		Load casts Slumps Anhydrite nodules	unidirectional currents
Sd04	Planar-bedded sandstone and shale	Maroon to beige sandstone and shale	Planar-bedded	Rip-up clasts Erosive surfaces Tangential cross-bedding Synaeresis marks	Mud drapes Oxidation stains	Desiccation marks Wavy-bedded Climbing ripples Wave ripples Lenticular-bedded	Unidirectional, tidal & *oscillatory currents suspension*

Table 2 (continued): Lithofacies list for the Birrindudu Basin.

Code	Facies description	Colour, lithology and granulometry	Bedding style	Sedimentary structure Common	Sedimentary structure Occasional	Sedimentary structure Rare	Major processes
				Siltstones			
St01	Planar-bedded siltstone and shale	Grey or green to maroon siltstone and shale	Planar-bedded	Fining-upward trends and erosive surfaces Rip-up clasts Lags and reworked elements	Mud drapes Slumps Sand-rich layers Tangential cross-bedding Desiccation marks Synaeresis marks	Mottled shale-rich layers Chaotic-bedded Algal mats and stromatolite Wavy-bedded Unidirectional current ripples Pyrite Carbonate nodules Lenticular-bedded Carbonate-rich layer Anhydrite	unidirectional & tidal currents
St02	Planar-bedded siltstone and shale with algal mats	Grey siltstone and shale	Planar-bedded	Algal mats	Synaeresis marks		unidirectional currents *suspension*
St03	Planar-bedded siltstone and shale with sandstone intervals	Grey to beige or green to maroon siltstone and shale	Planar-bedded	Fining-upward trends and erosive surfaces Desiccation marks Lags and reworked elements Synaeresis marks	Mud drapes Tangential cross-bedding	Stromatolites Bidirectional current ripples Wave ripples	unidirectional & tidal currents
St04	Planar- to wavy bedded siltstone and shale	Grey siltstone and shale	Planar- to wavy-bedded	Fining-upward trends and erosive surfaces Tangential cross-bedding	Mud drapes Lags and reworked elements Wave-ripples (SCS and HCS)	m-size coarsening-upward trends on top of beds Algal mats	oscillatory currents *suspension*
				Shales			
Sh10	Planar-bedded shale with dolomitic siltstone / fine-grained sandstone layers	Grey shale and dolostone	Planar-bedded	Synaeresis marks Shale can be red / maroon	Erosive surfaces Stromatolite Algal mats Mud drapes Desiccation marks Tangential cross-bedding Lags and reworked elements	m-size coarsening-upward trends Imbricated clasts Nodules Unidirectional current ripples Desiccation marks Synaeresis marks	unidirectional & tidal currents *suspension*
Sh11	Planar-bedded shale with carbonate layers	Grey shale and carbonate	Planar-bedded	Nodules	Pyrite		suspension
Sh01	Sub-massive to planar-bedded siltstone and shale	Dark grey silt and shale	Sub-massive to planar-bedded	Erosive surfaces	Oxidised pyrites	Algal mats	suspension
Sh02	Sub-massive to planar-bedded siltstone and shale	Dark grey to maroon silt and shale	Sub-massive to planar-bedded	Fining-upward trends and erosive surfaces Synaeresis marks Erosive surfaces	Sand-rich layers Mud drapes Tangential cross-bedding Lags and reworked elements Rip-up clasts	Desiccation marks Anhydrite layers Load casts Unidirectional current ripples m-size coarsening-upward trends Wave-ripples (SCS and HCS)	unidirectional & tidal currents *oscillatory currents* *suspension*

Table 2 (continued): Lithofacies list for the Birrindudu Basin.

Code	Facies description	Colour, lithology and granulometry	Bedding style	Sedimentary structure *Common*	Sedimentary structure *Occasional*	Sedimentary structure *Rare*	Major processes
Shales (continued)							
Sh03	Sub-massive shale	Maroon shale	Sub-massive to planar-bedded		Mud drapes Silt-rich layers Mottled Fining-upward trends and erosive surfaces Desiccation marks Rip-up clasts	Unidirectional current ripples Synaeresis marks Anhydrite layers	suspension *unidirectional & tidal currents*
Sh04	Sub-massive shale	Dark grey to green shale	Sub-massive to planar-bedded			Silt-rich layers Mud drapes Tangential cross-bedding Nodules Slumps Pyrites Algal mats Fining-upward trends and erosive surfaces Reworked elements Maroon intervals Stromatolites Synaeresis marks Desiccation marks	suspension *unidirectional & tidal currents*
Sh05	Planar-bedded shales with sandstone layers	Maroon to beige shale and sandstone	Planar-bedded	Rip-up clasts Erosive surfaces Tangential cross-bedding Synaeresis marks	Mud drapes Oxidation stains Wavy-bedded	Desiccation marks	unidirectional & tidal currents *suspension*
Dolostones							
Do01	Planar-bedded dolomitic siltstone / fine-grained sandstone and shale	Grey to green dolostone and grey to marroon shale	Planar-bedded	Synaeresis marks Desiccation marks Erosive surfaces Mud drapes	Sand-rich layers Lags and reworked elements Fining-upward trends and erosive surfaces Tangential cross-bedding Rip-up clasts Nodules	Wavy-bedded Mottled shale-rich layers Algal mats Stromatolites Anhydrite Wave ripples	tidal currents suspension *unidirectional currents*
Do02	Planar-bedded dolomitic sandstone and shale	Grey to green dolostone and shale	Planar-bedded	Fining-upward trends and erosive surfaces	Lags and reworked elements Slumps Wave ripples	Mud drapes Stromatolites	tidal currents suspension *unidirectional currents*
Do03	Planar-bedded dolomitic sandstone	Beige to grey dolostone	Planar-bedded	Rip-up clasts Desiccation marks Erosive surfaces Lags and reworked elements	Slumps Synaeresis marks Shale-to silt-rich layers Mud drapes Lags and reworked elements	Stromatolites Algal mats Nodules	tidal currents suspension *unidirectional currents*

Table 2 (continued): Lithofacies list for the Birrindudu Basin.

Code	Facies description	Colour, lithology and granulometry	Bedding style	Sedimentary structure *Common*	*Occasional*	*Rare*	Major processes
Dolostones (continued)							
Do04	Planar-bedded dolomitic stromatolite	Grey to beige dolostone	Planar-bedded	Multiple forms of stromatolites	Erosive surfaces Lags and reworked elements Mud drapes Synaeresis marks	Wave ripples	tidal currents suspension *unidirectional currents*
Do05	Planar-bedded dolomitic sandstone and siltstone	Beige to green dolostone	Planar-bedded	Erosive surfaces Rip-up clasts Desiccation marks Fining-upward trends and erosive surfaces	Lags and reworked elements	Shale-rich layers Algal mats Stromatolites Can be red Mud drapes Wavy-bedded	tidal currents suspension *unidirectional currents*
Ca01	Planar- to wavy-bedded calcilutite	Grey to green calcilutite	Planar- to wavy-bedded	Nodules Algal mats Slumps Mud drapes	Lags and reworked elements Fining-upward trends		Suspension *unidirectional currents*
Ca02	Planar- to wavy-bedded calcilutite and shale	Grey to green calcilutite and shale	Planar- to wavy-bedded	Algal mats			Suspension *oscillatory currents*
Miscellaneous							
Ms01	Tuff with volcaniclastics	Beige to grey					N-A
Ms02	Evaporite	White					N-A
Ms03	Volcanic rocks	Dark grey					N-A

3.3.2 Facies associations and sedimentary environments

Identification of sedimentary environments is carried out by grouping sedimentary facies into facies associations (as defined by R. Dalrymple, 2010). Indeed, one single lithofacies can be present in several environments, for instance a massive sandstone can be found in shallow-water environments and in basin floor fan settings. A total of 9 main facies associations were identified out of the sedimentary logging (Table 3). They span from tide-dominated environments — Tidal plain (TP), Supratidal zone (SpZ), Intertidal zone (IZ), Subtidal zone (SbZ), to flow-dominated environments — Delta front (DF), Pro-delta (PD) and includes rare wave-dominated environment — Shoreface (SF), Offshore transition (OT) and Offshore (OF) (see Figure 2).

Table 3: Facies associations for the Birrindudu Basin. Note in dark grey the main sedimentary lithofacies for each association and in light grey the lithofacies that are secondary.

Facies association	Co			Br		CoSd		Sd				St				Sh							Do					Ca		Ms
	01	02	03	01	02	01	02	01	02	03	04	01	02	03	04	01	02	03	04	05	10	11	01	02	03	04	05	01	02	02
Tidal plain (TP)																														
Supratidal zone (SpZ)																														
Intertidal zone (IZ)																														
Subtidal zone (SbZ)																														
Delta front (DF)																														
Pro-delta (PD)																														
Shoreface (SF)																														
Offshore transition (OT)																														
Offshore (OF)																														

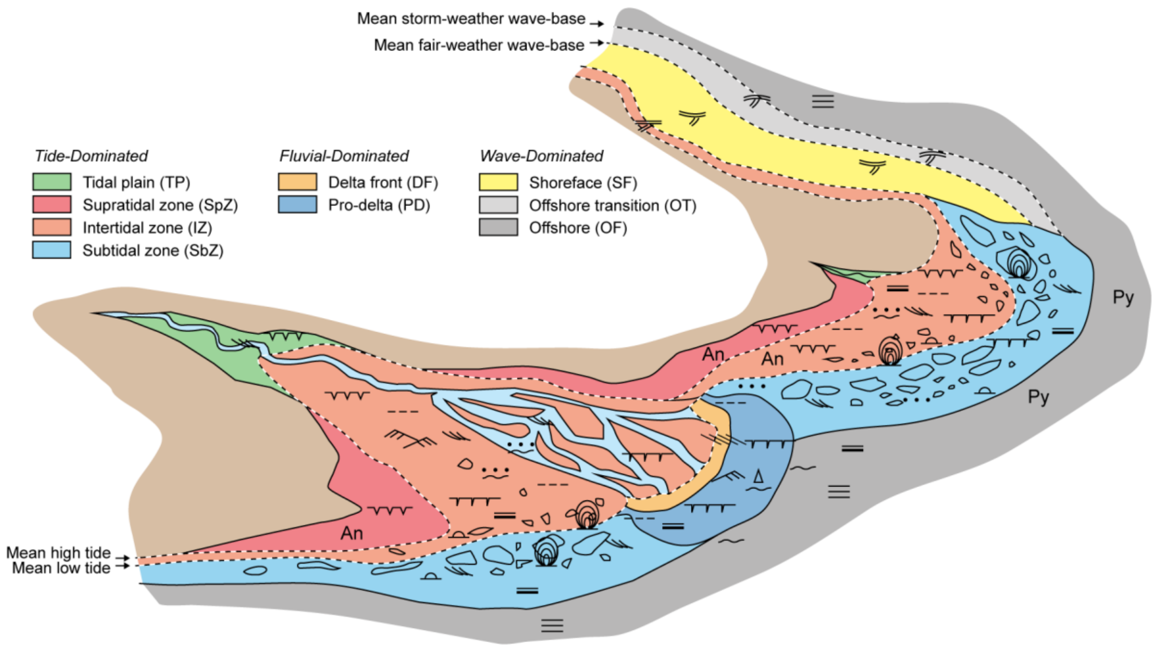

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Figure 2: Illustration of the relations between the different sedimentary environments observed on the six drill cores from the Birrindudu Basin. Refer to Appendix 1-6 for symbols captions.

Tidal plain (TP)

In the present work, the tidal plain is defined above the mean high tide along the areas where the tidal influence is recorded in the river system. On the six drill cores, this environment is only encountered once and is mainly composed of cross-bedded sandstone (Sd01-02) and siltstones (St01). In this environment mud drapes are common and can be interpreted as a trace of the tidal currents. Furthermore, the lithofacies in this environment also present fining-upward trends, lags and reworked element, cross-bedding and tangential cross-bedding that are interpreted as traces of unidirectional current most likely related to channels in a riverbed (Bridge and Tye, 2000). The rare silt- to shale-rich intervals are interpreted to be related to the abandonment of the channels. In this environment, the rare occurrences of synaeresis marks are interpreted to occur in the part of the environment that is closer to the intertidal area, where fresh and salt water can mix (Plummer & Gostin, 1981).

Supratidal zone (SpZ)

The supratidal zone is defined above the mean high tide and is occasionally flooded during storm events or during king's tide (Flemming and Bartoloma, 2009). This facies is mainly composed of shales (Sh02, Sh03) and siltstones (St01, St03). In this environment mottling is frequently observed in shale-rich interval and is interpreted as the development of paleosols (Buurman, 1980). Anhydrite layers (Ms02) and nodules are commonly occurring in this environment and support that these locations are occasionally flooded by salt water. Lastly, the silt-rich intervals present are interpreted to be related to the distal part of small crevasse splays from adjacent rivers (Mjøs et al., 1993), or to be related to the occasional flooding by the sea. In this association rare occurrences of carbonate-rich lithofacies (Do05) are interpreted as the development of restricted saline ponds along the mean high tide area.

Intertidal zone (IZ)

The intertidal zone is located in between the mean high tide and the mean low tide (Flemming and Bartoloma, 2009). In the case study this environment is a mix of carbonate- (Do01-03 and Do05) and clastic-dominated (St01, St03, Sh02-04) lithofacies. In this environment, carbonate-dominated lithofacies, often presenting algal structure are interpreted to be located away from detrital supply, either on the side of a tidal embayment or along a coast with no major river mouths. In some intervals, rare, mottled texture are interpreted as the upper limit of this environment. This environment commonly present mud drapes together with sedimentary features showcasing unidirectional, bidirectional, and rare oscillatory currents. Lags and reworked element are common. Desiccation marks are common and interpreted to be better preserved closer to the mean high tide line. In some locations, synaeresis marks are present and interpreted as the present of a fresh-water input close by (Plummer and Gostin, 1981).

Subtidal zone (SbZ)

The subtidal zone is interpreted to extend below the mean low tide and is mainly composed of carbonate-rich lithofacies (Do01-05) in the case study and occasional clastic (St03). This environment will be mostly sub-aqueous and present the largest occurrences of algal structures (Do04, Cantine et al., 2020; Logan et al., 1964). Sedimentary facies in this environment will often record mud drapes, but also reworked elements interpreted to be the product of the erosion of the large algal structures. Similar to the intertidal zone, synaeresis marks are present and interpreted to be recorded in the vicinity of fresh-water inputs. The bottom limit of the sub tidal zone is interpreted to be where suspension become one of the main sedimentary process and where tidal influence decreases. In the present case study, this limit is placed were carbonate content decreases significantly. The SbZ environment is the most occurring in the studied drill core, it can be sub-divided in 3 sub-associations: the SbZ itself, Stromatolites (str), which is composed of large algal structures; the lower subtidal zone lSbZ which often present shale-rich interval and generally a finer grain size.

Delta front (DF)

The delta front environment is interpreted to occur in rare intervals along the described drill cores. It is composed of coarse-grained lithofacies (Sd01-02, St01). Occurrences of cross-bedding in the lithofacies are interpreted as the sign of unidirectional currents in channels or mouth bars (Goodbred and Saito, 2012). Furthermore, the occasional presence of mud drapes suggests the influence of tidal currents which is common in tidal influence deltaic systems (Dalrymple, 1992).

Pro-delta (PD)

In the present work, the pro-delta environment is mainly composed of fine-grained lithofacies (St01-02, and Sh01-03). This environment commonly present lithofacies with small erosional surfaces followed by finning upward trends and associated to gutters and occasional lags and reworked elements that are interpreted as small pulses of sediments delivered by the river and reflect the activity of currents on a slope (Pattison et al., 2007). Furthermore, lithofacies in this environment often present synaeresis marks which attest of freshwater delivery to the systems which is interpreted as coming from estuarine or river-mouths located along the shoreline in shallower setting (Plummer and Gostin, 1981). In some rare occasions pro-delta environment will present small algal structures and carbonate-rich lithofacies (Do04-05), this is interpreted to happen in areas at the junction with the carbonate-rich, subtidal environments.

Shoreface (SF)

The shoreface environment is defined as extending from the mean low tide to the fair-weather wave base. This environment is only intersected once in the present work and is composed of coarse-grained sediments (Sd02). This environment presents well-sorted sandstones that are mainly planar-bedded (possibly low angle cross-stratifications). Here, the well-sorted nature of the lithofacies is interpreted as the effect of the oscillatory currents (Dumas and Arnott, 2006; Suter, 2006).

Offshore transition (OT)

The offshore transition environment is defined as ranging from the fair-weather wave base to the storm-weather wave base (Dumas and Arnott, 2006). In the present work it is composed of fine-grained lithofacies (St01, St04 and Sh02-04). In these lithofacies, wave structures (e.g. hummocky cross-stratification) are present together with small erosional surfaces and tangential cross-bedding. These structures are interpreted to reflect the effect of oscillatory currents mainly related to storm activities (Dumas and Arnott, 2006).

Offshore (OF)

The offshore environment is the deepest sedimentary environment present in the case study and is interpreted as being deposited below storm-wave base (Dumas and Arnott, 2006). On the described drill cores, it is mainly composed of fine-grained lithofacies (Sh01-02, Sh04, Sh10-11, St01-03). In these lithofacies few sedimentary features are present, and the sediments are mainly planar-bedded. Rare silt-rich intervals are present and are interpreted as the effect of pelagic settling (Stow and Piper, 1984) or the effect of bottom currents or gravity flows (Macquaker et al., 2010). This environment may present carbonate-rich intervals (Do02-05, Ca02), this is interpreted to represent the deposition of sediments in “deep-water” setting in front of a carbonate platform (e.g. SbZ environment). Lastly, this facies may present reddish intervals in shallow drilling depths layers which are interpreted to be related to a secondary oxidation of the shale intervals.

3.3.3 Paleoenvironmental evolution along described drill cores

The sedimentary logging of drill cores from the Birrindudu Basin enabled the identification of 9 main sedimentary environments. The distribution of the sedimentary environments for each of the drill core is presented on Figure 3. The interpretation of these changes will be carried out as part of module 2 of the present work. Note that on these drill cores, no major stratigraphic unconformity has been recognised.

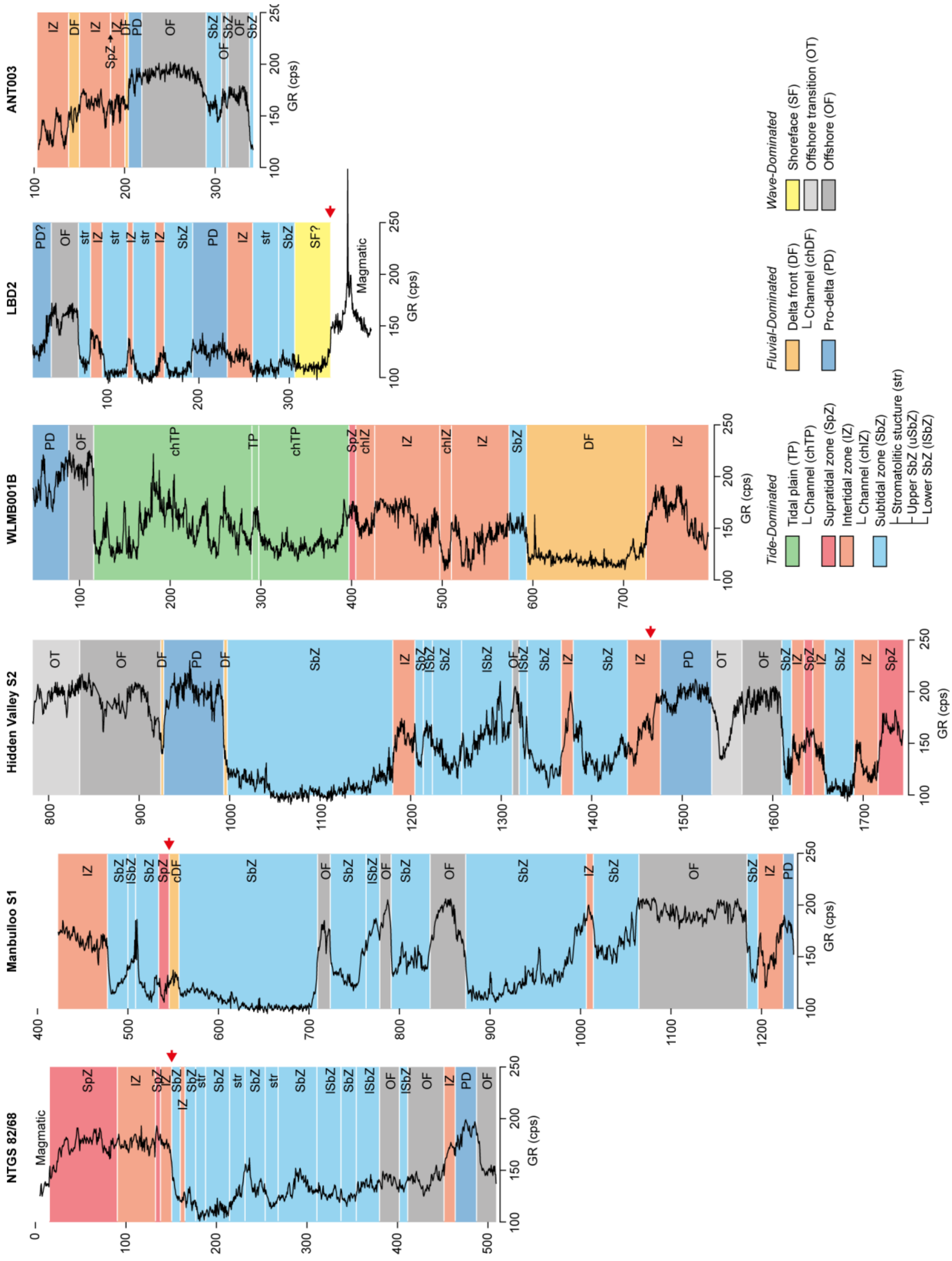

Figure 3: Paleoenvironmental evolution along the six studied drill cores in the Birrindudu Basin. Red arrows represent tentative interpretation of break in the sedimentary records, potentially related to hiatus.

4 Conclusions

By focussing on the sedimentary structures, the lithology and the bedding, the logging of 6 drill cores from the Birrindudu Basin allowed the definition of 32 sedimentary lithofacies. By gathering these lithofacies into facies associations, a total of nine main sedimentary environments were identified — Tidal plain (TP), Supratidal zone (SpZ), Intertidal zone (IZ), Subtidal zone (SbZ), Delta front (DF), Pro-delta (PD), Shoreface (SF), Offshore transition (OT) and Offshore (OF). Further investigations on the stratigraphic evolution the basin is required to fully grasp the relation between the six drill cores, which will be the focus of this project's module 2.

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