



Government of Western Australia
Department of Mines, Industry Regulation and Safety



ImageStrat

Specialists in borehole image processing and interpretation

Structural and sedimentological interpretation of the Waukarlycarly-1 acoustic televiewer image log

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Basins Workshop, Perth
4th December 2020



Acknowledgements

► DMIRS

Deidre Brooks

Peter Haines

Leon Normore

Louisa Dent

► Emerson (Paradigm)

Diego Vasquez

Download the report!



<https://wapims.dmp.wa.gov.au/WAPIMS/>

See Leon Normore's GSWA presentation

The screenshot shows a Vimeo video player interface. At the top, there are navigation links: 'vimeo' (with a green 'Join' button), 'Log in', 'Product', 'Solutions', 'Watch', and 'Pricing'. A search bar says 'Search videos, people, and more' and a 'New video' button is visible. The main content area features a video thumbnail with the title 'Waukarlycarly 1 deep stratigraphic drilling, preliminary results' overlaid on a photograph of a drilling rig at sunset. The thumbnail includes logos for 'Australian Government', 'Geoscience Australia', 'Exploring for the Future', 'Geological Survey of Western Australia', and 'EXPLORATION INCENTIVE SCHEME'. Below the thumbnail, the video title 'Leon GSWA Webinar' is displayed, along with a timestamp '1 week ago | More'. There are social sharing icons for 'DMIRS PRO + Follow', 'Download', and 'Share'. A note says 'Comments are disabled.' On the right side of the video player, there is a sidebar titled 'More from DMIRS' with links to other videos: 'Leon GSWA Webi...' and 'Au-Cu mineralizati...'. The bottom of the player has a progress bar showing '28:04'.

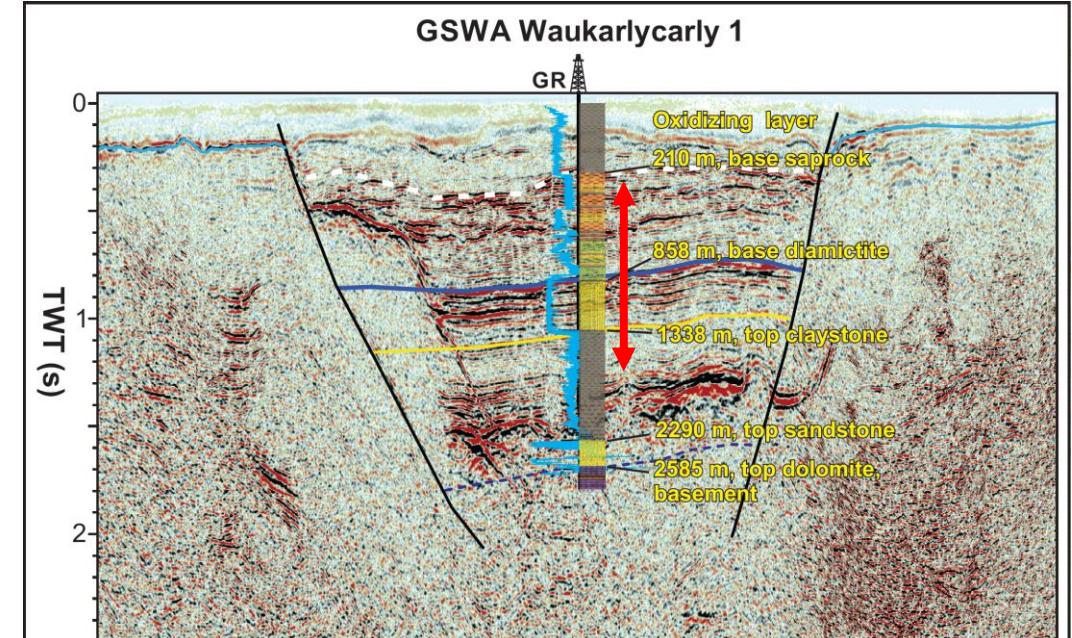
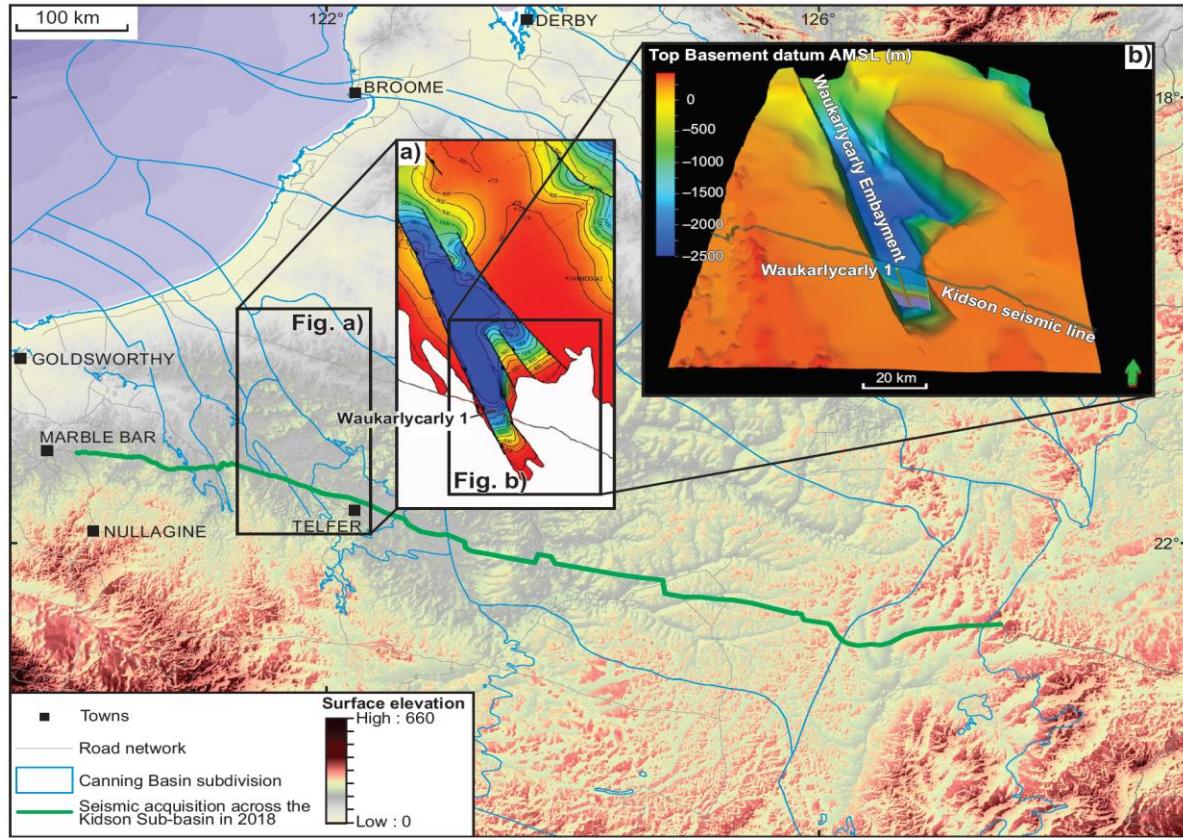
<https://vimeo.com/481039519>

This screenshot shows another Vimeo video player. The top navigation is identical to the first one. The main content area displays a video titled 'Waukarlycarly 1 Depositional Environment'. The thumbnail shows a stratigraphic column and a 3D geological model. The video title 'Leon GSWA Webinar' is present, along with a timestamp '1 week ago | More'. Social sharing icons for 'DMIRS PRO + Follow', 'Download', and 'Share' are shown. A note says 'Comments are disabled.' On the right side, there is a sidebar titled 'More from DMIRS' with links to other videos: 'Leon GSWA Webi...' and 'Au-Cu mineralizati...'. The bottom of the player has a progress bar showing '05:45'.

Outline

- ▶ Location and stratigraphy
- ▶ Workflow
- ▶ Synthesis box models

Waukarlycarly embayment, onshore Canning Basin



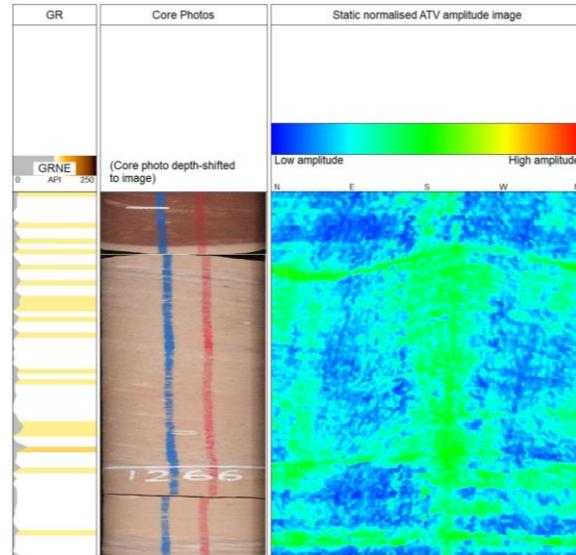
From Normore and Zhan (2020)

Formation	MD	Interval covered by ATV image
Recent clay	0.00	
Grant Group	72.00	
Unknown Sandstone #1	855.00	
Undifferentiated Ordovician (upper shale)	1400.00	
Undifferentiated Ordovician (lower sandstone)	2270.00	
Unknown Sandstone #2	2443.00	
Yeneena Basin	2585.00	
TD	2680.00	

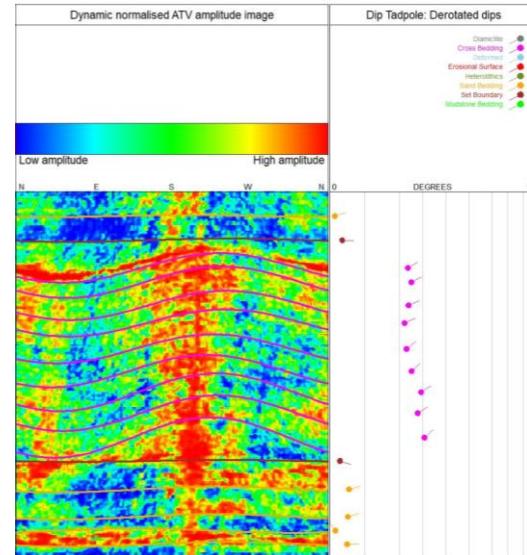
+ core photos

Image log analysis workflow: The basics

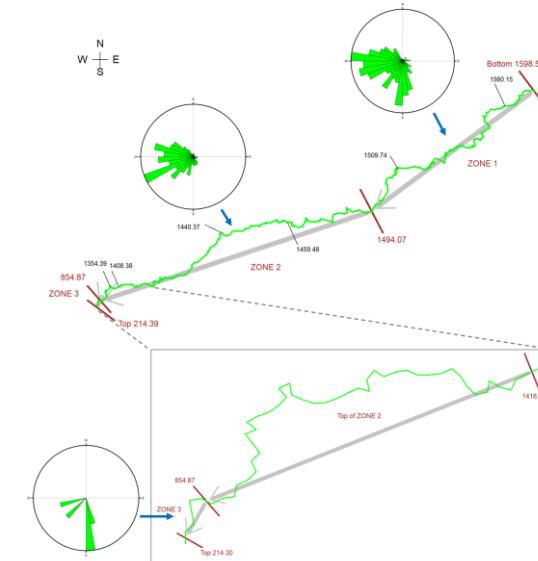
Processed image



Pick surfaces



Analyse dip data: structure



Analyse dip data: palaeocurrent

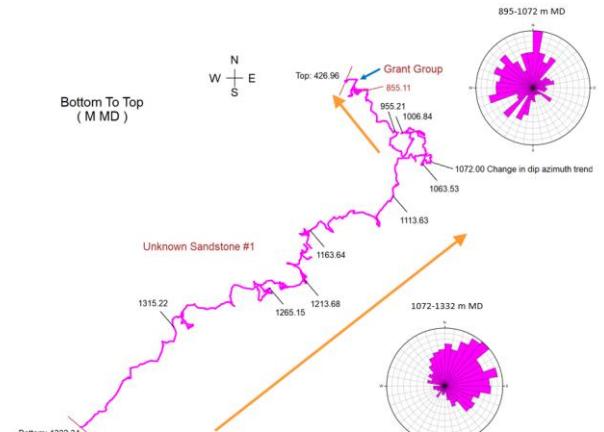
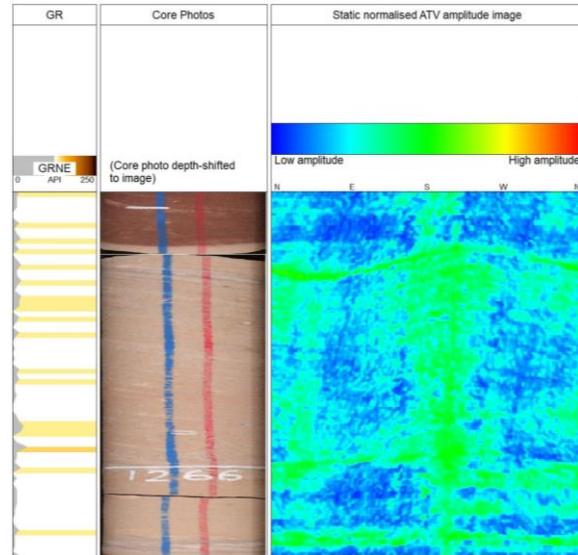
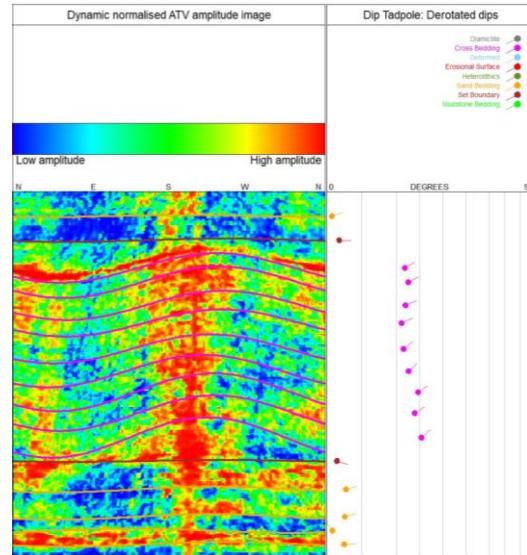


Image log analysis workflow: The basics

Processed image



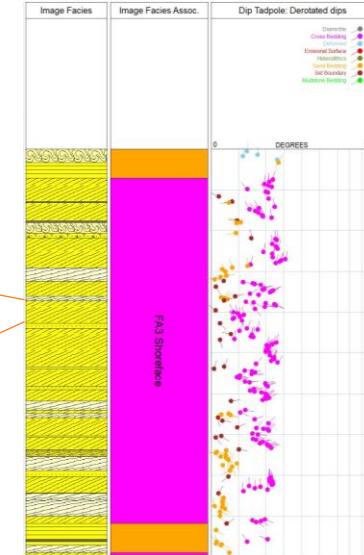
Pick surfaces



Pick facies

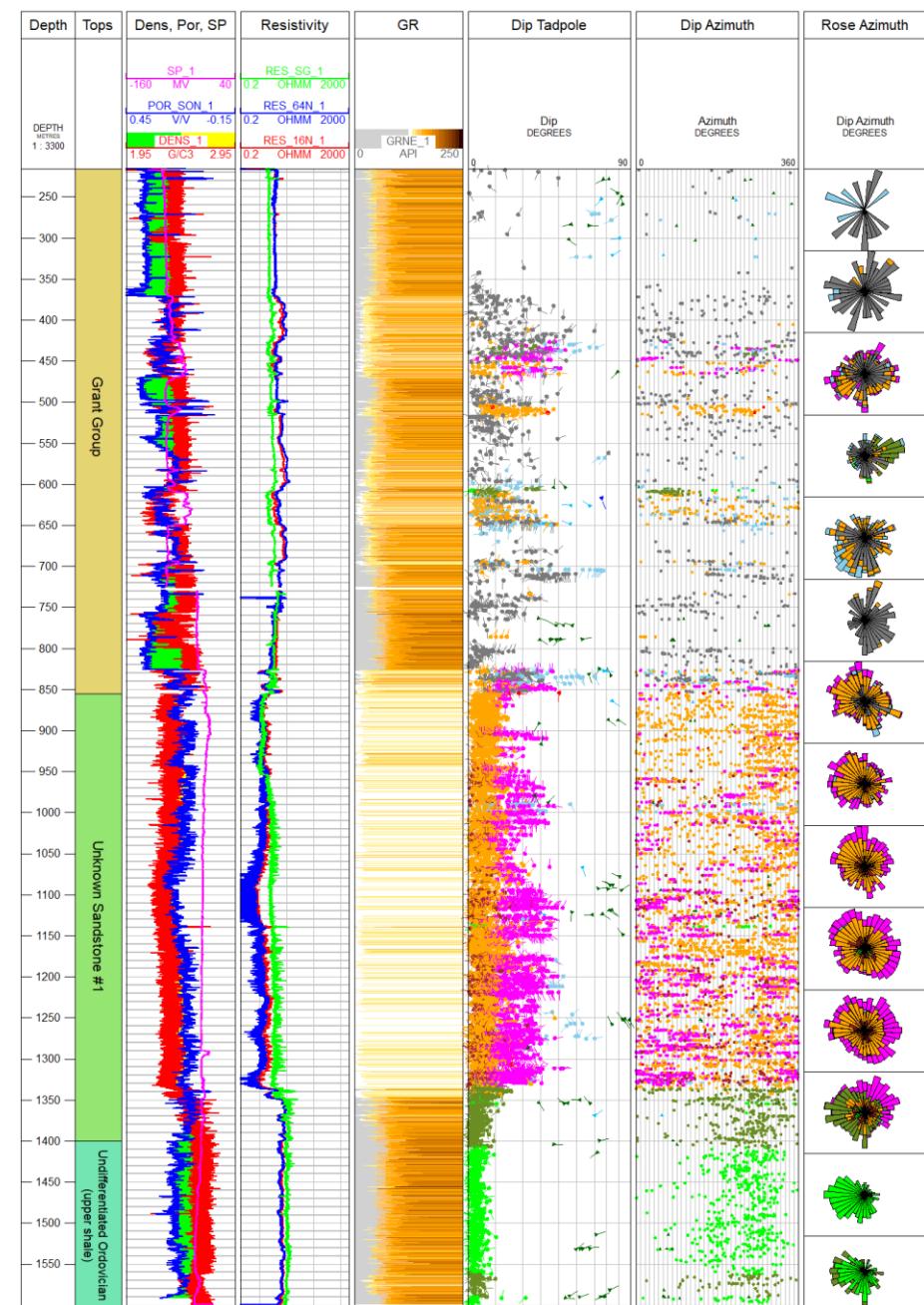


Assign facies associations



Dip distribution in study interval

Dip tadpole	Category	Description
Bedding and erosion surfaces		
	Mudstone bedding	Well-defined planar surfaces in mudstone intervals, GR usually high.
	Heterolithics	Well-defined planar surfaces in thinly interbedded sandstone/siltstones and mudstones.
	Sand bedding	Well-defined planar surfaces in sand dominated intervals, GR usually low.
	Cross-bedding	Well-defined higher angle surfaces in sand dominated intervals, often occurring in sets.
	Set boundary	Well-defined low-angle planar surfaces bounding intervals of cross-bedding.
	Diamictite	Bedding features in intervals characterised as diamictite, based on the image texture and on core photos.
	Erosional surface	Irregular planar surface truncating underlying beds/laminae.
	Deformed	Any bedding surface that is steepened relative to the formation average, associated with differential compaction features, soft sediment deformation features, or discontinuities (faulting/fracturing/slumping).
Faults and fractures		
	High amplitude fracture	High amplitude feature cross cutting bedding planes.
	Low amplitude fracture	Low amplitude feature cross-cutting bedding planes. May appear discontinuous.
	Fault	Higher-angle plane where displacement of bedding is visible and/or clear difference in texture on each side of fault.
Stress-induced features		
	Breakout	Along-borehole, irregular sided, rectangular features, typically occurring in pairs 180° apart around the borehole wall. Appear dark on traveltime image.



Facies analysis: Image facies – 26 types

Diamictites

- Diamictite - sandy
- Diamictite - muddy
- Diamictite - bedded

- Conglomerate - clast-supported
- Conglomerate - planar cross-bedded
- Conglomerate - stratified
- Conglomerate - matrix-supported

- Breccia
- Soft sediment deformation

Heterolithics

- Heterolithics - sandstone/siltstone dominated
- Heterolithics - sandstone/siltstone dominated mottled
- Heterolithics - mudstone dominated
- Heterolithics - mudstone dominated mottled

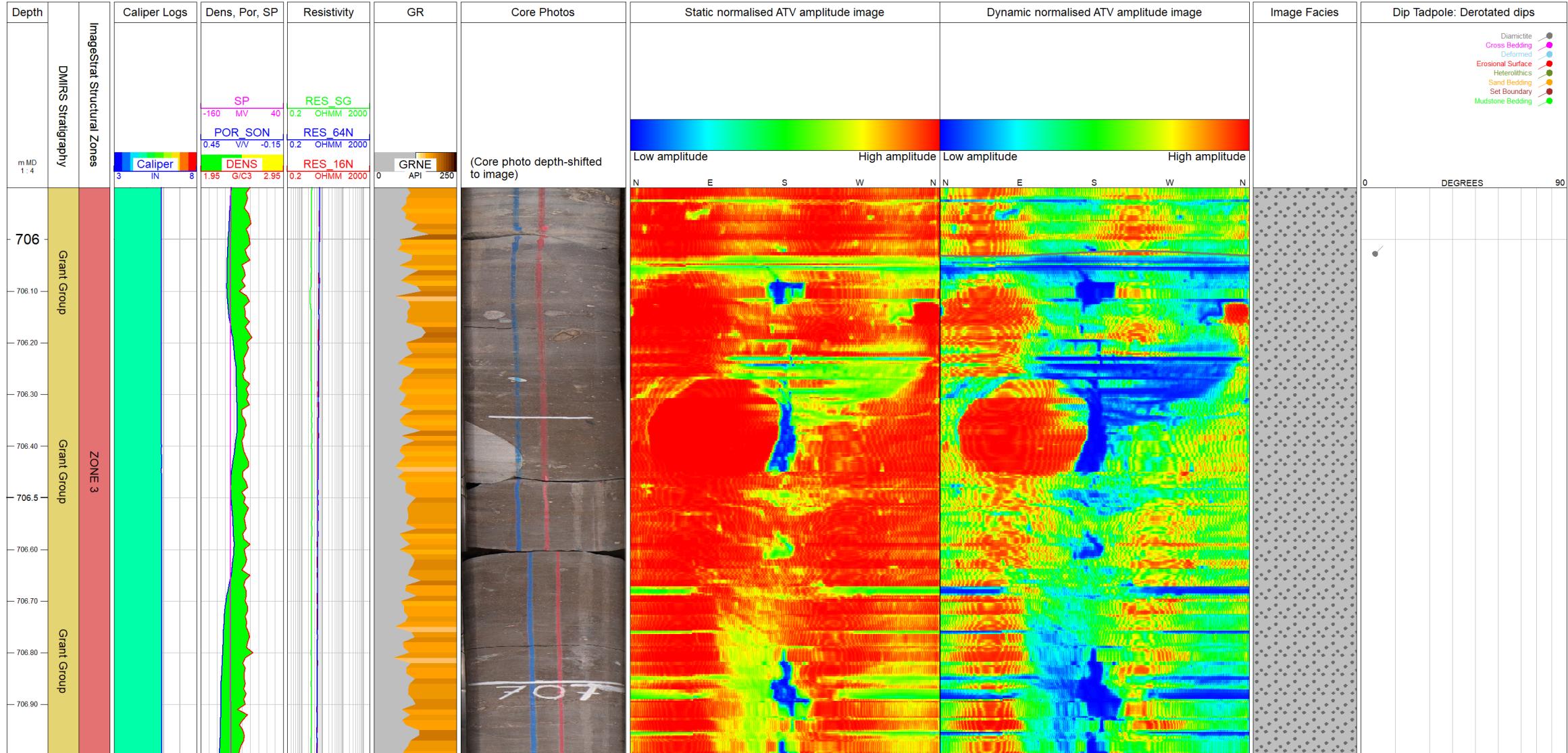
- Mudstone - massive
- Mudstone - mottled
- Mudstone - laminated
- Mudstone - high amplitude mottling

Mudstones

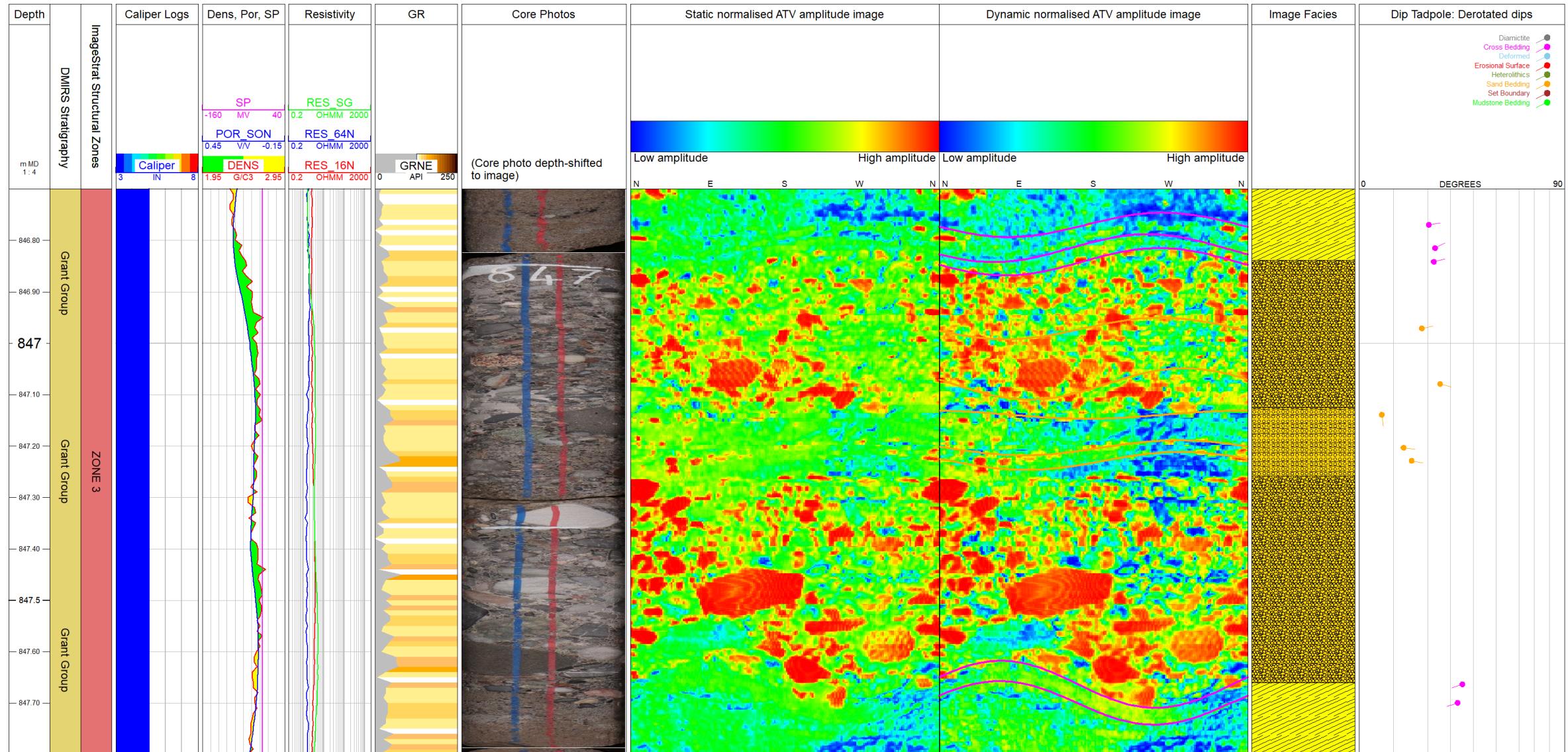
Sandstones

- Sandstone - massive
- Sandstone - massive, mottled
- Sandstone - laminated
- Sandstone - laminated, mottled
- Sandstone - low-angle planar cross-bedded
- Sandstone - low-angle planar cross-bedded mottled
- Sandstone - planar cross-bedded
- Sandstone - planar cross-bedded mottled
- Sandstone - trough cross-bedded (low angle)

Diamictite - muddy



Conglomerates



Facies analysis: Facies associations

Storm dominated shoreface

9 Ice distal proglacial marine

8 Ice proximal proglacial marine

7 Subglacial outwash fan/glaciofluvial

6 Tidal flats

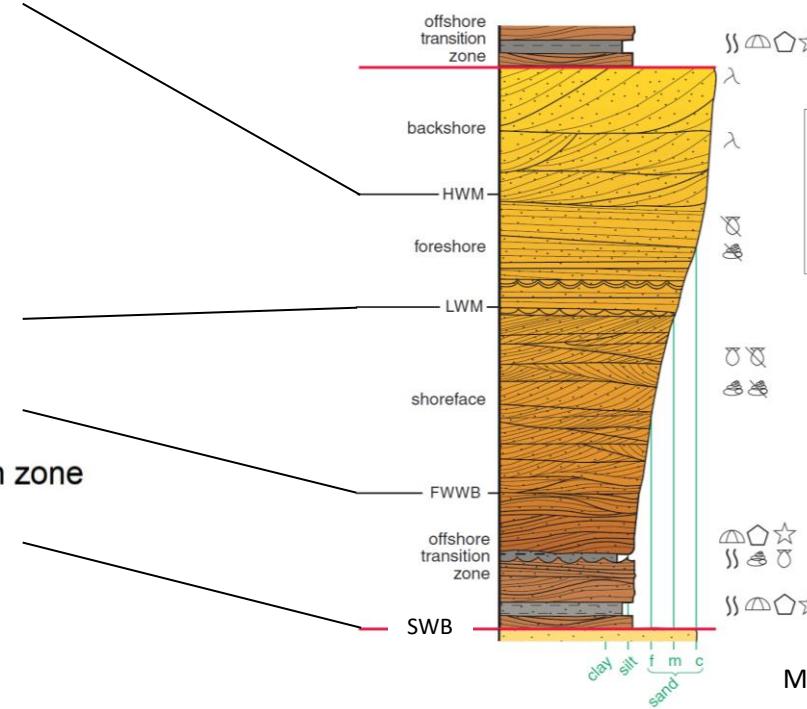
5 Lagoon

4 Foreshore

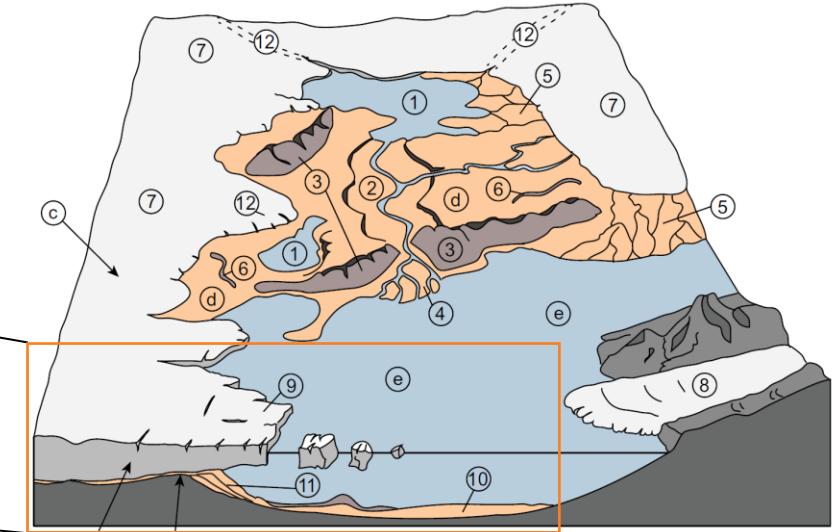
3 Shoreface

2 Offshore transition zone

1 Offshore



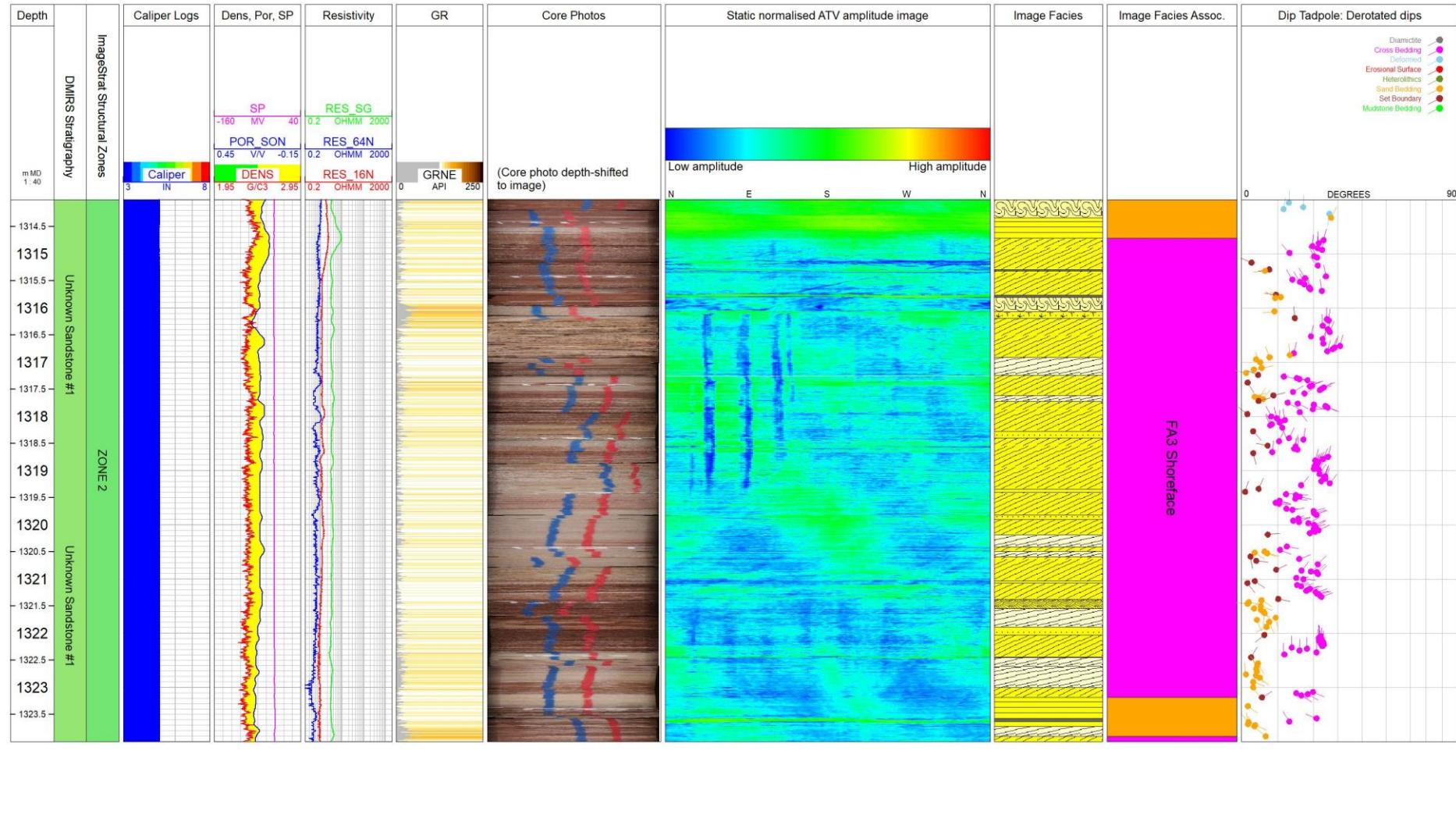
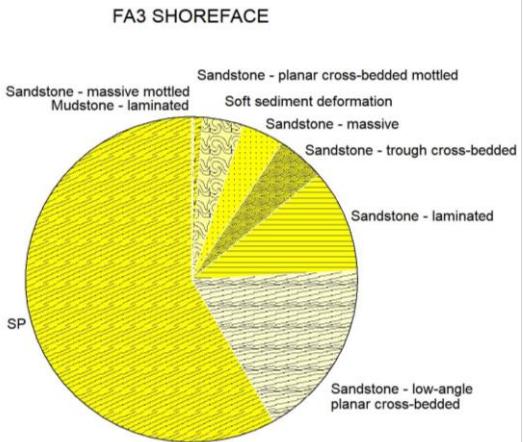
Modified from Coe et al. (2009)



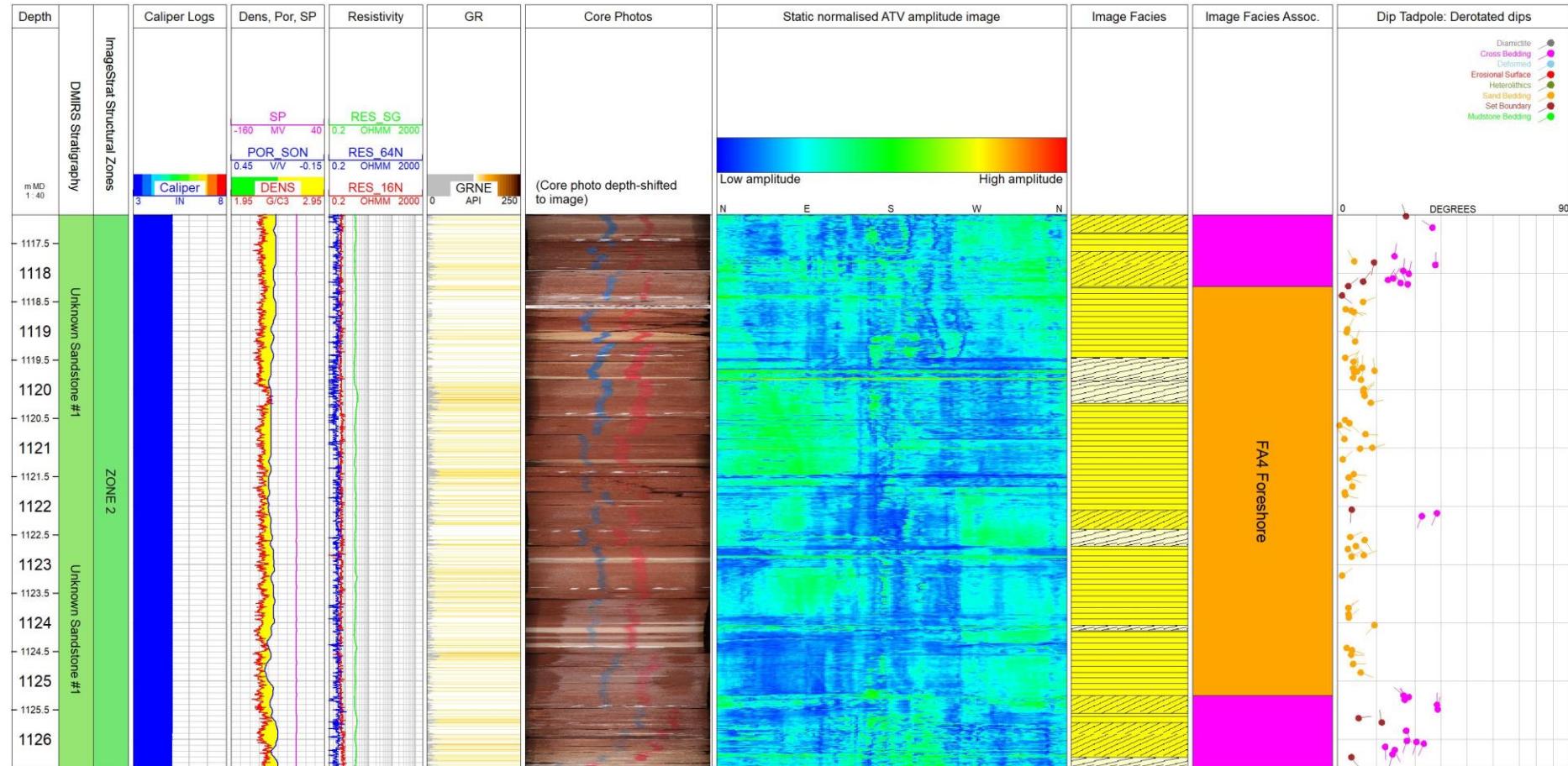
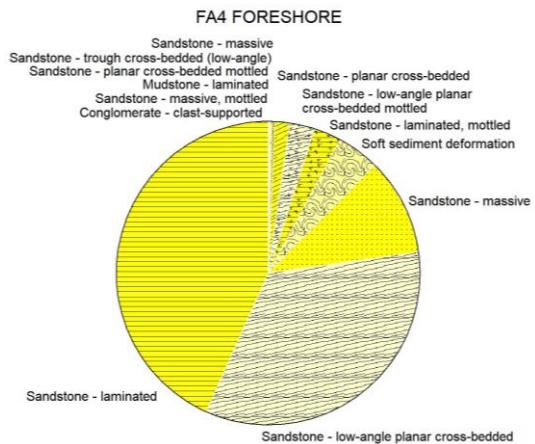
Glacial environments		Sedimentary environments
(a)	subglacial	① glacial lake
(b)	englacial	② fluvial system
(c)	supraglacial	③ moraine
(d)	proglacial	④ Gilbert-type delta
(e)	glaciomarine	⑤ outwash plain (sandur)
		⑥ esker
		⑦ ice sheet
		⑧ tide-water glacier
		⑨ floating ice-shelf
		⑩ turbidite sheets
		⑪ subaqueous outwash fan
		⑫ tunnel valley

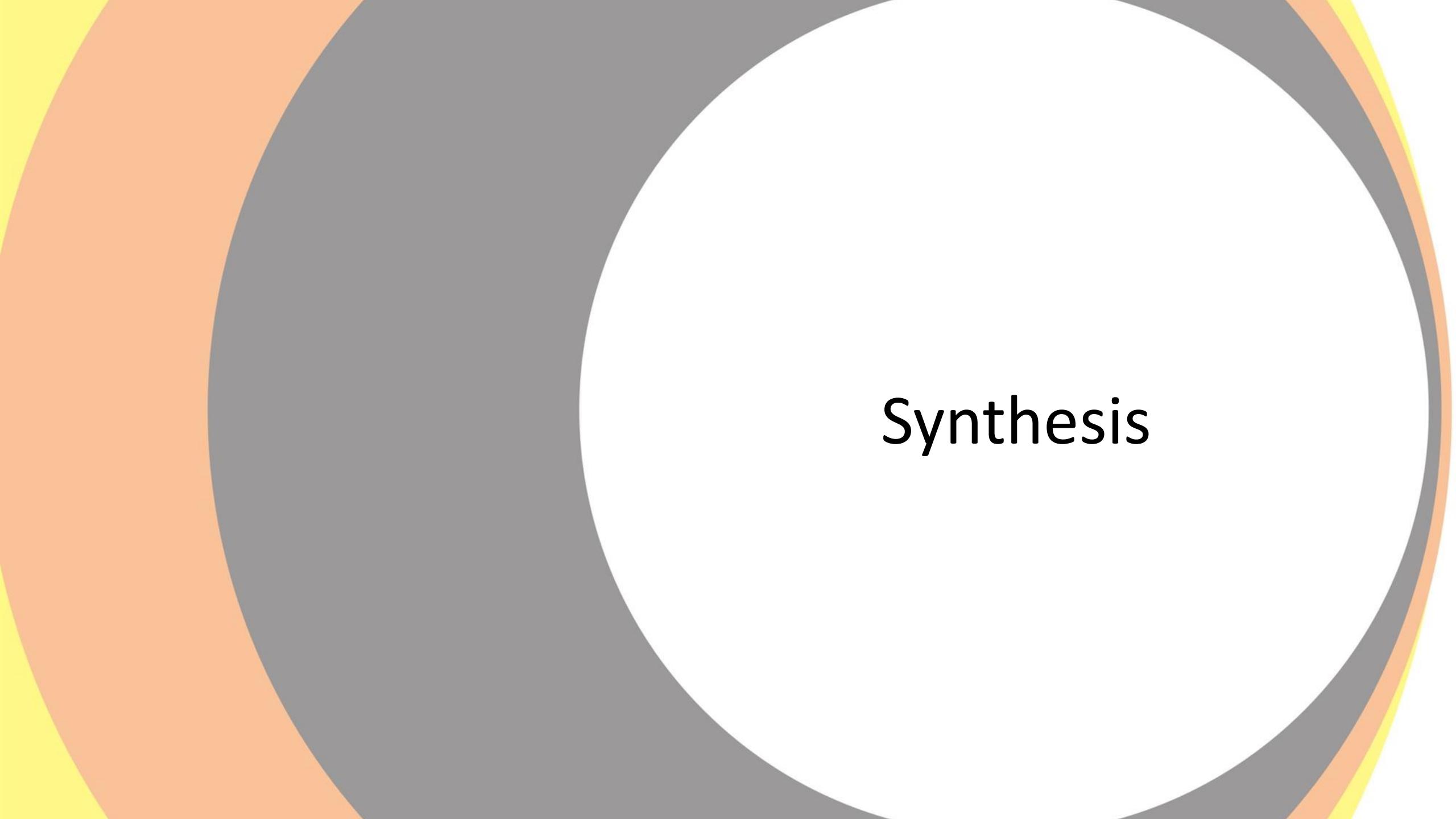
(Huuse et al., 2014, modified from Janszen 2012, re-drawn from Brodzikowski & van Loon, 1991)

FA3 Shoreface



FA4 Foreshore



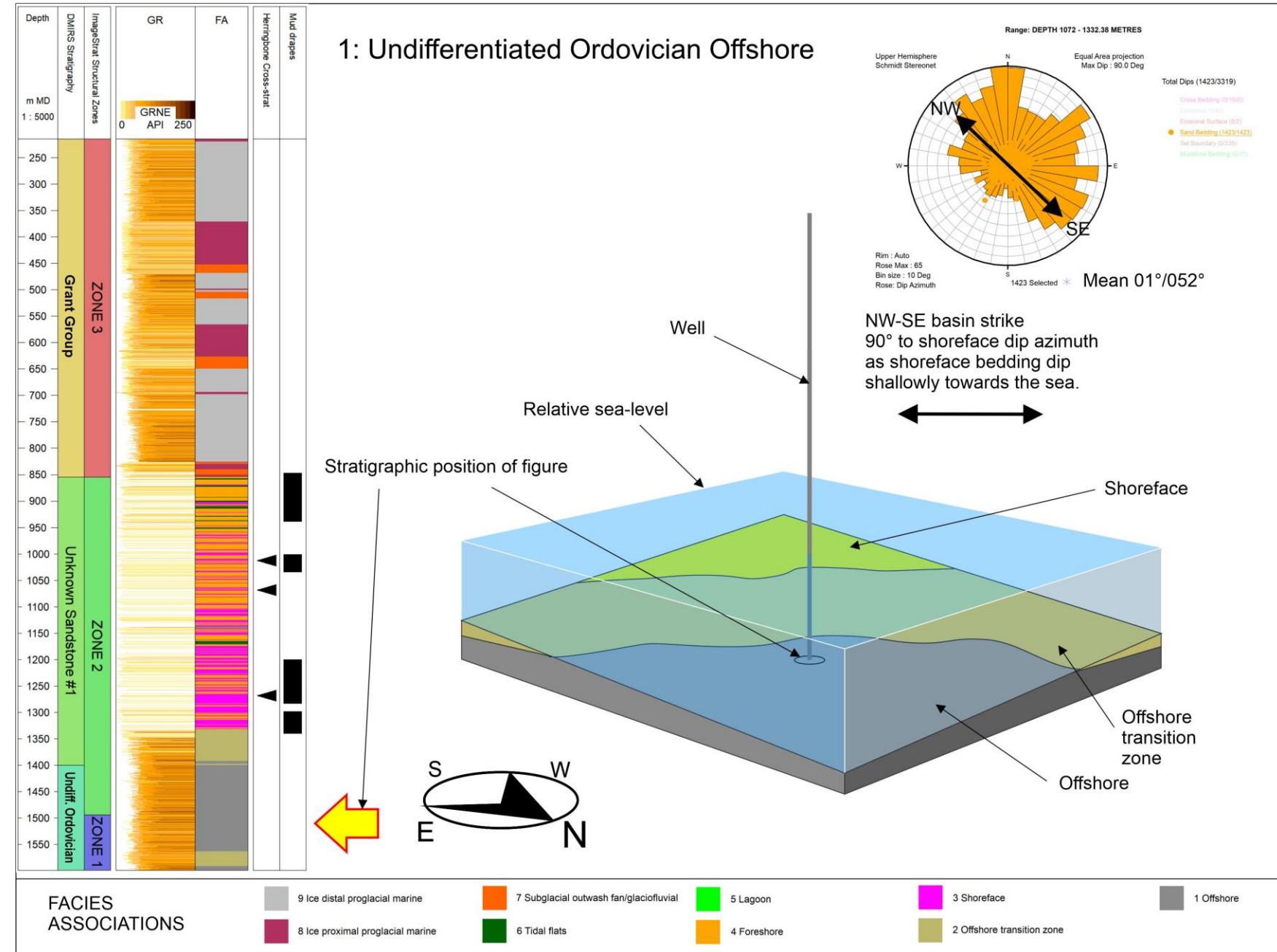


Synthesis

Synthesis 1

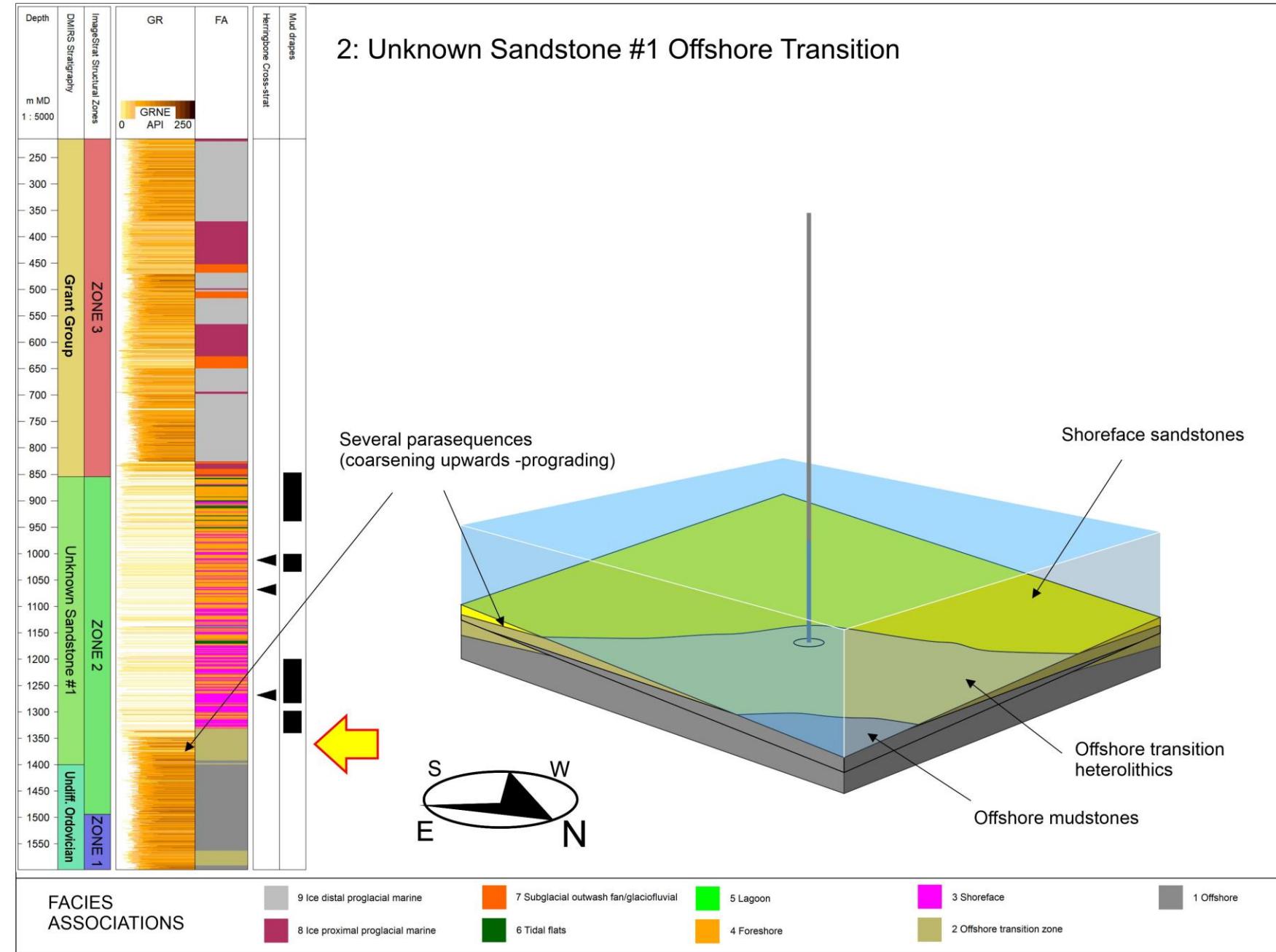
Image logs give us:

- ▶ Orientation from dip data
- ▶ Facies associations from facies analysis

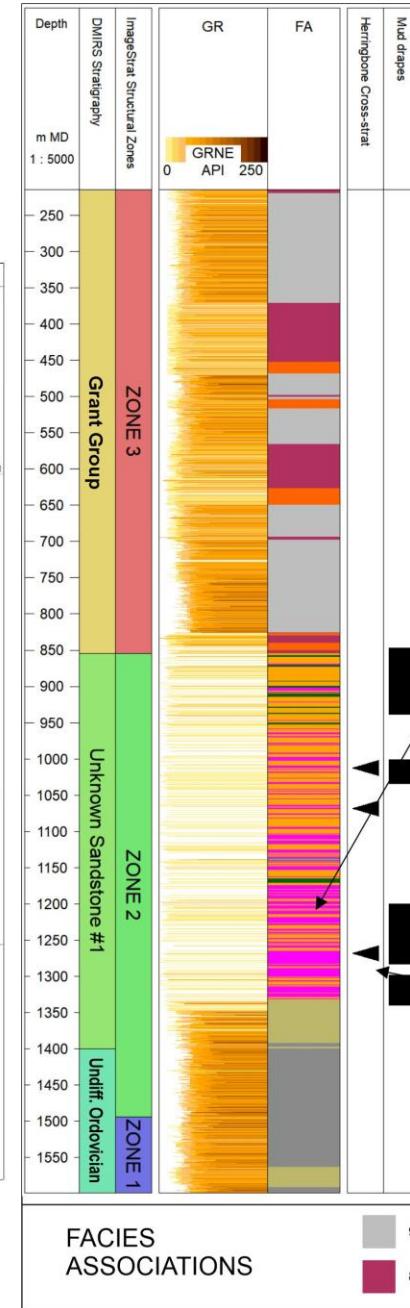
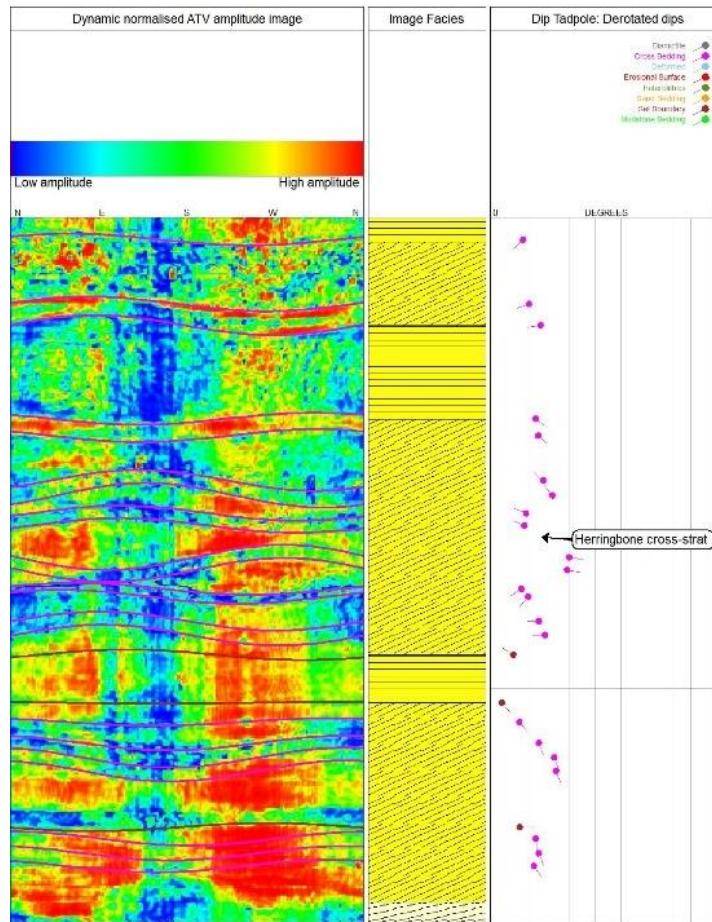


Synthesis 2

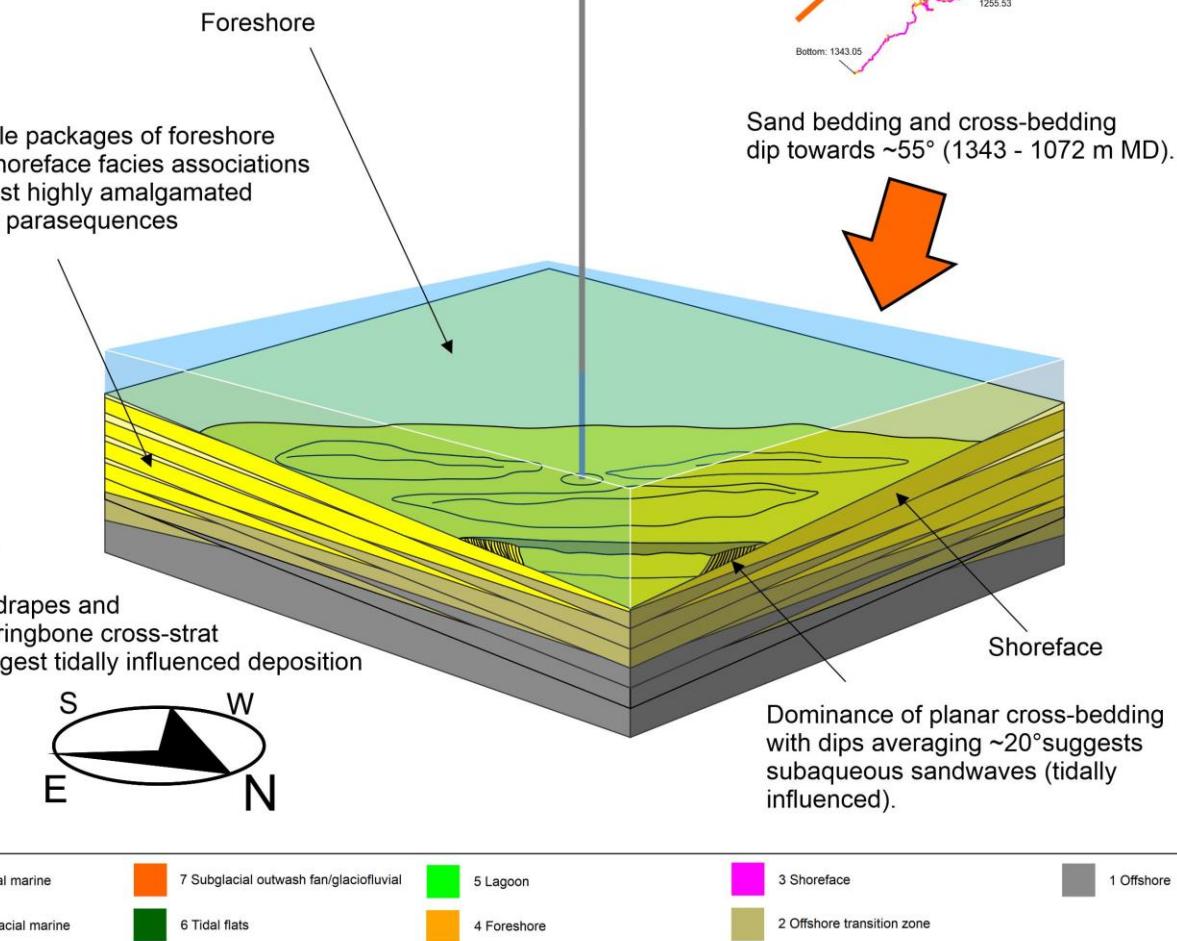
2: Unknown Sandstone #1 Offshore Transition



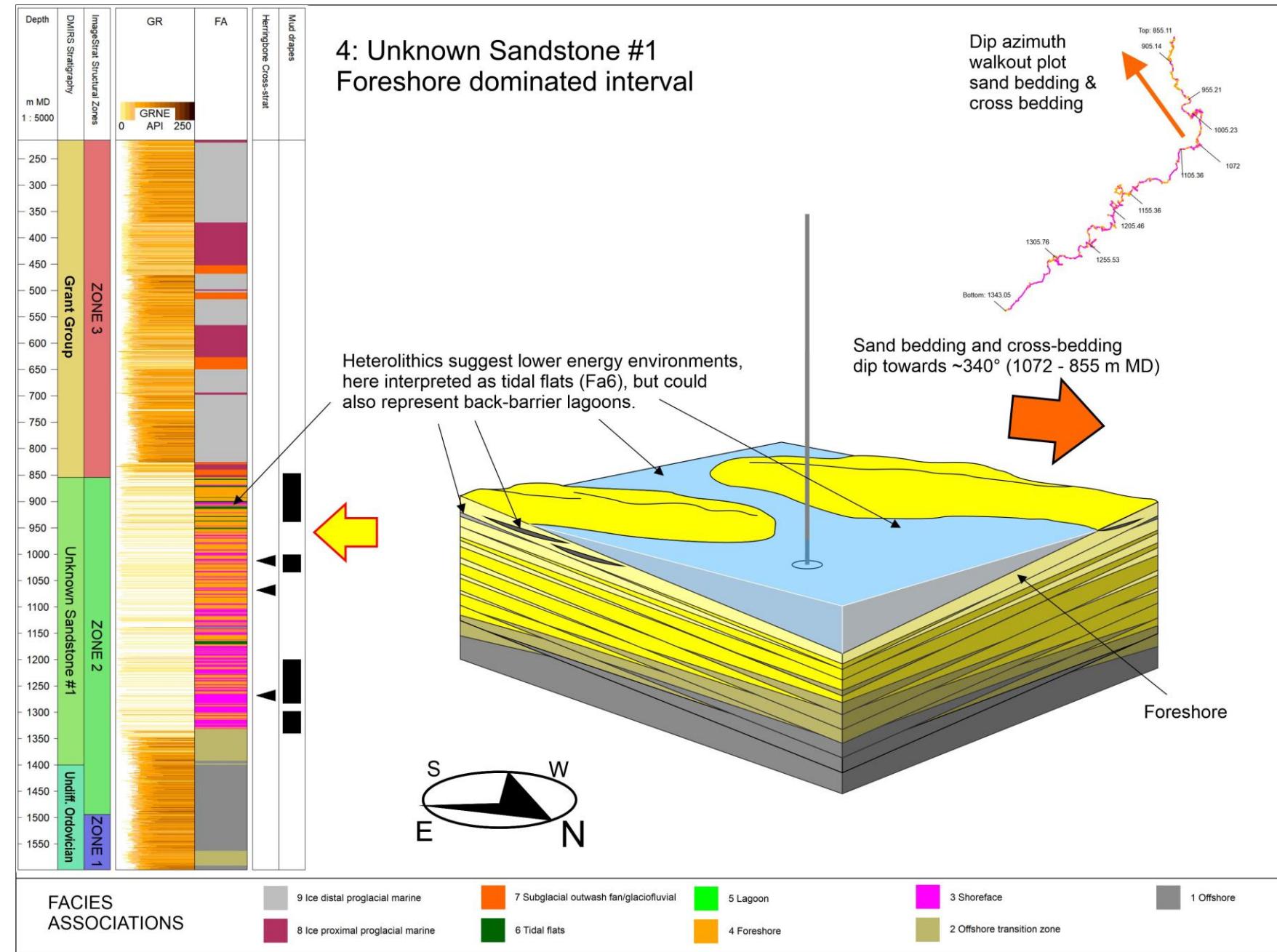
Synthesis 3



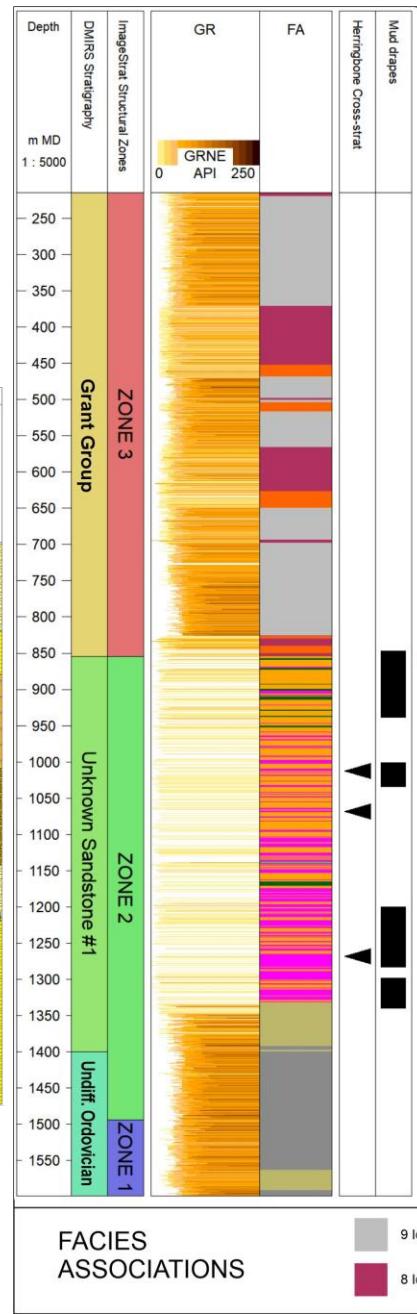
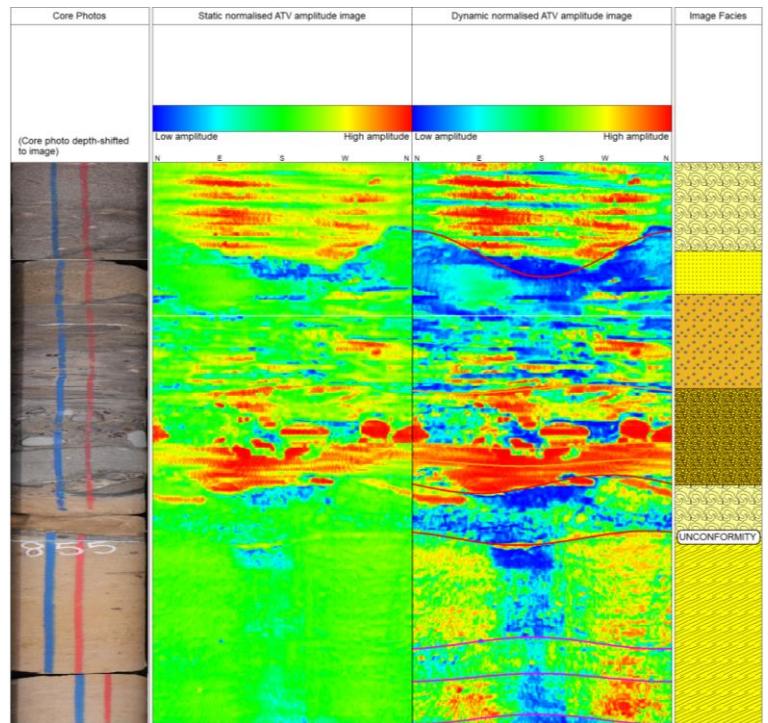
3: Unknown Sandstone #1
Shoreface dominated interval



Synthesis 4

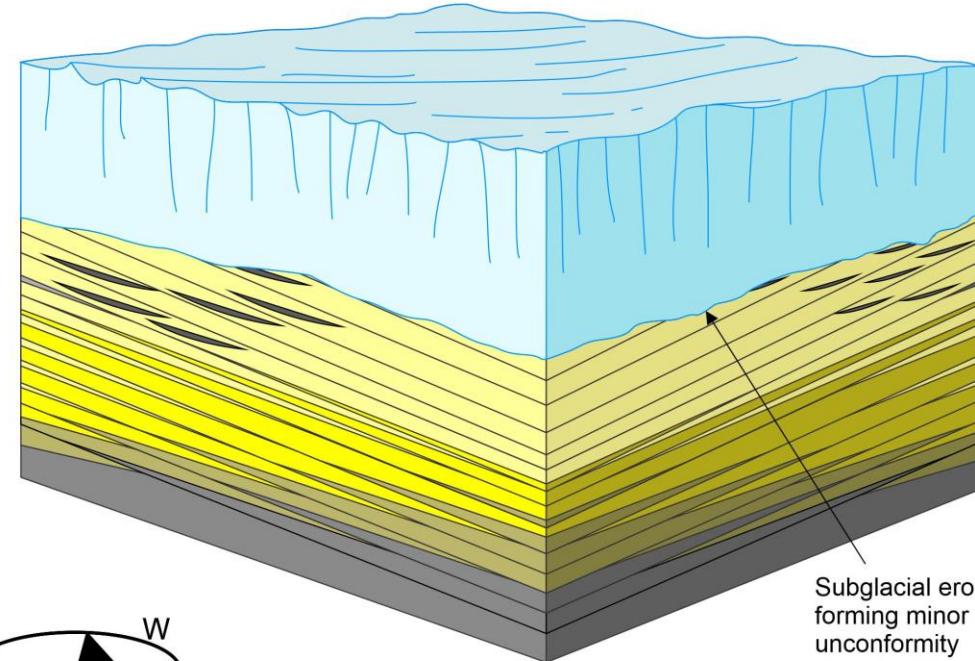
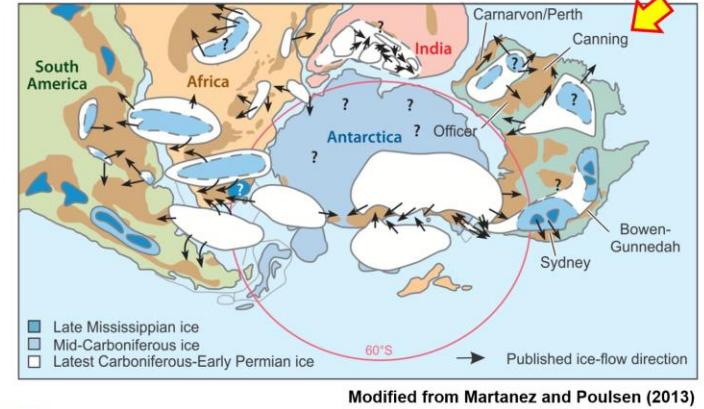


Synthesis 5



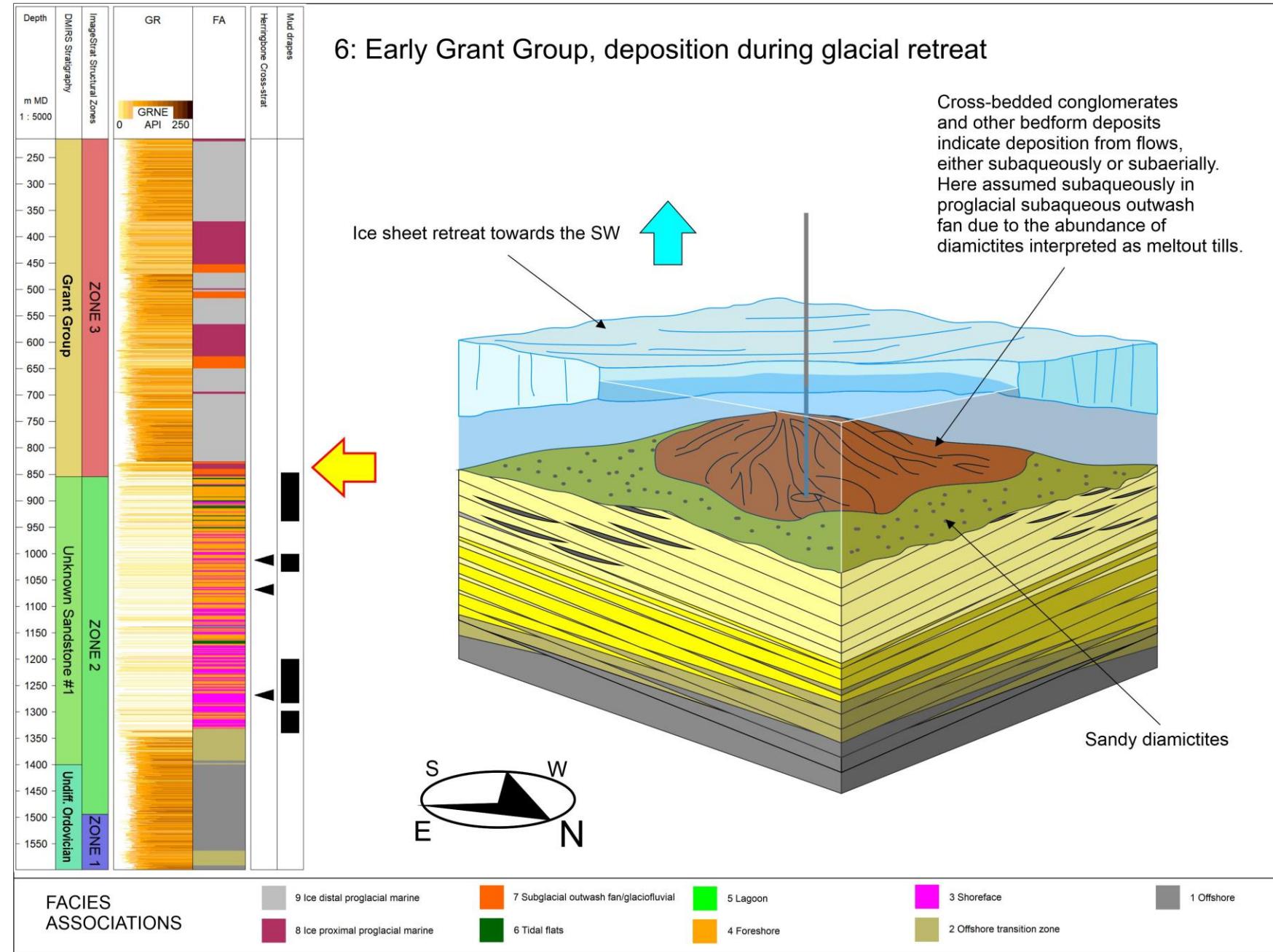
5: Structural zone 2/3 contact, and Unknown Sandstone #1/ Grant Group contact

Continental ice sheet moving ~NE downhill from Pilbara hinterland assumed from literature

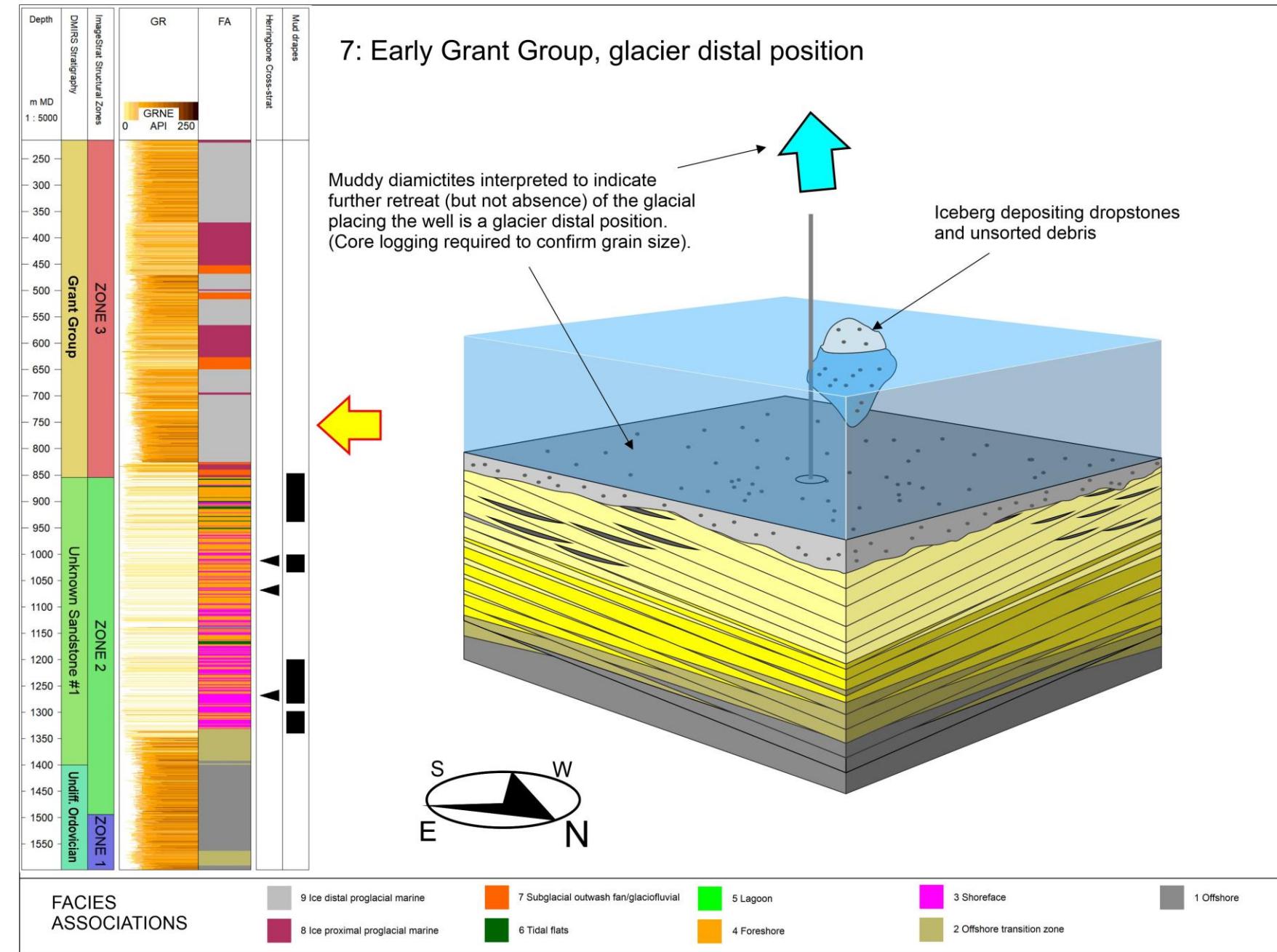


Synthesis 6

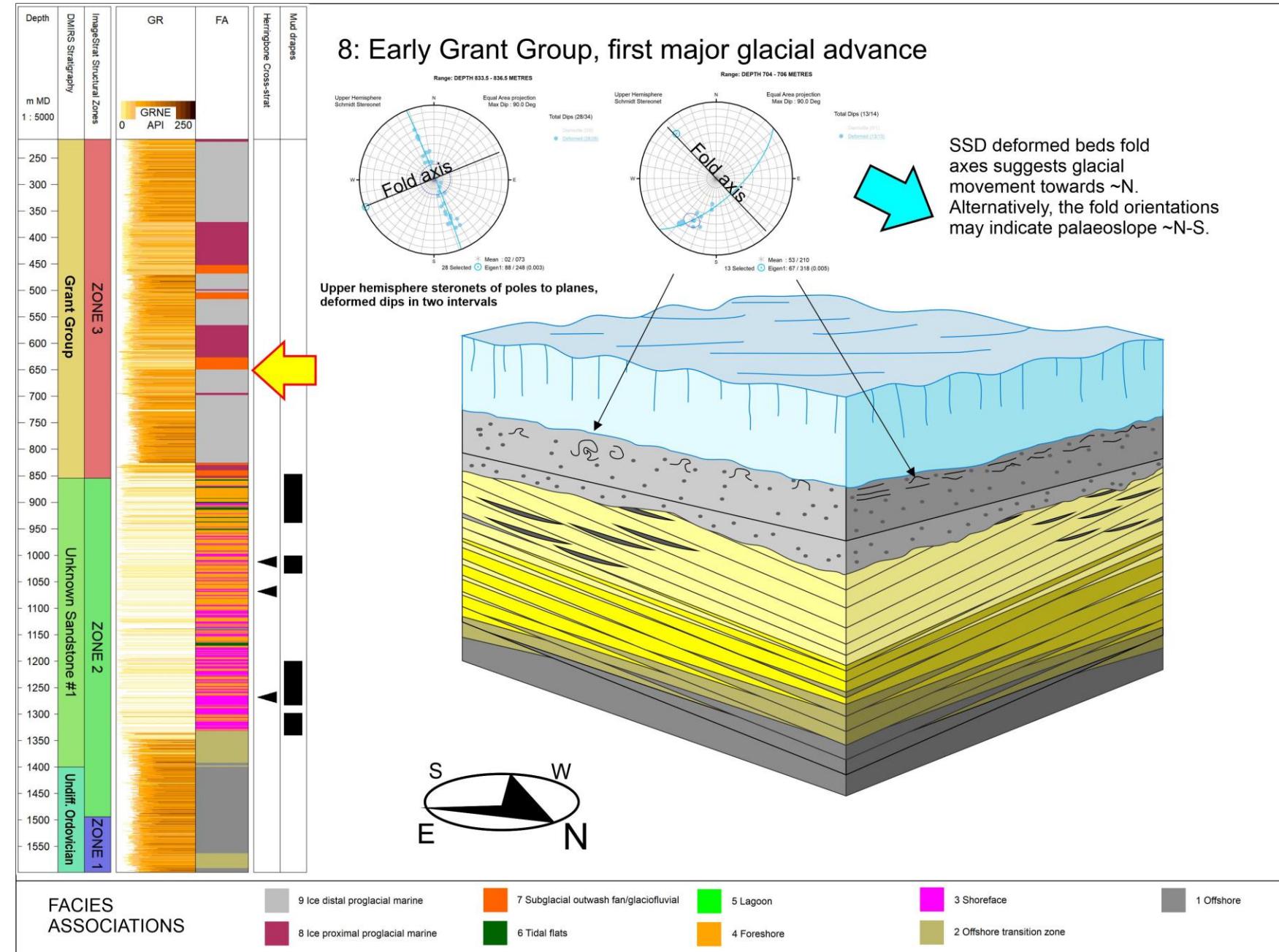
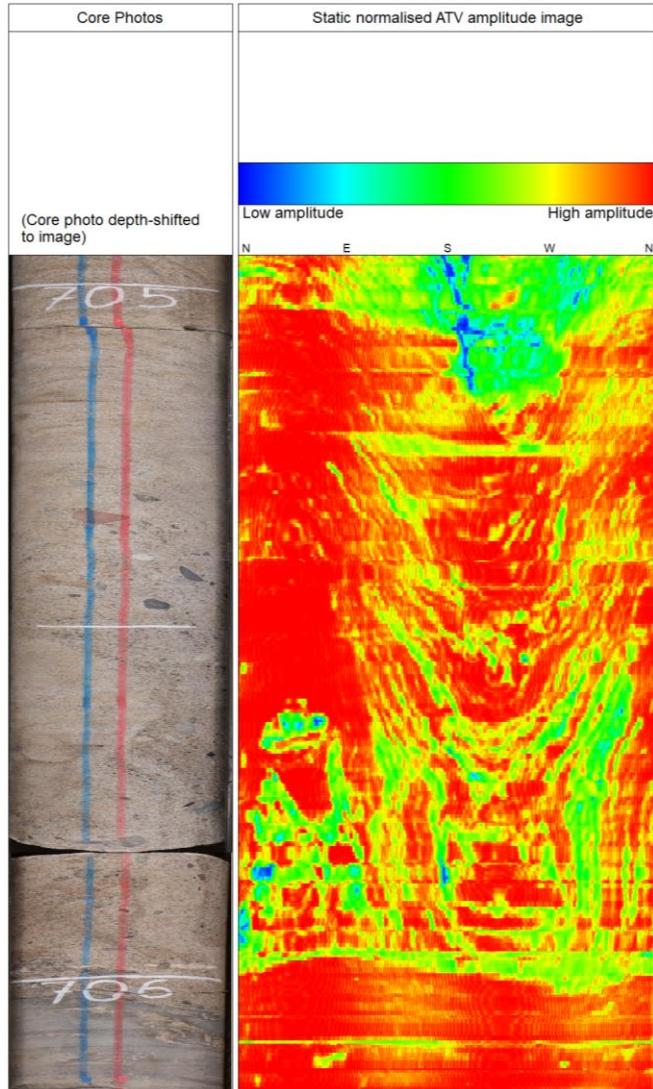
6: Early Grant Group, deposition during glacial retreat



Synthesis 7

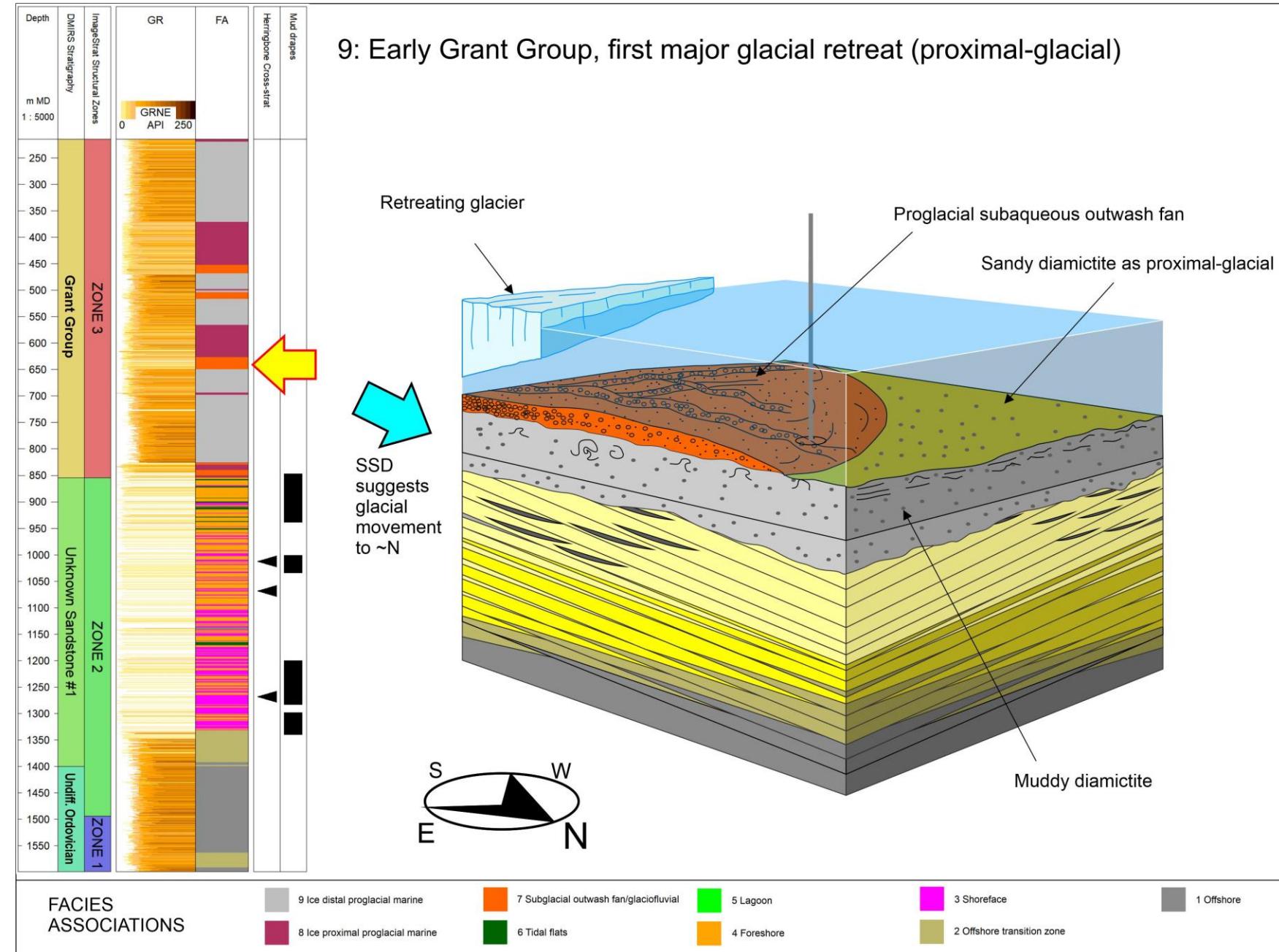


Synthesis 8



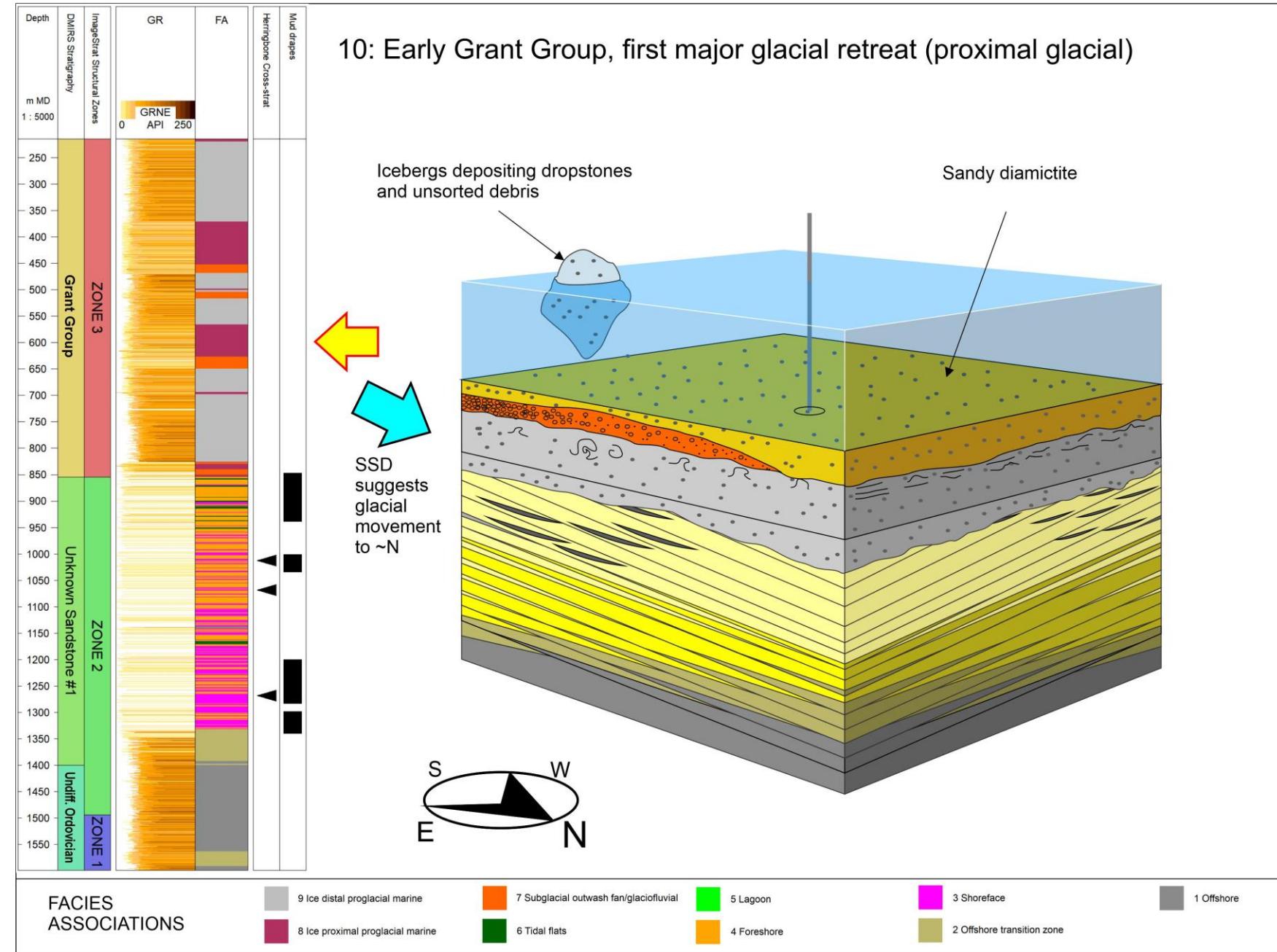
Synthesis 9

9: Early Grant Group, first major glacial retreat (proximal-glacial)

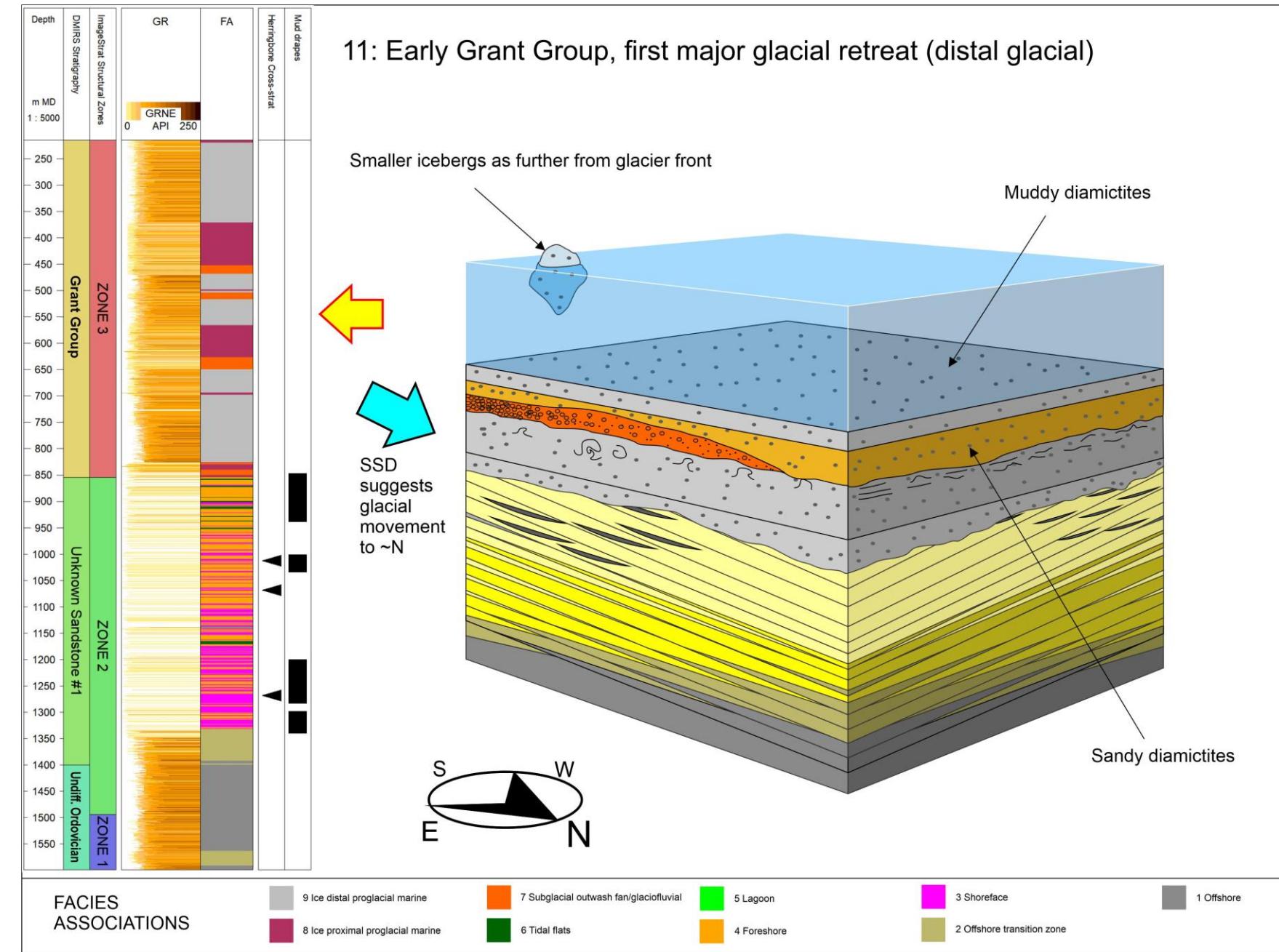


Synthesis 10

10: Early Grant Group, first major glacial retreat (proximal glacial)



Synthesis 11



References

- ▶ Coe, A.L., Bosence, D.W., Church, K.D., Flint, S.S., Howell, J.A., Wilson, R.C.L., 2009. The sedimentary record of sea-level change. Cambridge University Press.
- ▶ Huuse, M., Le Heron, D.P., Dixon, R., Redfern, J., Moscariello, A., and Craig, J., 2012. Glaciogenic reservoirs and hydrocarbon systems: an introduction *in*: Huuse, M., Redfern, J., Le Heron, D.P., Dixon, R.J., Moscariello, A., & Craig, J. (eds) 2012. Glaciogenic Reservoirs and Hydrocarbon Systems. Geological Society, London, Special Publications, 368, 1–28.
- ▶ Montañez, I.P., and Poulsen, C.J., 2013. The Late Paleozoic ice age: an evolving paradigm. Annual Review of Earth and Planetary Sciences, 41, pp.629-656.
- ▶ Normore, L.S., and Zhan, 2020, Exploring the southwest Canning Basin: GSWA Waukarlycarly 1 and the Kidson Sub-basin seismic survey in Western Australia, in GSWA 2020 extended abstracts: advancing the prospectivity of Western Australia: Geological Survey of Western Australia, Record 2020/2, p. 6–9.