Sedimentology and Image-Log Analysis of the Jurassic Deltaic Plover Formation, Browse Basin, Australian North West Shelf*

Federico Tovaglieri[1] and Annette D. George[1]

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Abstract

The Plover Formation in the Browse Basin (Australian North West Shelf) is an Early to Middle Jurassic, syn-rift, deltaic system which hosts reservoirs currently targeted for gas exploration and development. Depositional history and paleogeographical evolution of the Plover Formation in the Calliance field have been established through integrated analysis of core, borehole image log and wireline log data in conjunction with biostratigraphic data. Six facies associations have been identified through facies analysis of core and interpreted as tidally influenced channel- and tidal channel-fill complexes (FA1-FA2), crevasse splays and interchannel marshes (FA3), tidal bars and flats (FA4), shoreface (FA5) and offshore-transition to offshore (FA6) depositional settings. Analysis of FMI and FMS images reveals sedimentological features that are not visible in core that provide additional information regarding depositional processes and environments. Core-based and image-log analysis shows that the Plover Formation in the Calliance area was deposited on a tidally influenced delta plain to delta front. Tidal processes exerted a fundamental control on the development of porosity and permeability with highest reservoir quality associated with FA1. Combining sedimentological results with biostratigraphic data has been used to identify five second-order stratigraphic units bounded by surfaces with sequence-stratigraphic significance (~5-9 Ma duration). Integration of the depositional model with sediment-dispersal interpretations from paleocurrent data derived from image-log analysis, and identification of major synsedimentary faults from seismic data, is being used to interpret reservoir geometry of the Plover Formation in the Calliance field which is complicated by volcanic and volcaniclastic facies recording active volcanism during deltaic deposition.

Reference

Kennard, J.M., I. Deighton, D. Ryan, D.S. Edwards, and C.J. Boreham, 2004, Subsidence and thermal history modelling; new insights into hydrocarbon explusion from multiple petroleum systems in the Browse Basin, *in* G.K. Ellis, P.W. Baillie, and T.J. Munson (eds.), Timor Sea Petroleum Geoscience, Proceedings of the Timor Sea Symposium, Darwin, Northern Territory, Australia, 19-20 June 2003: Special Publication Northern Territory Geological Survey, Report #1, 25 p.

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AAPG ACE
Long Beach, April 2012

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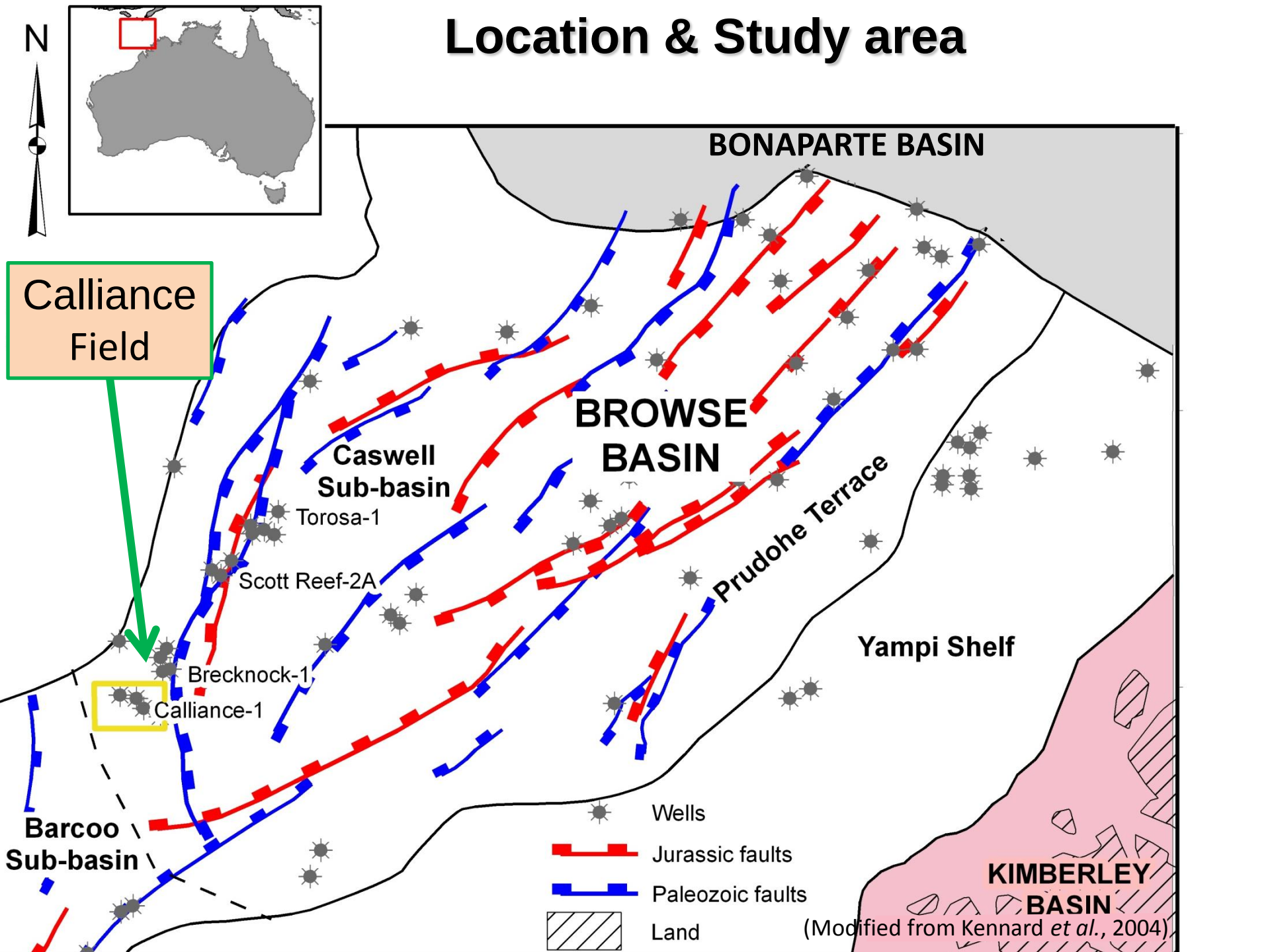
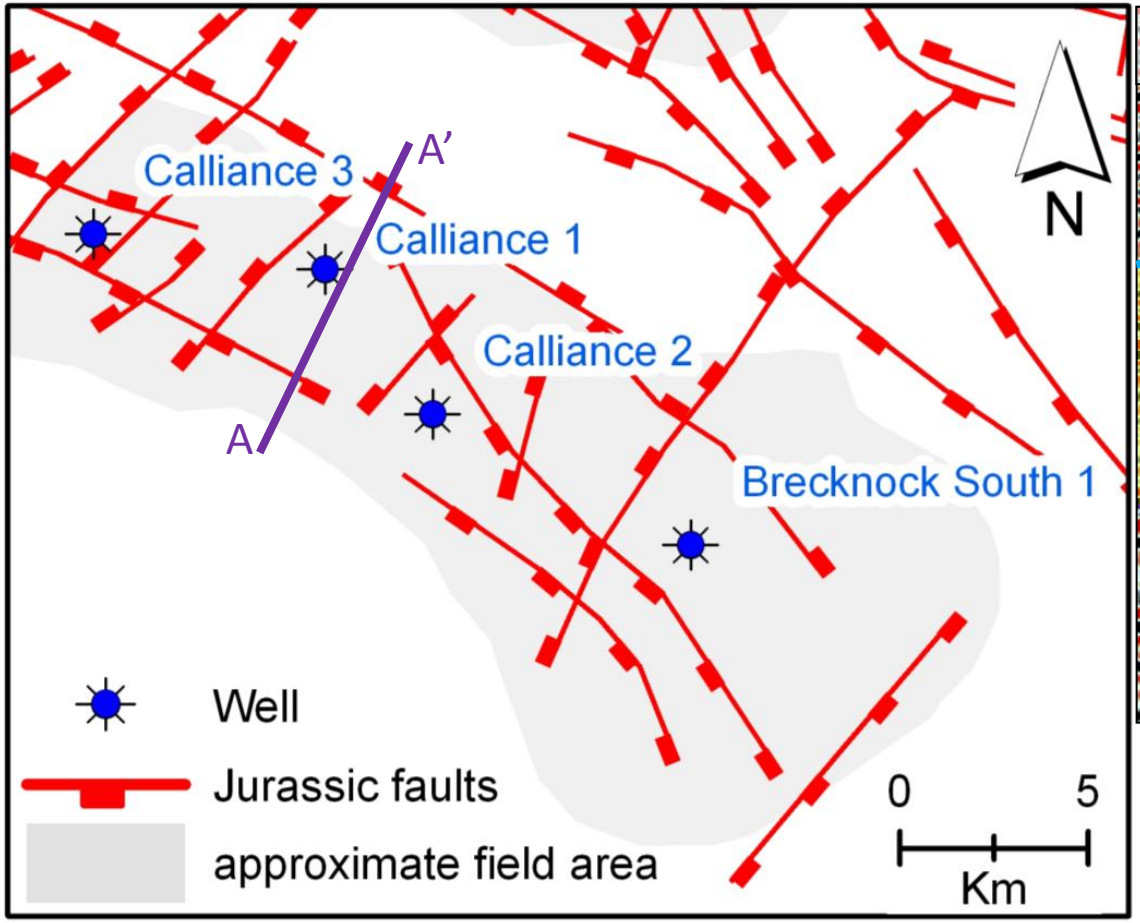
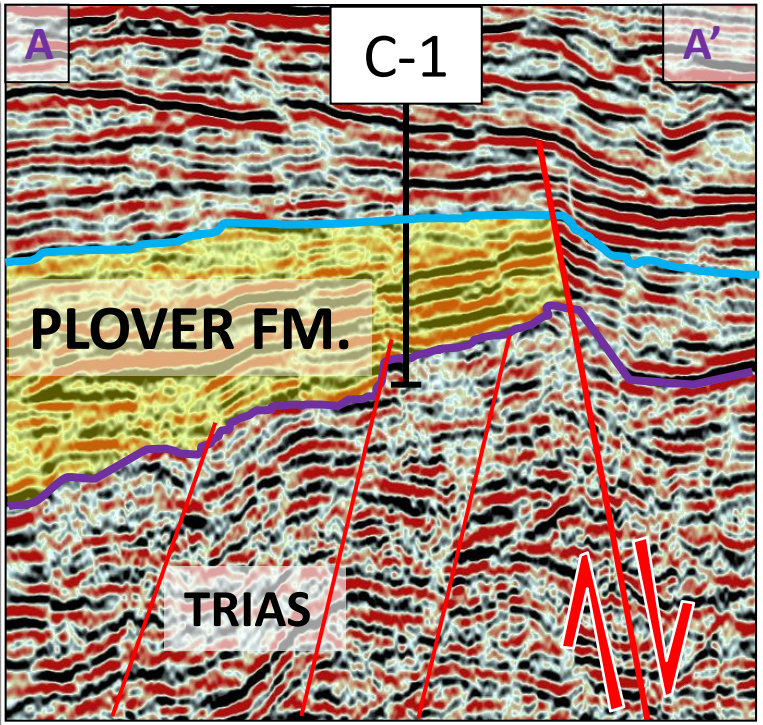
Location & Study area



(Modified from Kennard *et al.*, 2004)

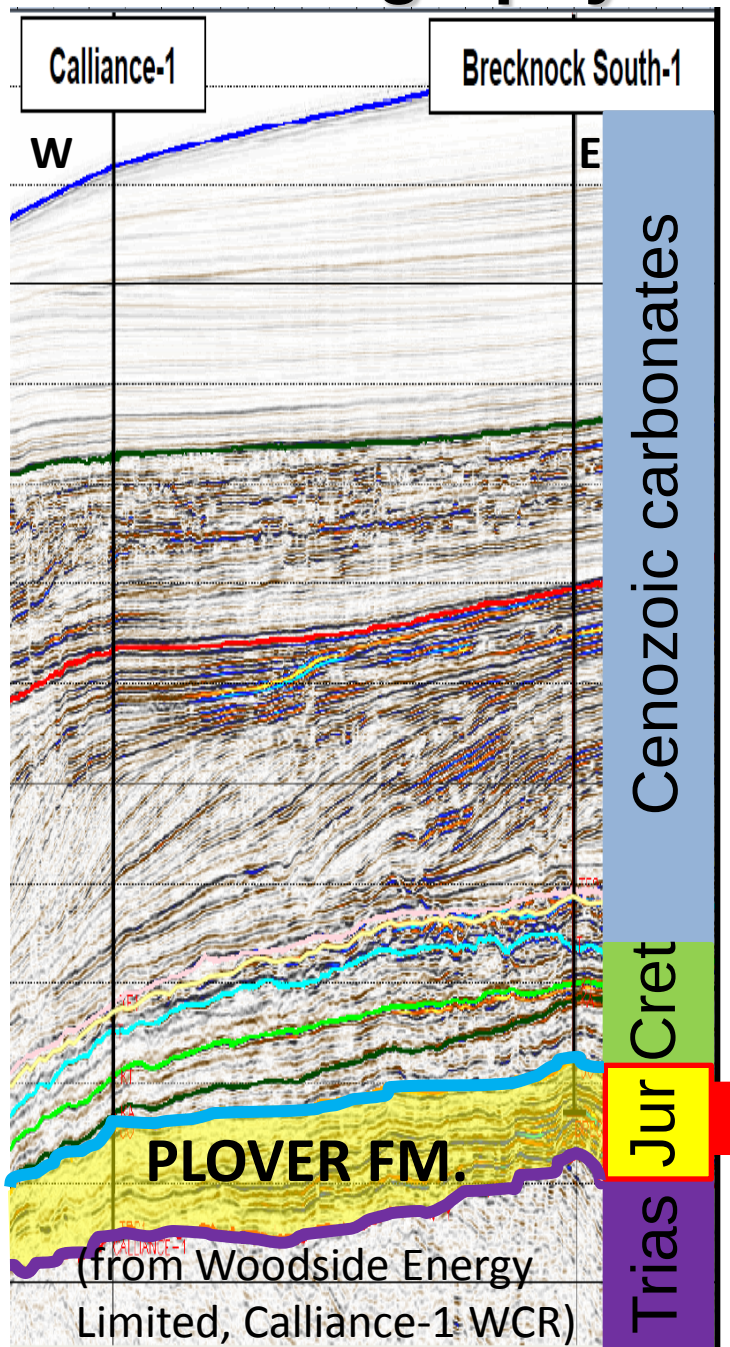
Calliance field

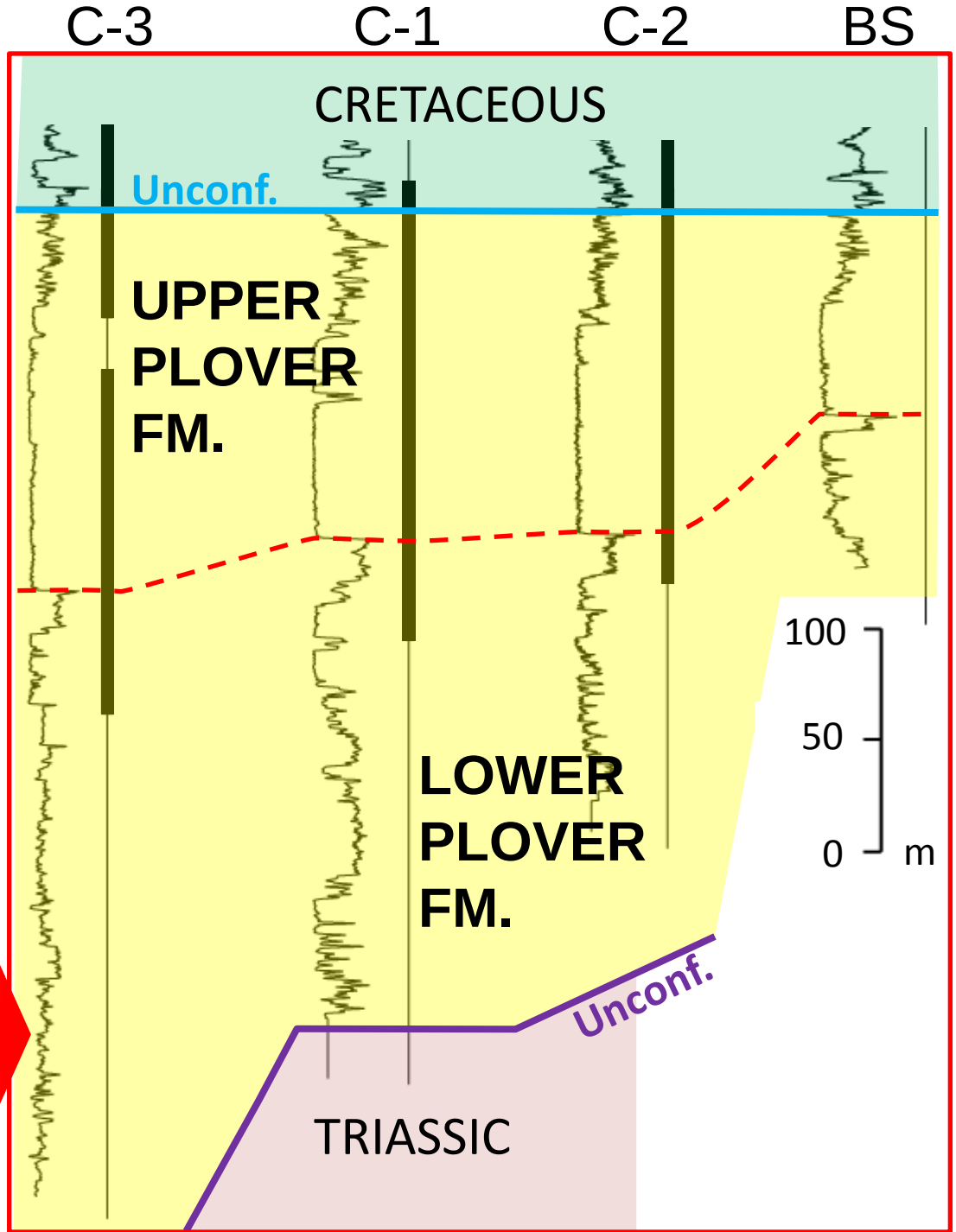




- Compartmentalized reservoir
- Synsedimentary tectonic activity
- Location on fault block
- Variable thickness
- Igneous units

Lithostratigraphy

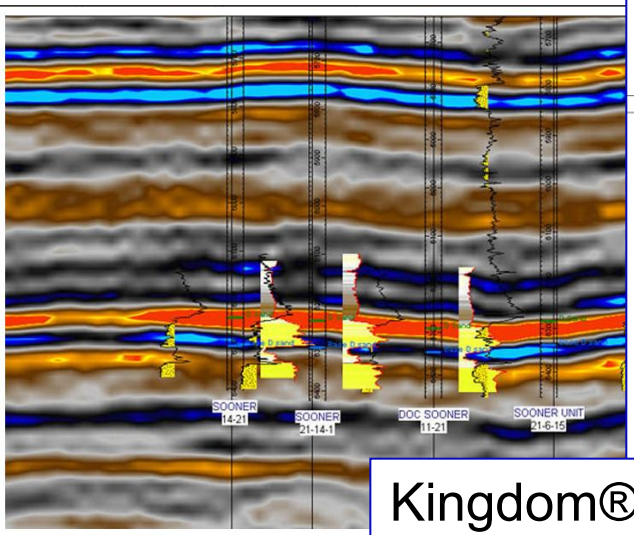




Project objective & Methods

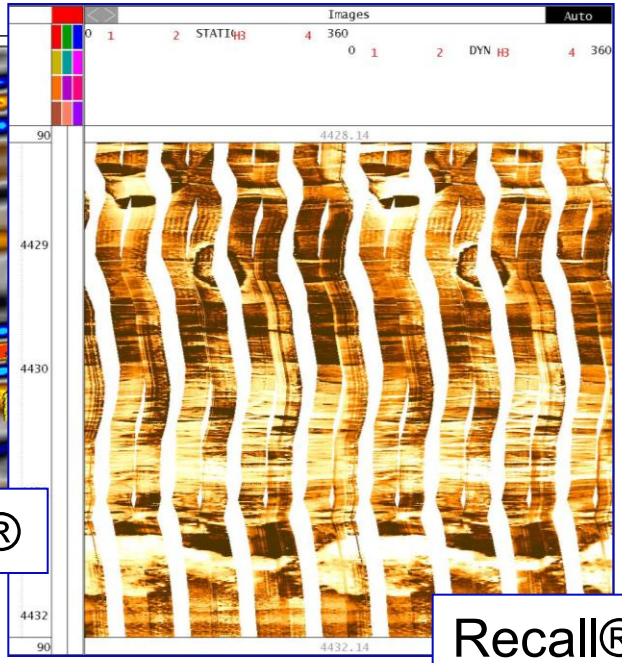
- Core logging
- Facies analysis
- Image-log analysis
- Seismic interpretation
- Biostratigraphic data

Depositional history & paleogeography



Kingdom®

(*from* http://www.seismicmicro.com)



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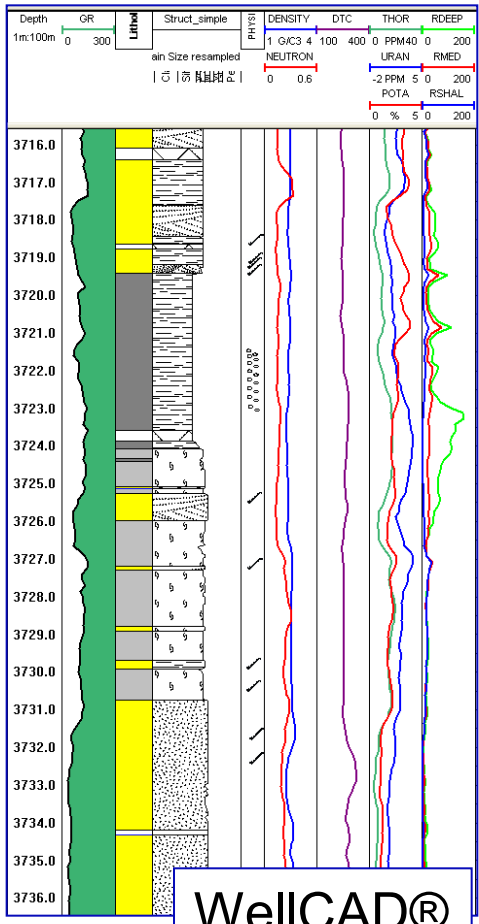

WellCAD®

Project objective & Methods

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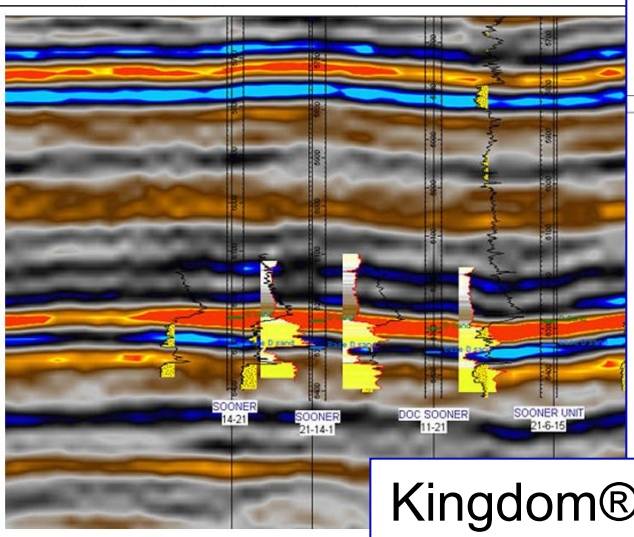
Depositional history & paleogeography



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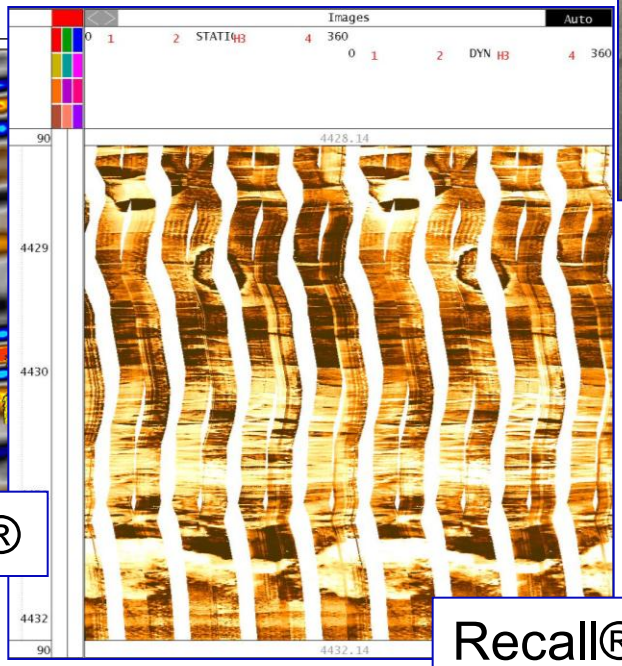
(*from* http://www.seismicmicro.com)



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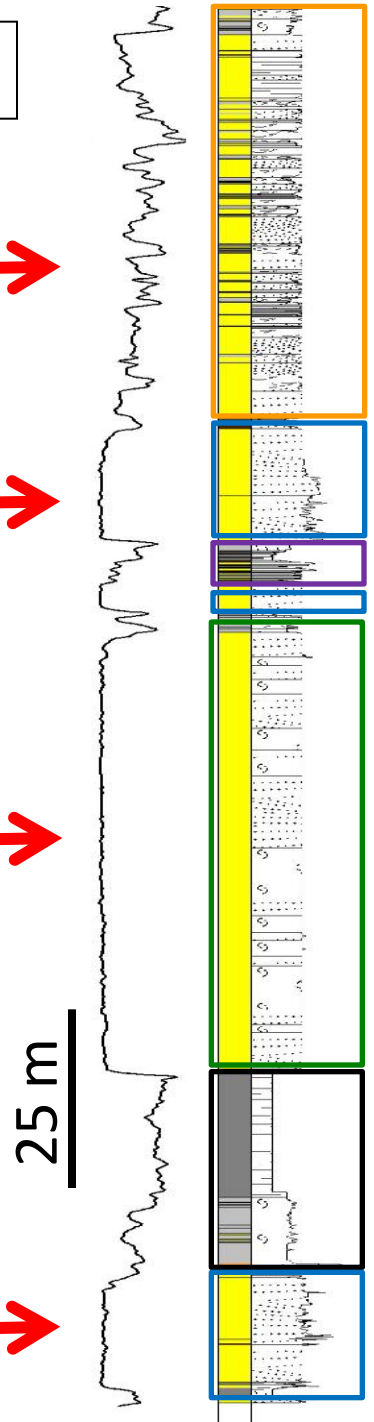
Calliance-1 core



Reservoir

Reservoir

Main Reservoir

Reservoir (low quality)

Facies analysis

14 facies, 6 facies associations

Heterolithic mouth bars and sand flats (FA4)

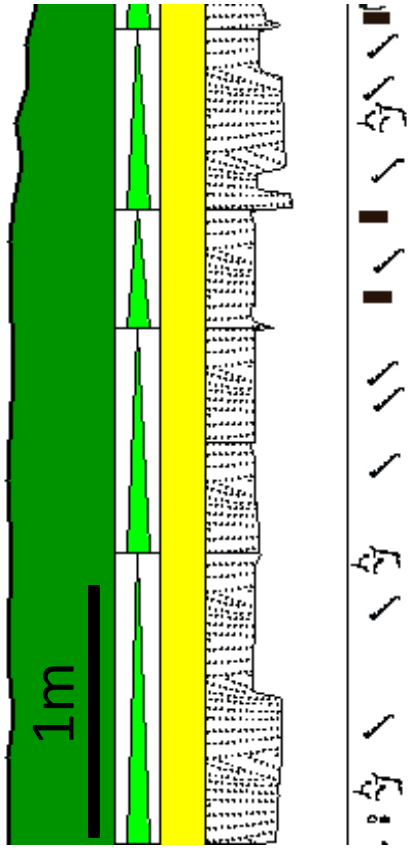
Crevasse splays and interchannel marshes (FA3)

Sandy mouth bars (FA5)

Offshore-transition to offshore deposits (FA6)

Channel-fill complexes (FA1-FA2)

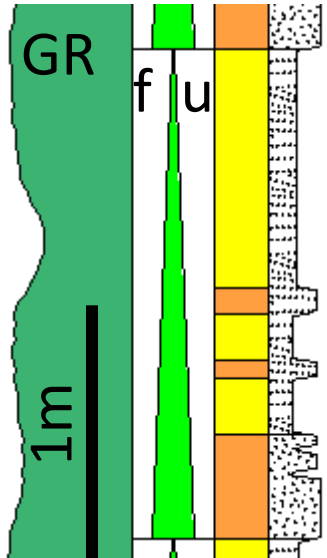
Channel-fills



FA2 Tidal channel-fill

(Sx, Sxm, Hsx, Hfs)

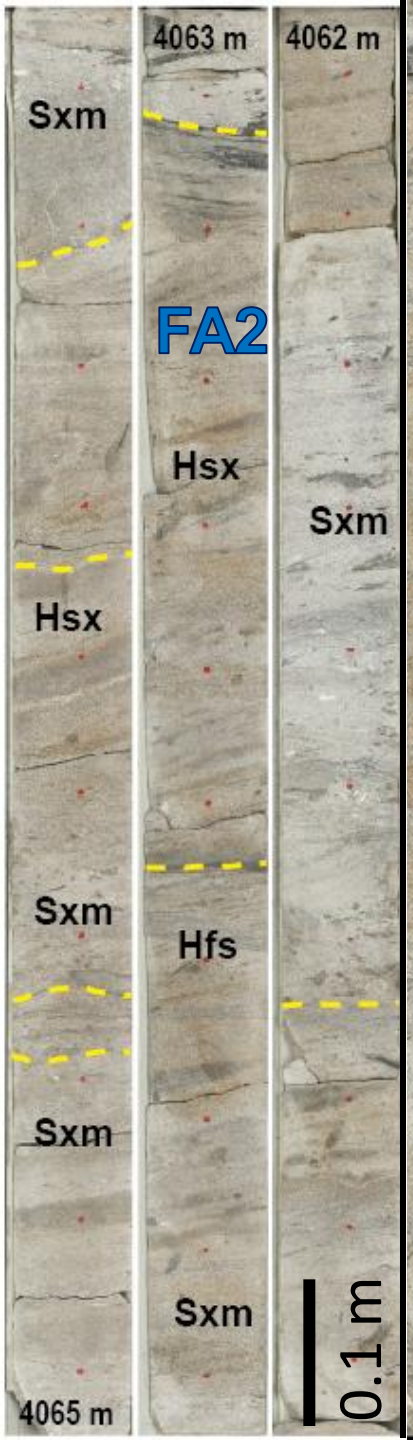
Calliance-2

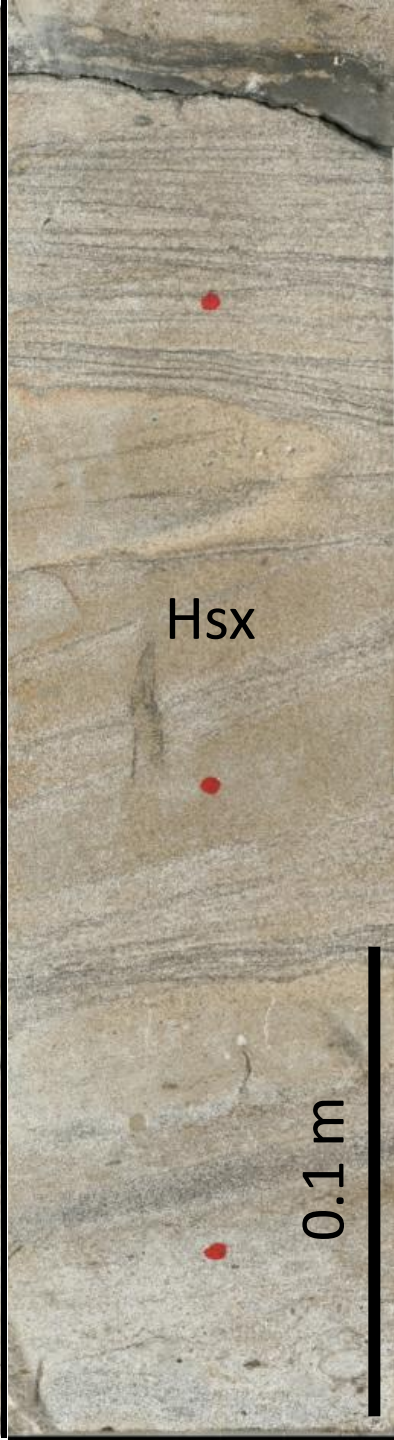


FA1 Tidally influenced channel-fill

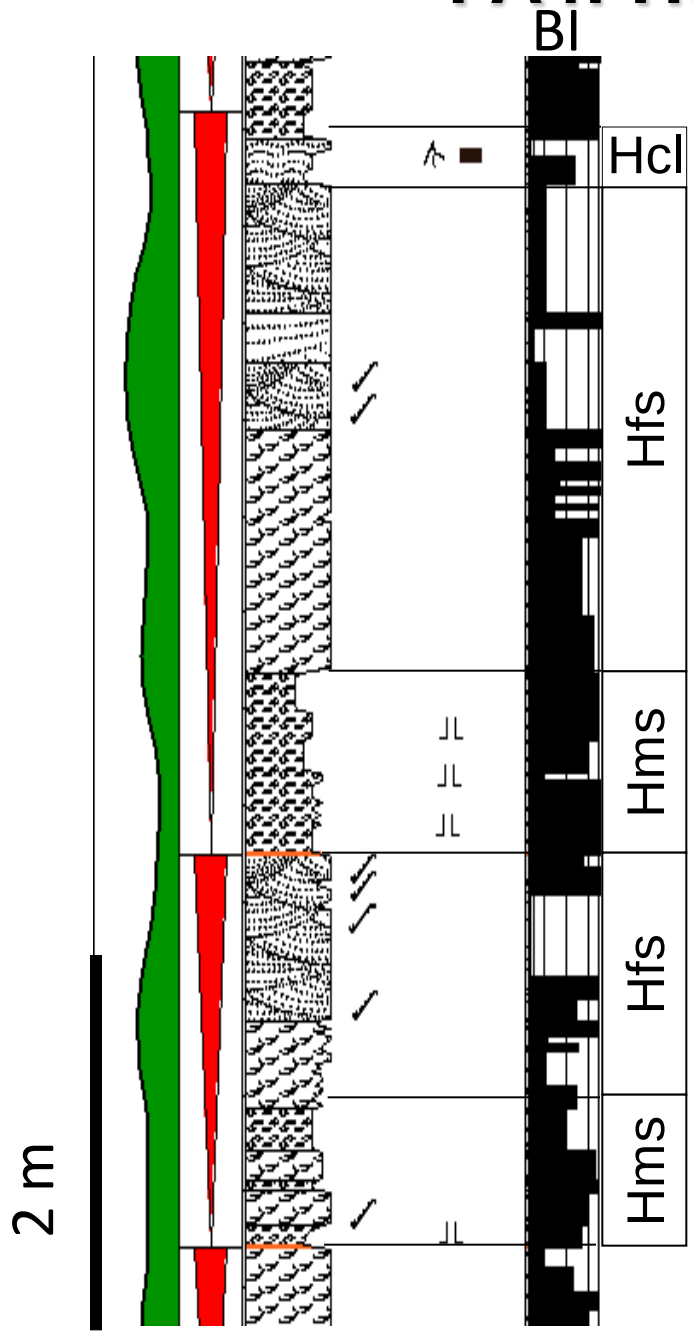
(Gmt, Sx, Sxm)

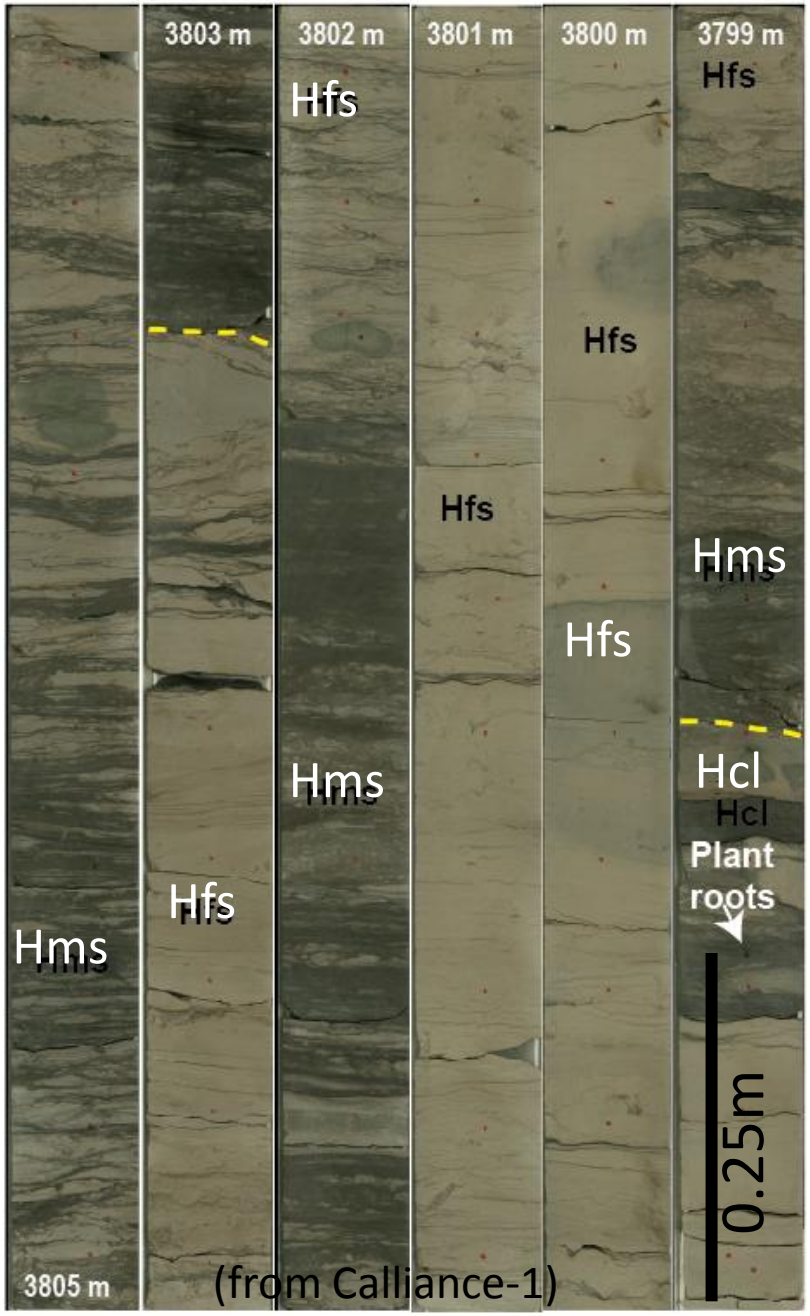
Calliance-3





FA4: Heterolithic mouth bars





(from Calliance-1)

FA5: Stacked mouth bars

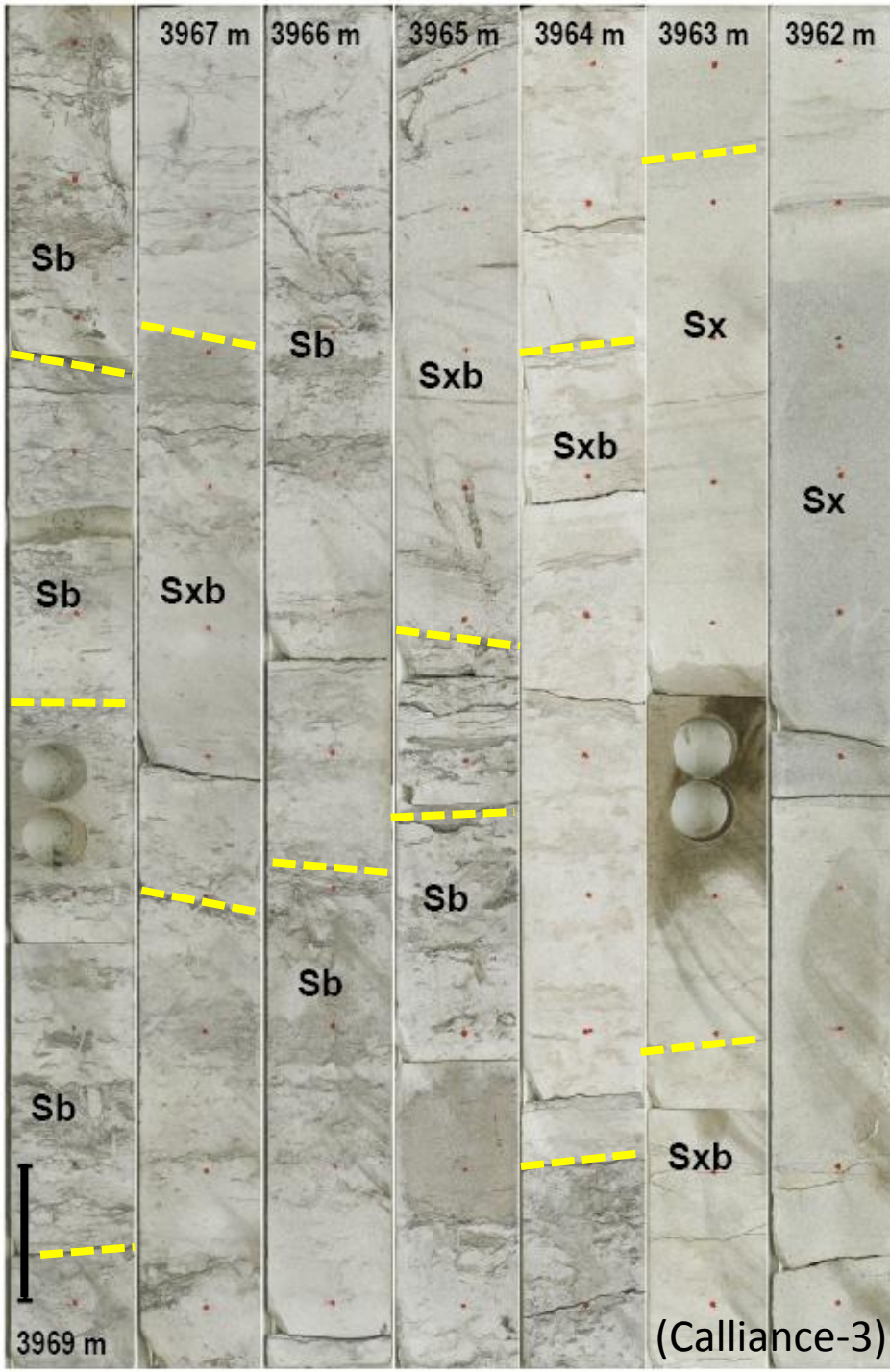
(Sb, Sxb, Sx/Sxm)

~100 m thick

Cross-bedded

Scoured surfaces

High BI, decreasing upwards



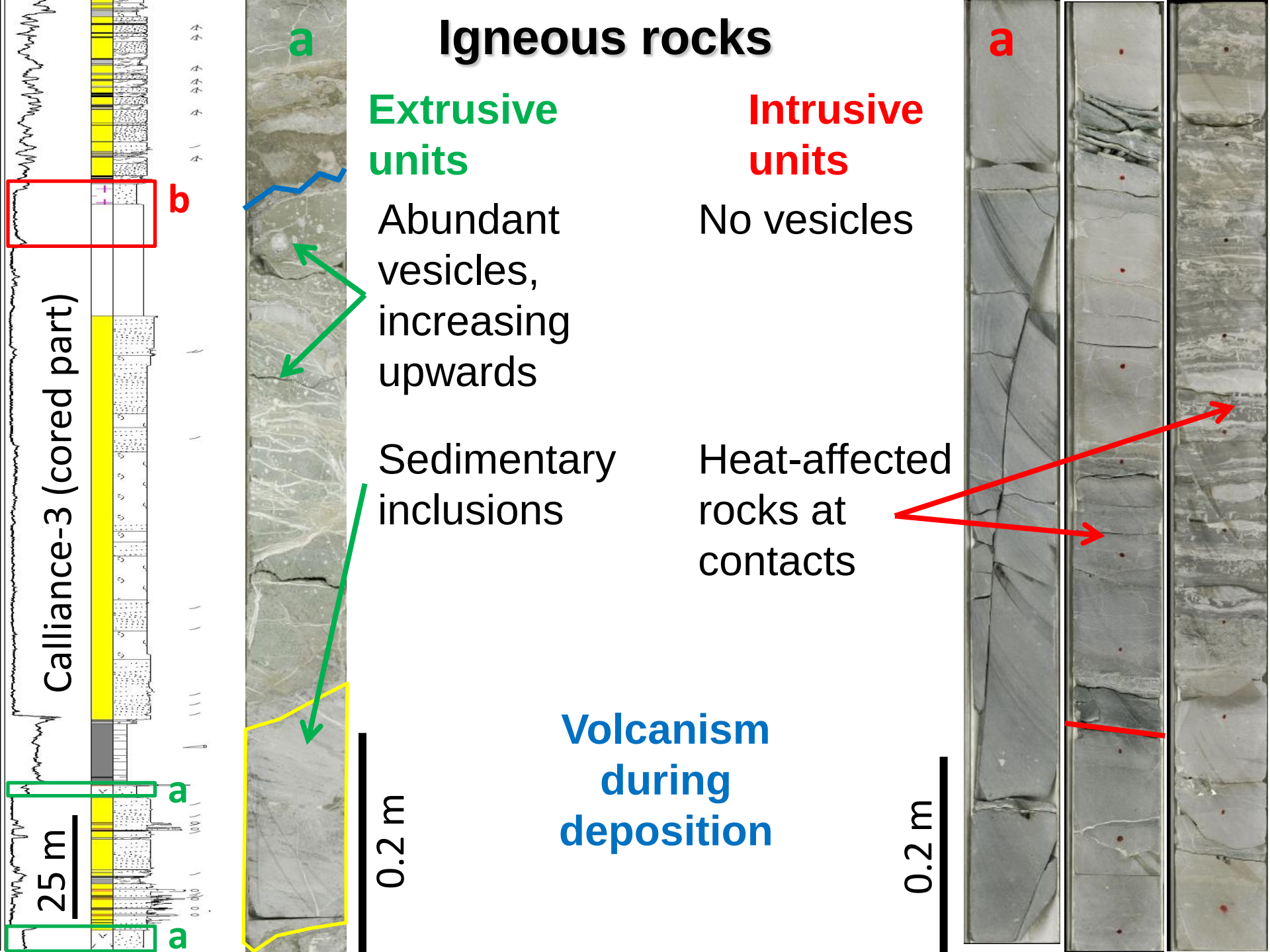
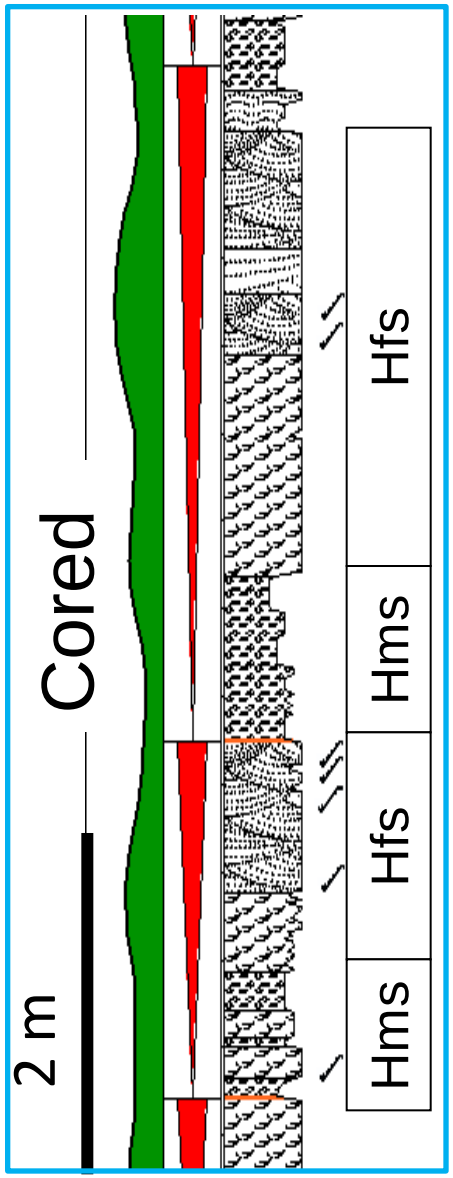
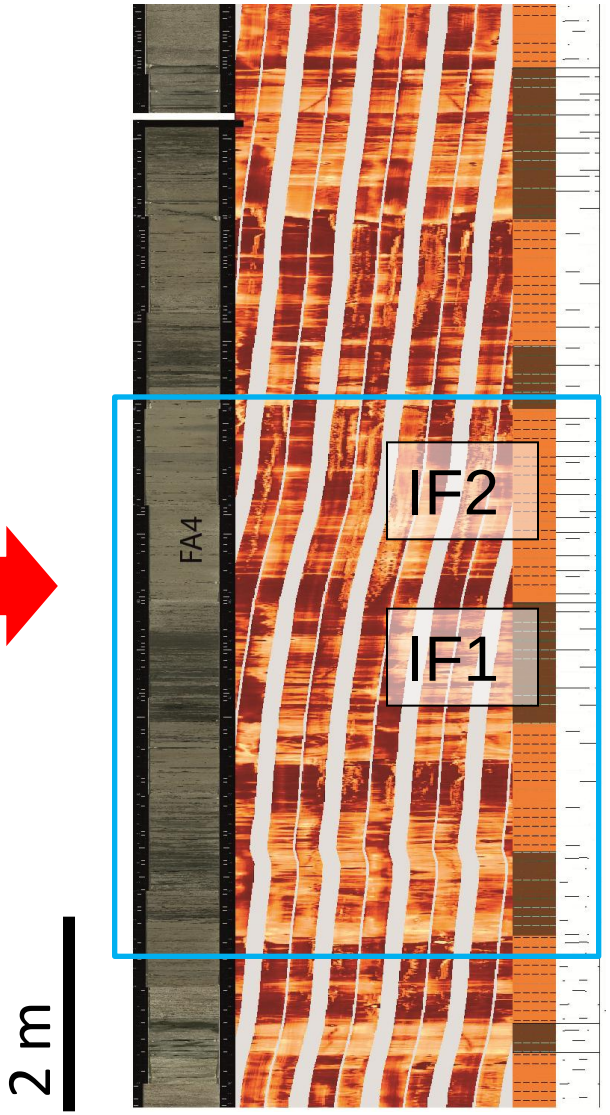

Igneous rocks
Extrusive units
Intrusive units
Abundant vesicles, increasing upwards
No vesicles
Sedimentary inclusions
Heat-affected rocks at contacts
Volcanism during deposition
Calliance-3 (cored part)
25 m
a
b
0.2 m
0.2 m

Image-log analysis



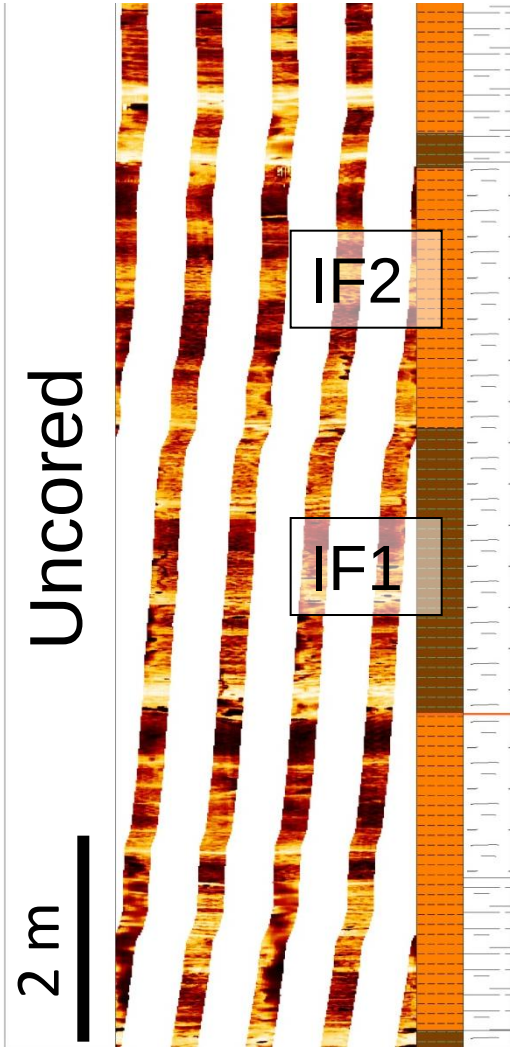
Heterolithic mouth bars (FA4)

IFA2



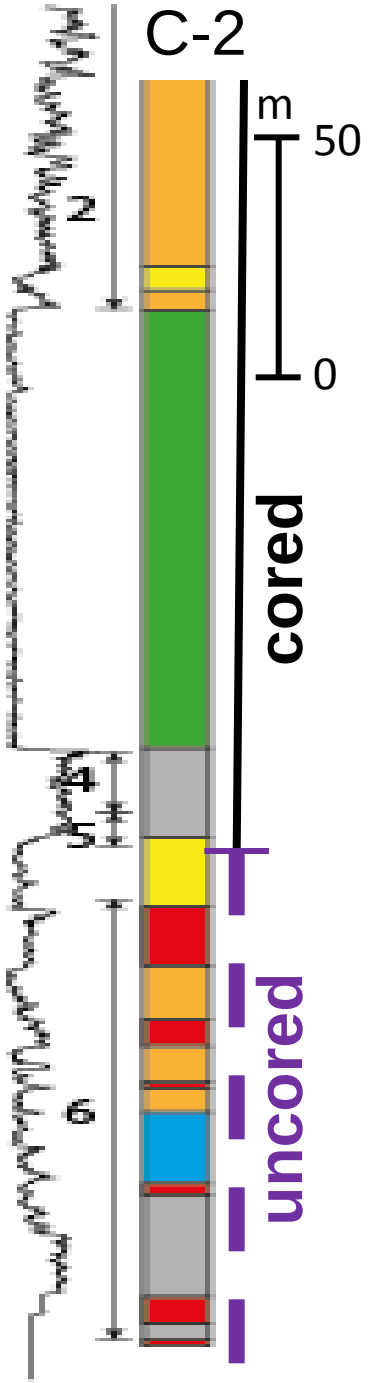
FMI Static
(from Calliance-1)

IFA2



FMS Static
(from Brecknock South)

Image-log analysis - Results

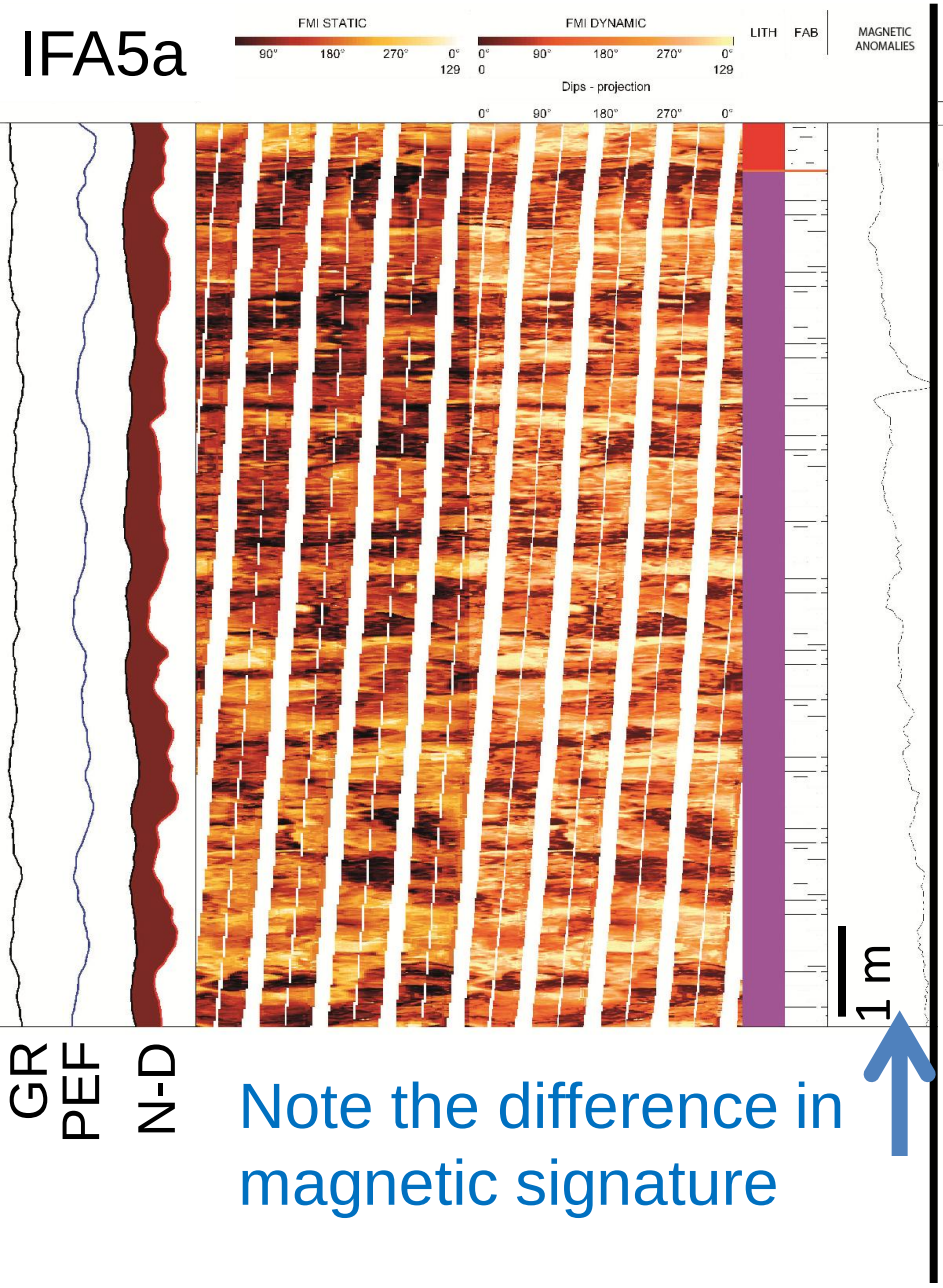


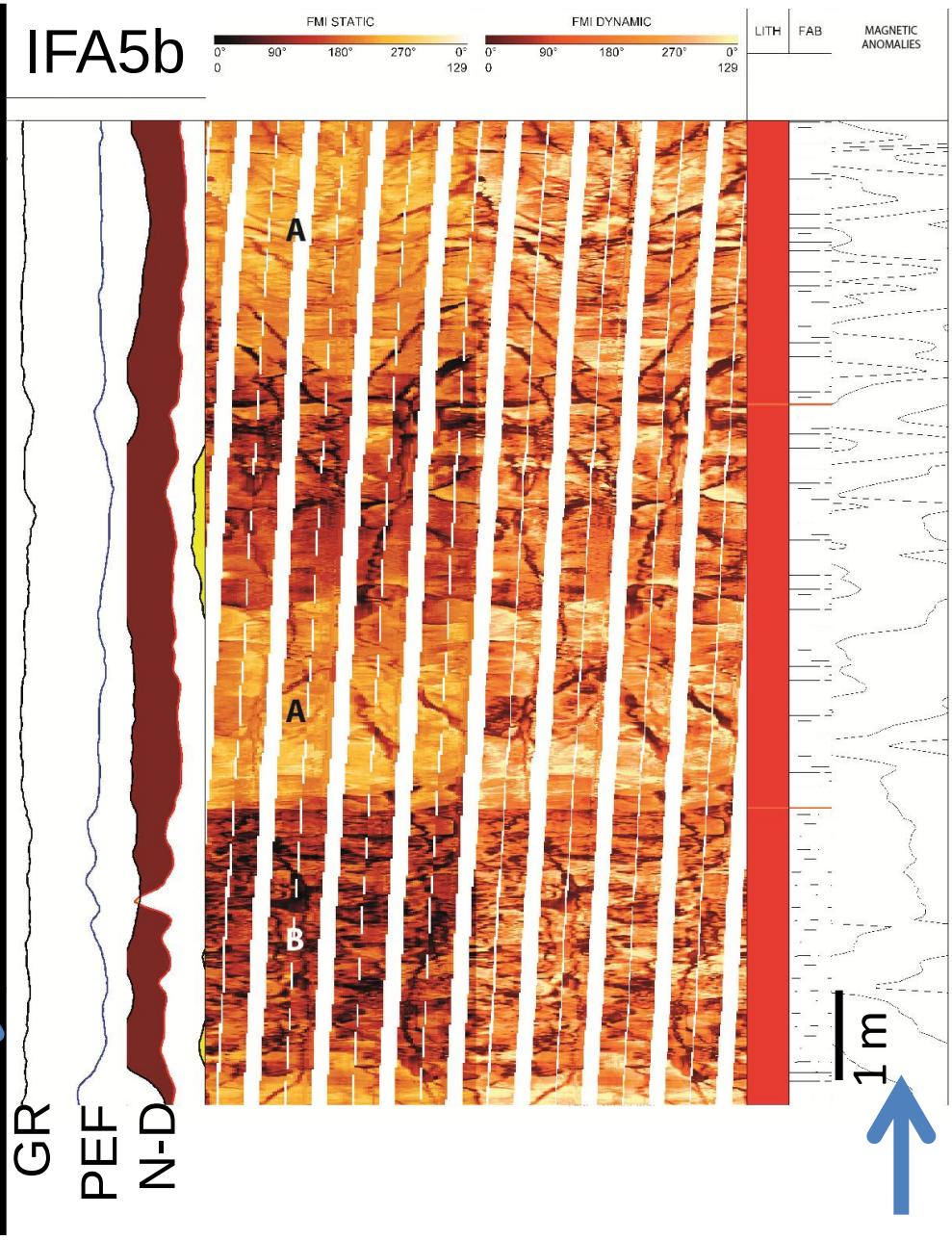
11 image facies and 5 image facies associations

- IFA1a – Channel-fill sandstones (=FA5)
- IFA1b – Sandy mouth bars (=FA1 and FA2)
- IFA2 – Heterolithic mouth bars and interchannel facies (=FA3 and FA4)
- IFA3 – Carbonate cemented sandstones
- IFA4 – Offshore to Lower Shoreface (=FA6)
- IFA5 – Igneous and Volcaniclastic rocks

VOLCANICLASTIC DEPOSITS

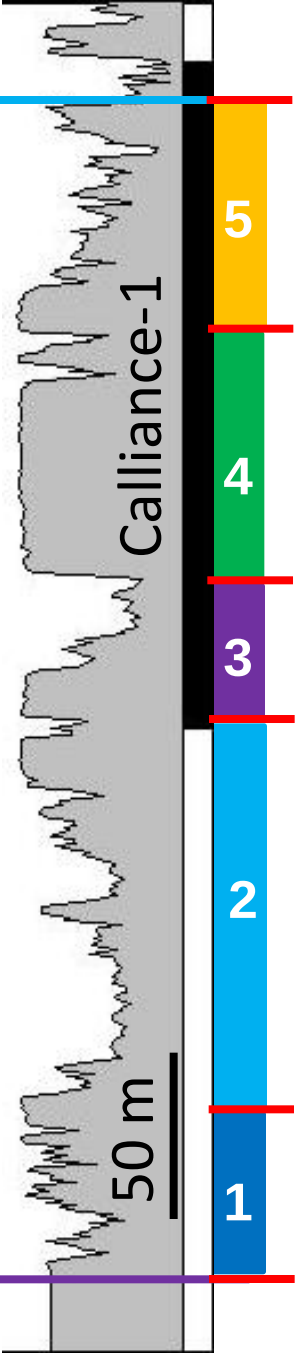
IGNEOUS UNITS

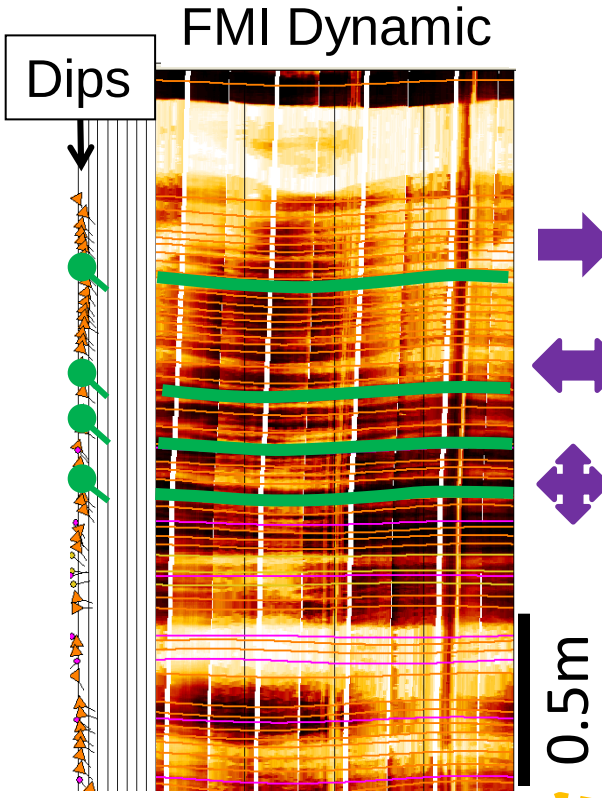




Note the difference in magnetic signature

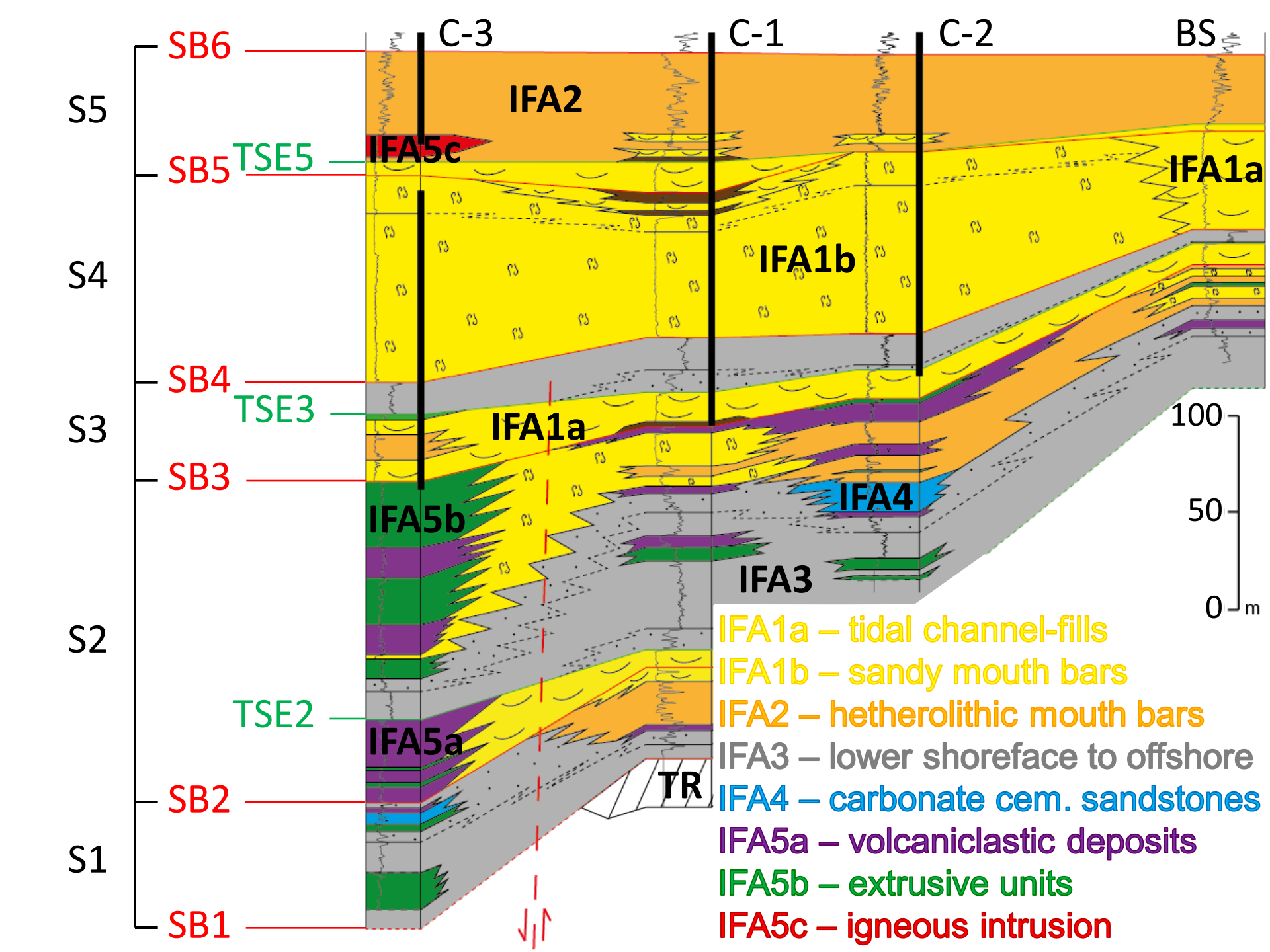
Paleocurrent analysis



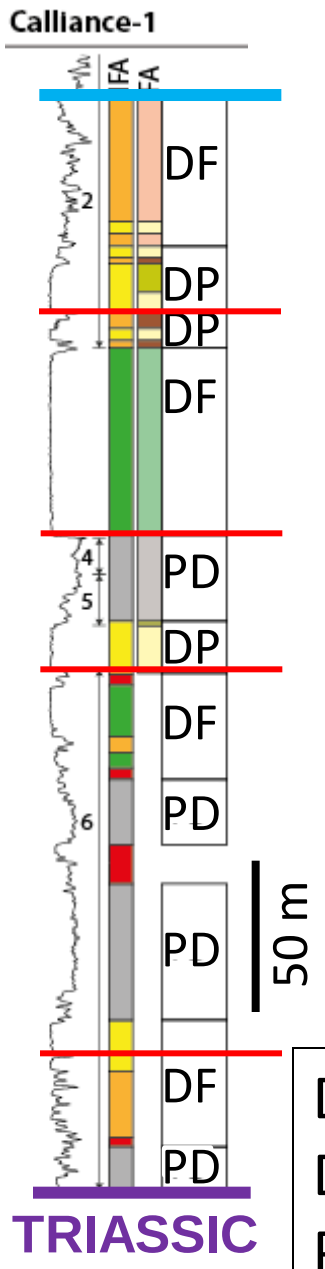


Trends:

- Unimodal
- Bimodal
- Polymodal


C-3
C-1
C-2
BS
SB6
SB5
SB4
SB3
SB2
SB1
TSE5
TSE3
TSE2
S5
S4
S3
S2
S1
IFA2
IFA5c
IFA1a
IFA1b
IFA1a
IFA5b
IFA4
IFA3
IFA5a
TR
100
50
0
m
IFA1a – tidal channel-fills
IFA1b – sandy mouth bars
IFA2 – hetherolithic mouth bars
IFA3 – lower shoreface to offshore
IFA4 – carbonate cem. sandstones
IFA5a – volcaniclastic deposits
IFA5b – extrusive units
IFA5c – igneous intrusion

Conclusions



1) Depositional model is tidally influenced deltaic system

- DP, DF, DP sub-environments
- Abundant tidal indicators
- Complex paleocurrent patterns
- Phases of delta progradation recognised

2) Thick delta front sandy mouth bars (FA5)

•Sandy depositional site with abundant sediment supply

•Potential evidence for tectonic control on accommodation

DP – Delta plain
DF – Delta front
PD – Prodelta

3) Integration of image log and core analysis proved valuable

Acknowledgements

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Advanced Logic Technology — WellCAD® license

Geoconferences (WA) Inc. — Travel grant