Revisiting the rocks and seismic

Discovers turbidites and a new exploration play in the Penola Trough, Otway Basin, South Australia

SA/NT PESA February technical luncheon

Sharon Tiainen and Rob Kirk | 29 February 2024

https://www.energymining.sa.gov.au/

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Acknowledgement of Country

As guests here on Kaurna land, we acknowledge everything this department does impacts on Aboriginal country, the sea, the sky, its people and their spiritual and cultural connection which have existed since the first sunrise. Our responsibility is to share our collective knowledge, recognise a difficult history, respect the relationships made over time, and create a stronger future. We are ready to walk, learn and work together.

Ngaityalngadlu taikunthitya yalaka

Yantupinarna Kaurna yartangka, ngadlu tampinthi tupa yaintya pirku wapinthi, wiwunthi yaitya yarta, yarlu, ngayirda, miyurnakuma parnaku tuwila tapa purruna tarraitpayinthi. Muna tirntu parrka-parrka wanti.

Ngadluku taingi ngutu yungkurrinthi, tampinthi yurni ngantanthi pukingka, niipurna pintyathi mankurrititya, taingintya tarrkarri pintyanthi.

Nata ngadlu padnitha, tirkatha Kuma kumangka warpulayi-utha.

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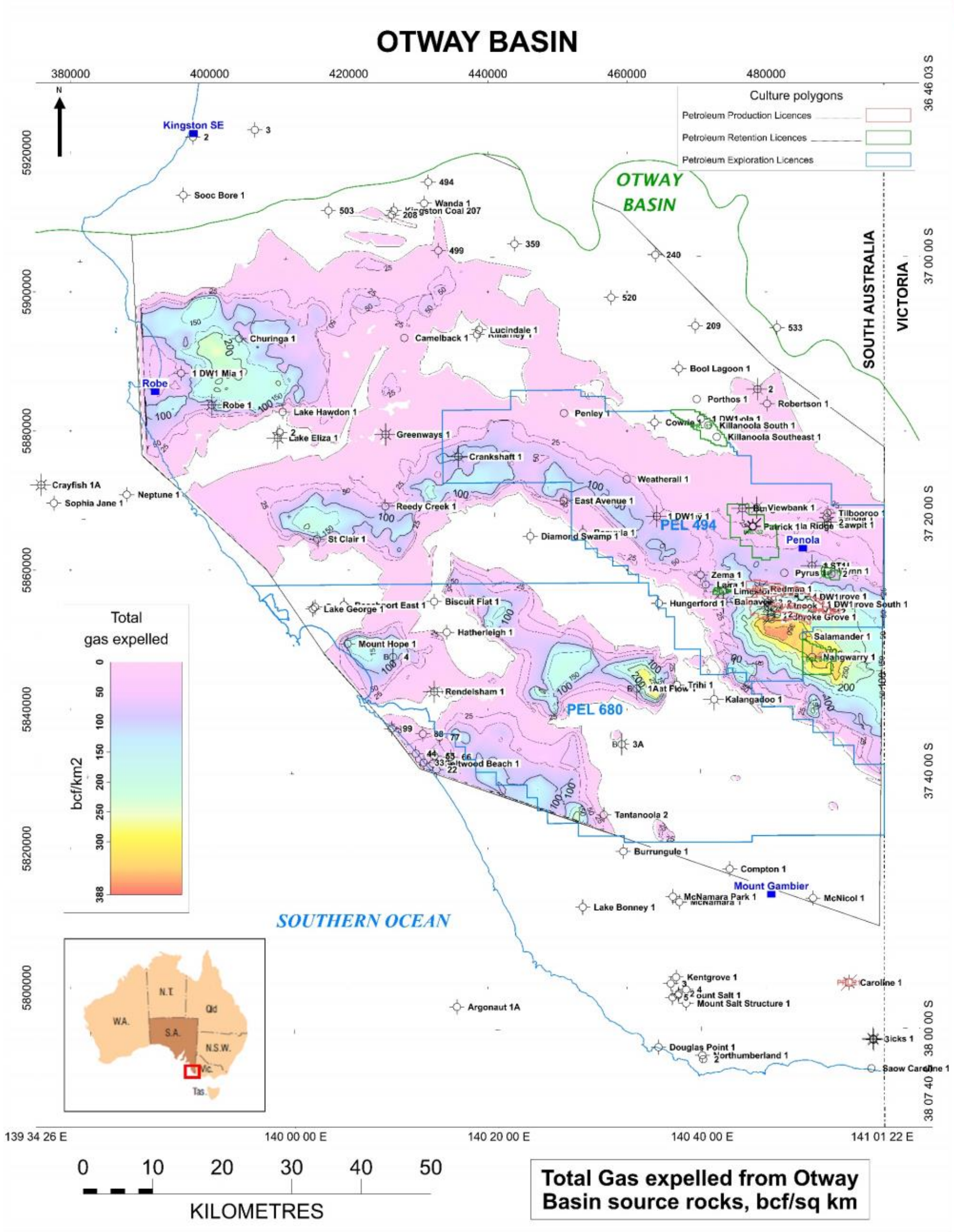
Background

Part of the Otway Project

- Whole of basin petroleum system model
- Generate new datasets
- Generate new exploration concepts
- Stimulate the next phase of gas exploration in the onshore Otway Basin to supply South Australian customers
- Commenced 2020 and completed Q4 2023
- Three extended abstracts in AEP May 2024
- Two report books in prep
- One PESA workshop
- One PESA talk …

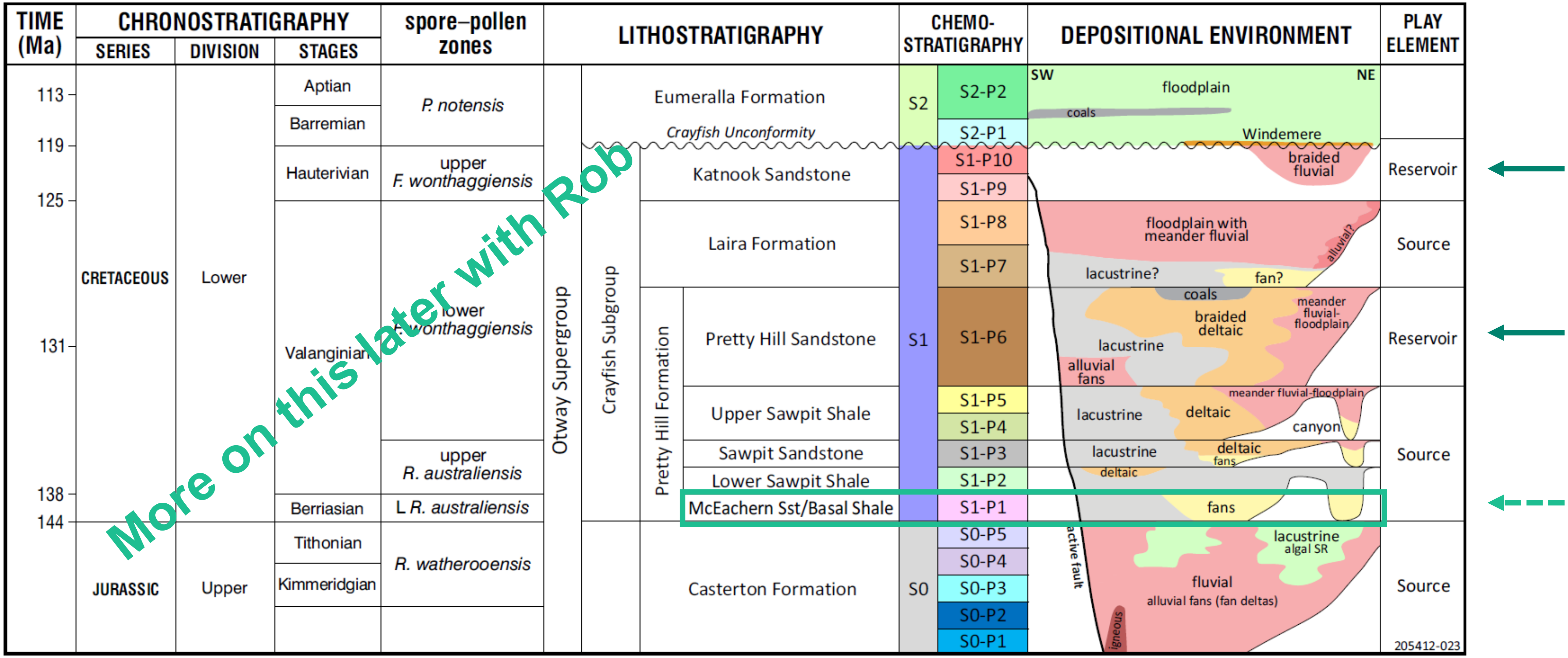


Revisiting the rocks and seismic

Photos from PESA core workshop 23/11/2023

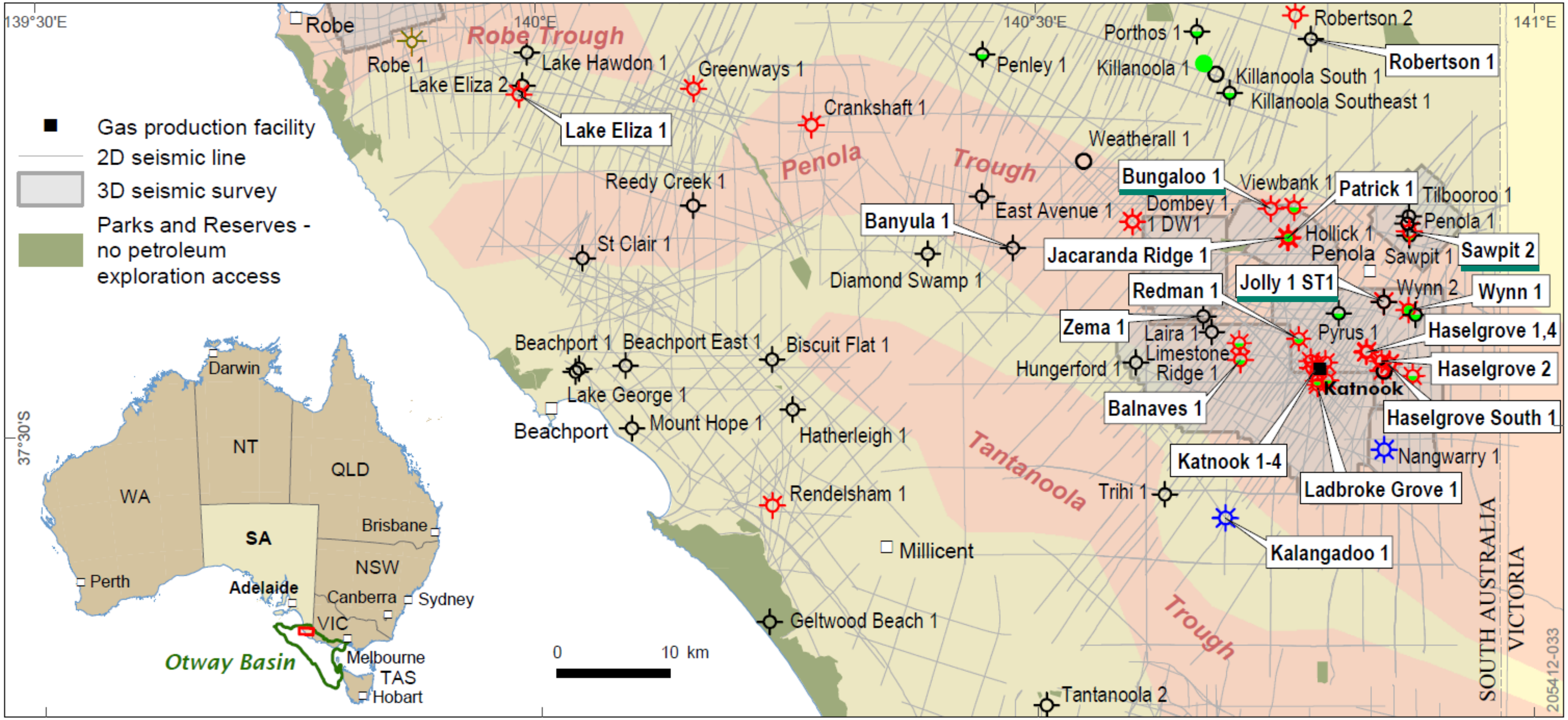
Proven province | 63 BCF

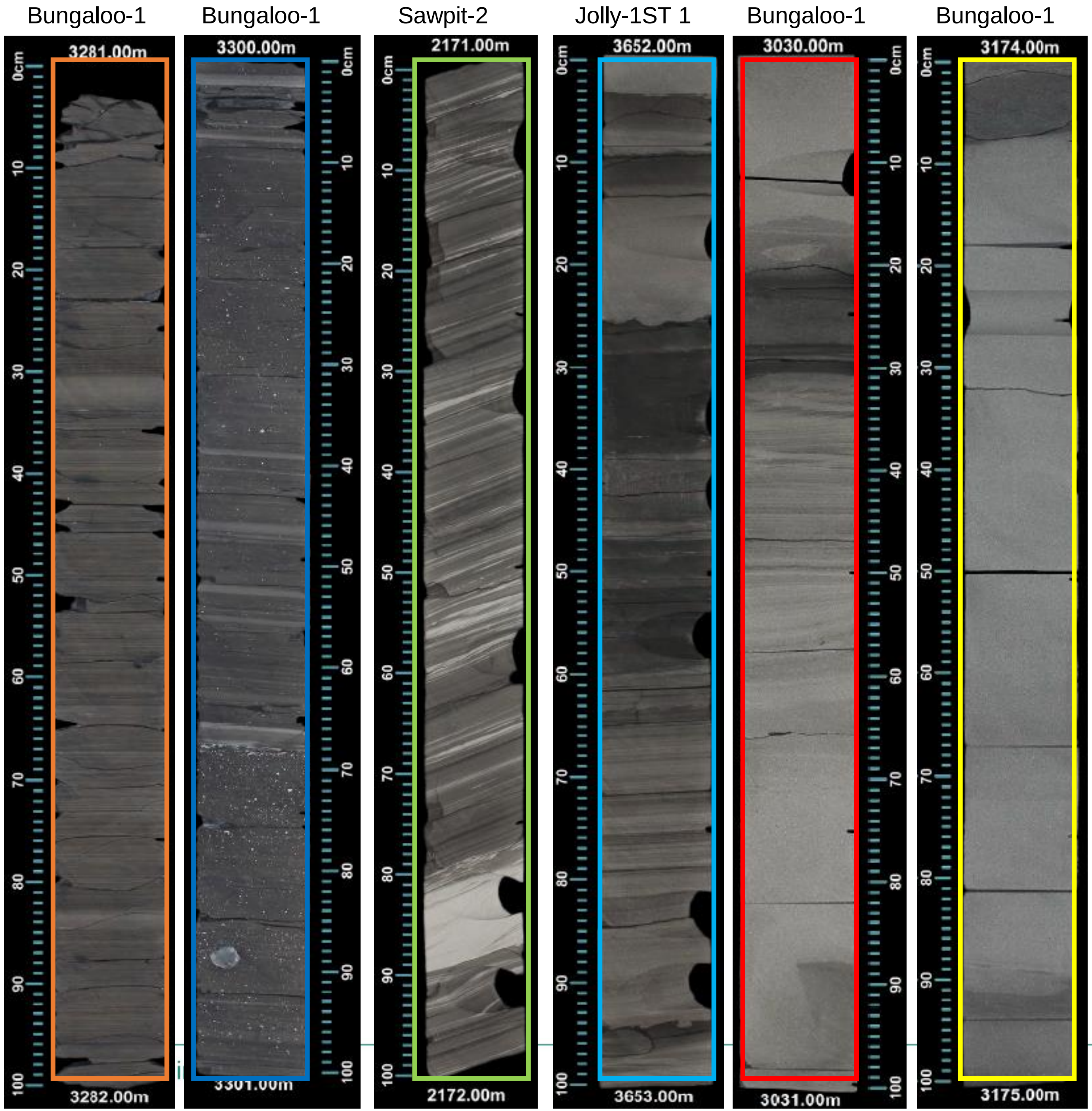
S1-P1 = McEachern/Basal Shale



After Kirk 2024 in prep

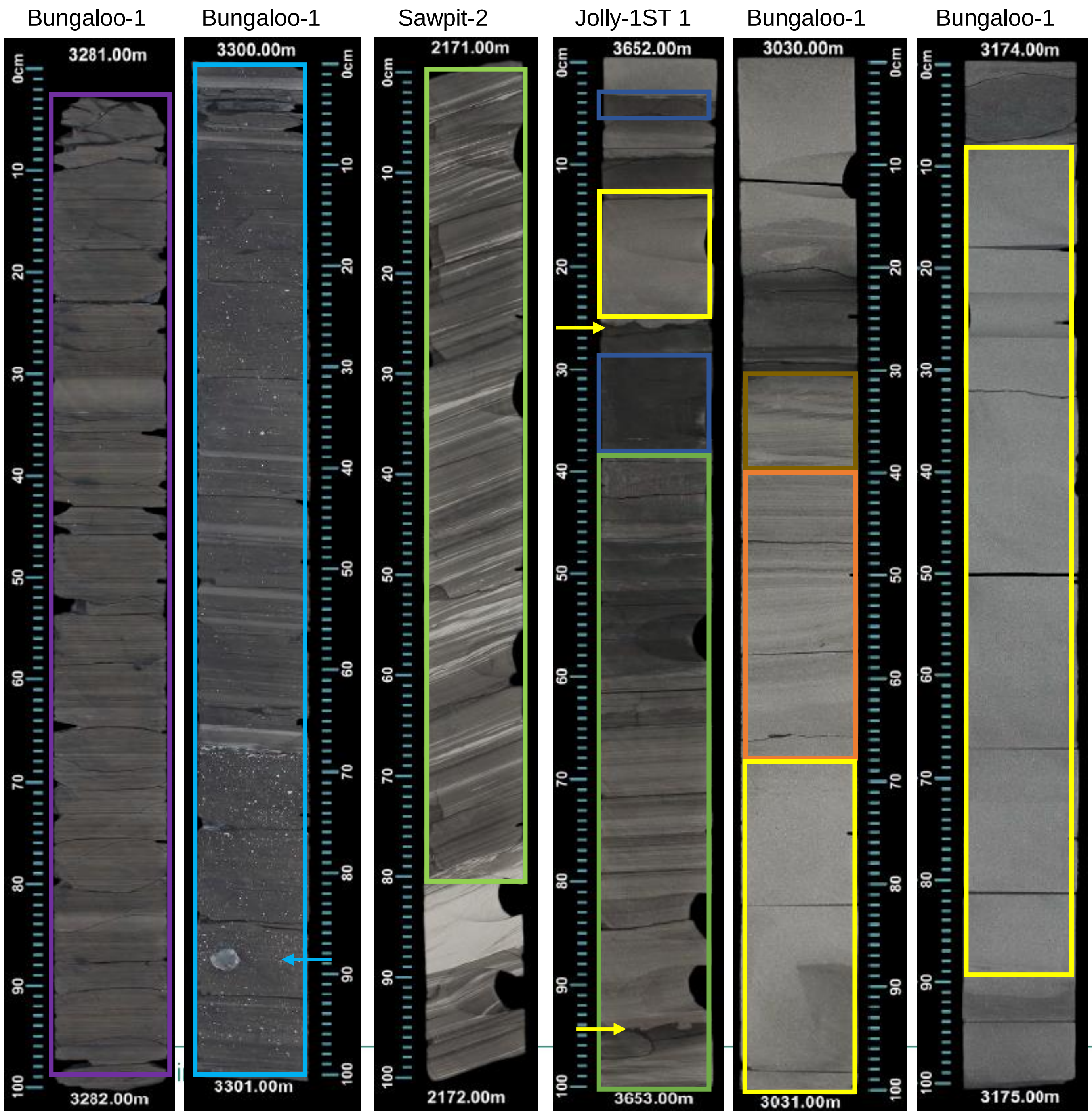
Cores | Bungaloo-1, Jolly-1ST1 and Sawpit-2





Past interpretation from WCRs

- Orange rectangle = open lacustrine
- Dark blue rectangle = open lacustrine
- Green rectangle = floodplain lake
- Blue rectangle = proximal crevasse, channel sands and crevasse splays
- Red rectangle = stacked crevasse splays and floodplain /floodplain lake
- Yellow rectangle = stacked crevasse splays



Present interpretation

- Yellow = sand-sized massive bedding (Ta)
- Orange = sand sized planar bedding (Tb)
- Brown = sand-silt sized rippled bedding (Tc)
- Green = sand-silt-clay sized planar bedded (Td)
- Dark blue = clay sized massive bedded (Te)
- Light blue = clay sized planar with sand-pebble clasts (dropstones, deep-water lacustrine)
- Purple = clay-sized planar bedded (varves, deep-water lacustrine)
- Yellow arrows = scour and/or loading
- Blue arrow = pebble, note sand-sized clasts throughout (dropstones, deep-water lacustrine)

Past and present interpretations
Alluvial plain vs deep-water lacustrine

WELL	CORE	DEPTH (mDD)	PAST	PRESENT
Bungaloo-1	1 2 3 4	3019.0 – 3046.0 3148.0 – 3175.0 3277.0 – 3304.0 3304.6 – 3326.8	Crevasse splay and flood-plain lake Crevasse splay and flood-plain lake Lacustrine with dropstones Lacustrine with dropstones	Deep-water lacustrine turbidite (BOUMA a-e) Deep-water lacustrine turbidite (BOUMA a-e) Deep-water lacustrine with varves and dropstones Deep-water lacustrine with varves and dropstones
Jolly-1ST1	1 2 3 4	3640.0 – 3667.0 3787.0 - 3788.0 3788.0 – 3815.0 3815.0 – 3839.0	Fluvial plain Open lacustrine to pro delta Open lacustrine to pro delta Open lacustrine to pro delta	Deep-water lacustrine turbidite (BOUMA a-e) Deep-water lacustrine turbidite (BOUMA a-e) Deep-water lacustrine with varves Deep-water lacustrine with varves
Sawpit-2	1 2 3	2171.0 – 2198.0 2402.0 – 2415.6 2415.6 – 2433.6	Fluvial plain Lacustrine Lacustrine	Deep-water lacustrine turbidite (BOUMA a-e) Deep-water lacustrine with varves and dropstones Deep-water lacustrine with varves and dropstones

Alluvial plain and deep-water lacustrine

Modern depositional environments

Left Balranald, Australia

Alluvial fluvial-flood plain

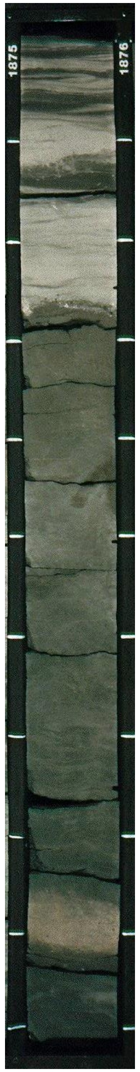
Right Lake Kivu, Africa

Rift deep-water lacustrine

~40km

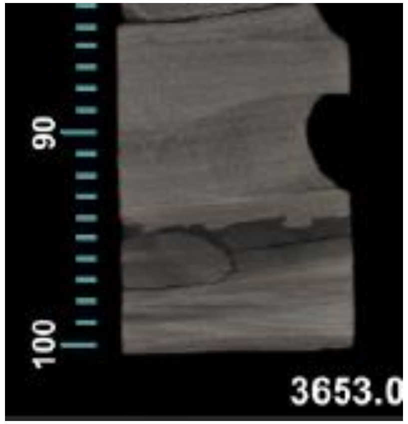
Images from Google maps

Crevasse up-section ≠ crevasse down-section



Rippled sand-silt, over massive clay

Katnook-4

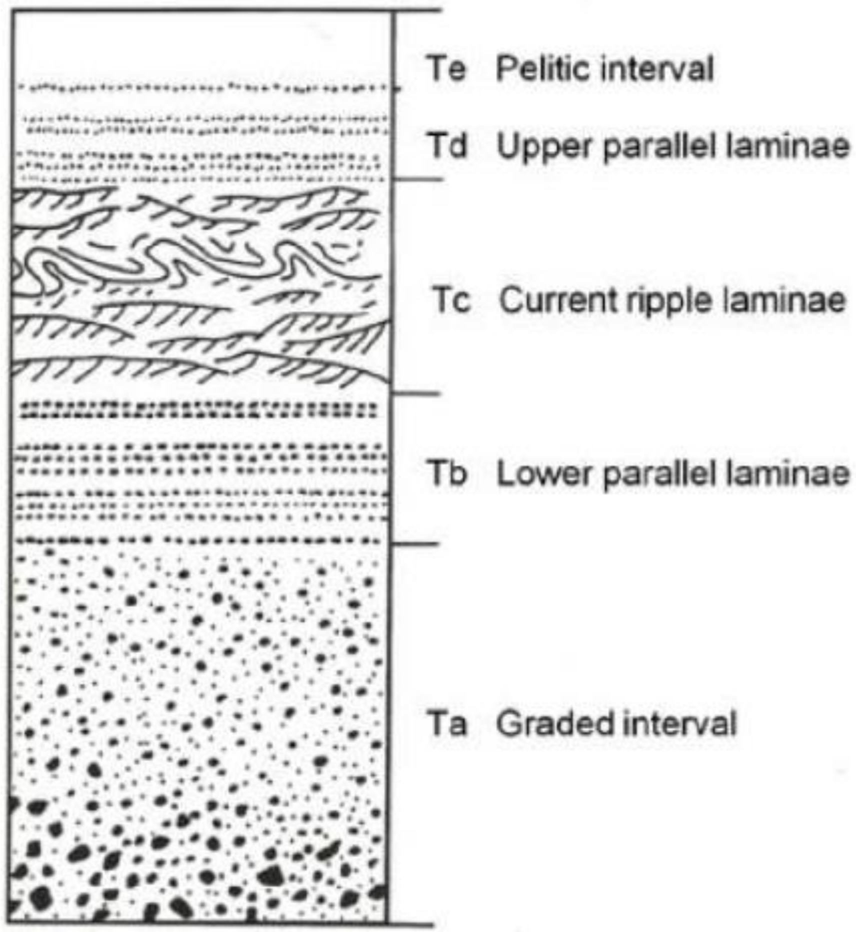


Jolly-1ST 1

Interbedded sand-silt-clay with loading and flames structures soft sediment deformation

Sawpit-2

Bouma Sequence
Sawpit-2



After Bouma 1962

Planar clay

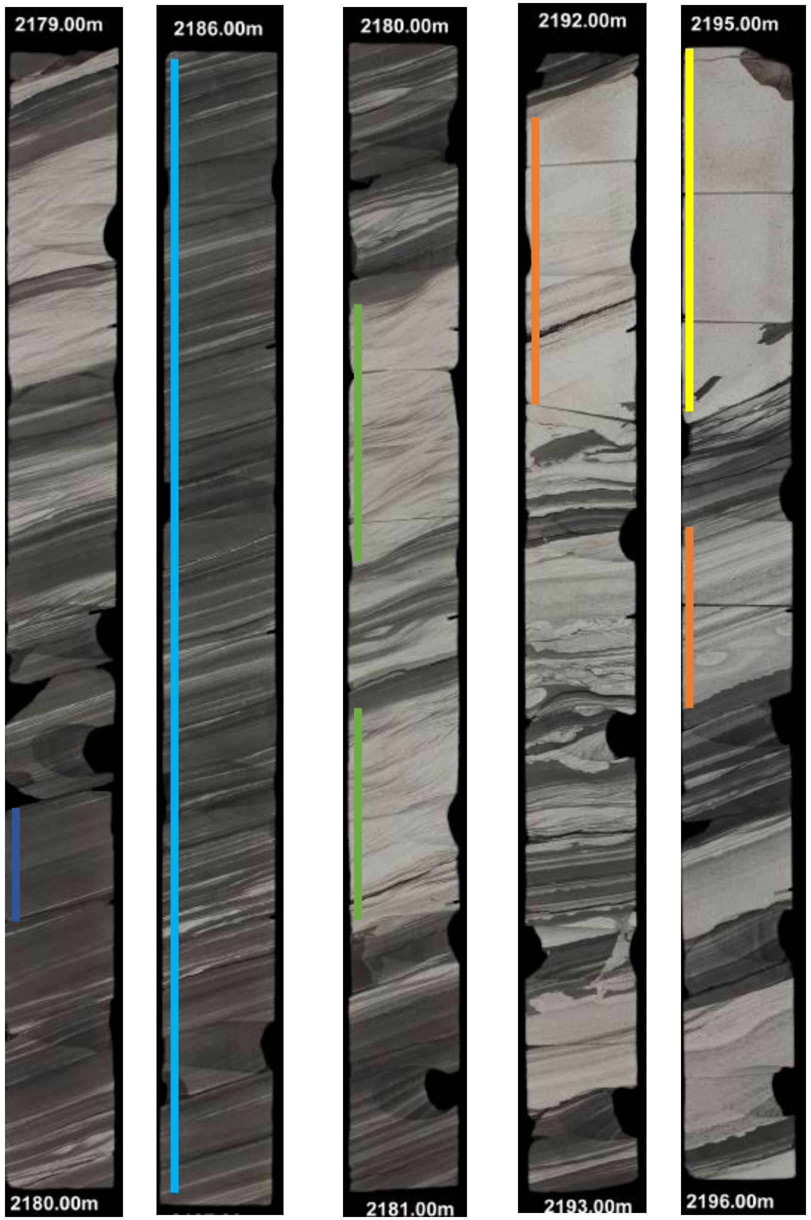
Planar silt and clay

Rippled and/or wavey silt and sand

Planar bedded sand

Massive to normally graded bedding sand

Soft sediment deformation/loading/flames



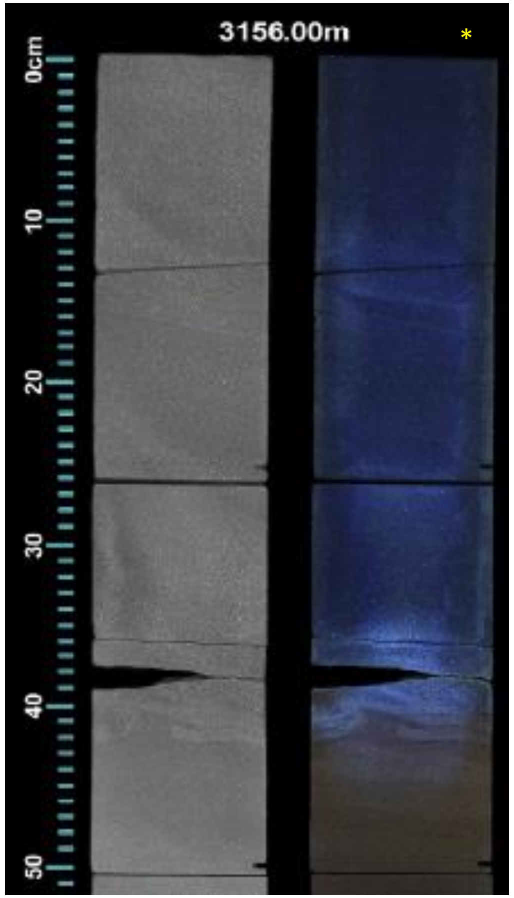
Observations | 7 x lithology types

Depositional environment (DE) interpretation

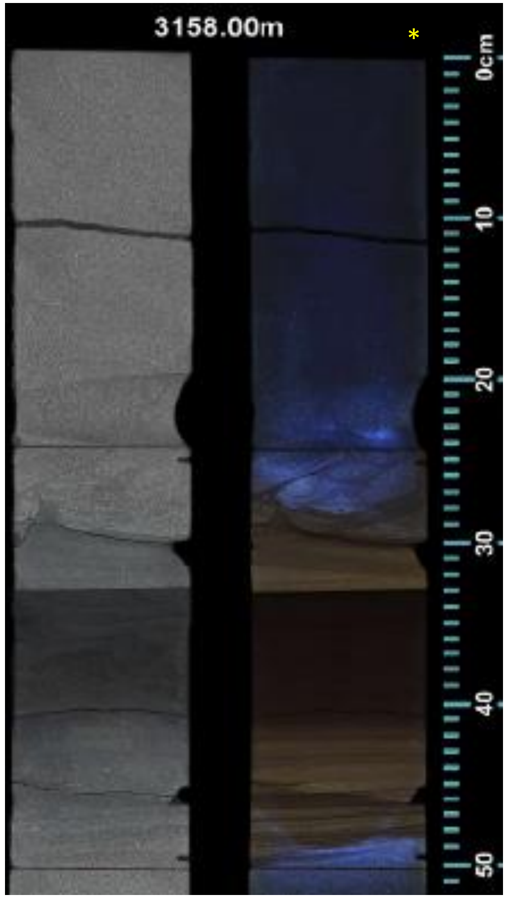
Lithology	Characteristic/s (interpretation)	DE interpretation (Bouma)
1 Clay-siltstone	Planar lamination (suspension varves)	Deep-water lacustrine
2 Diamictite	Planar lamination + clasts (suspension, drop-stones)	Deep-water lacustrine
3 Clay-siltstone	Massive-planar lamination (suspension)	Lacustrine turbidite (Te)
4 Silt-sandstone	Planar lamination (suspension + low flow)	Lacustrine turbidite (Td)
5 Sandstone	Ripple lamination (low flow)	Lacustrine turbidite (Tc)
6 Sandstone	Planar lamination (upper flow)	Lacustrine turbidite (Tb)
7 Sandstone	Massive bedding +/- rip-up clasts (upper flow)	Lacustrine turbidite (Ta)

Hydrocarbon shows | Bungaloo-1 and Jolly-1ST1

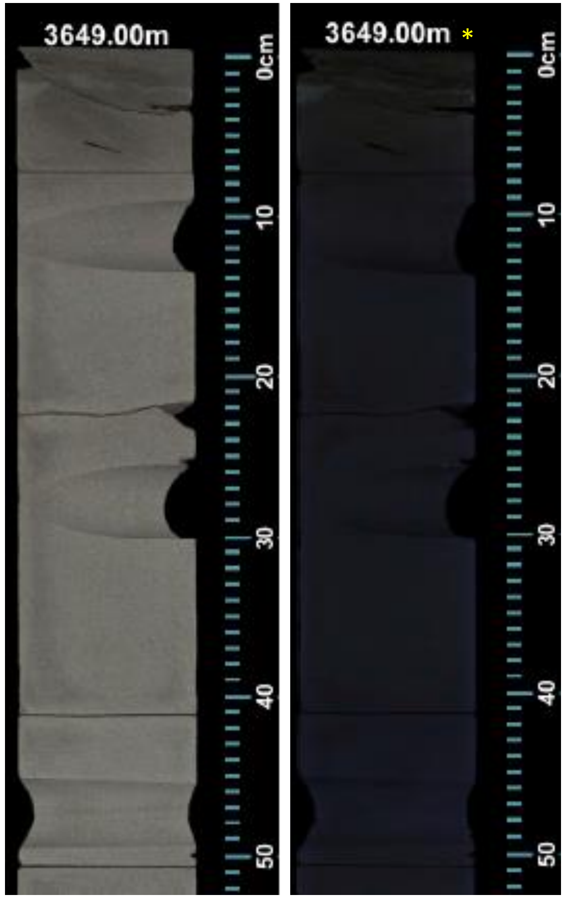
Reservoir, source and seal present, trap …



Bungaloo-1
Left and right
Blue fluorescence
under UV light *
Gas summary (ppm)
3148-3161 mDD
C1 7823, C2 1,614, C3
1113, iC4 190, nC4
303, iC5 91, nC5 88
70/14/10/2/3/1/1



Jolly-1ST 1
Right
Dull blue fluorescence
under UV light *
Gas summary ppm
3640-3667 mDD
C1 38526, C2 4577,
C3 1015, iC4 230, nC4
121, iC5 68, nC5 19
86/10/2/1/<1/<1/<1



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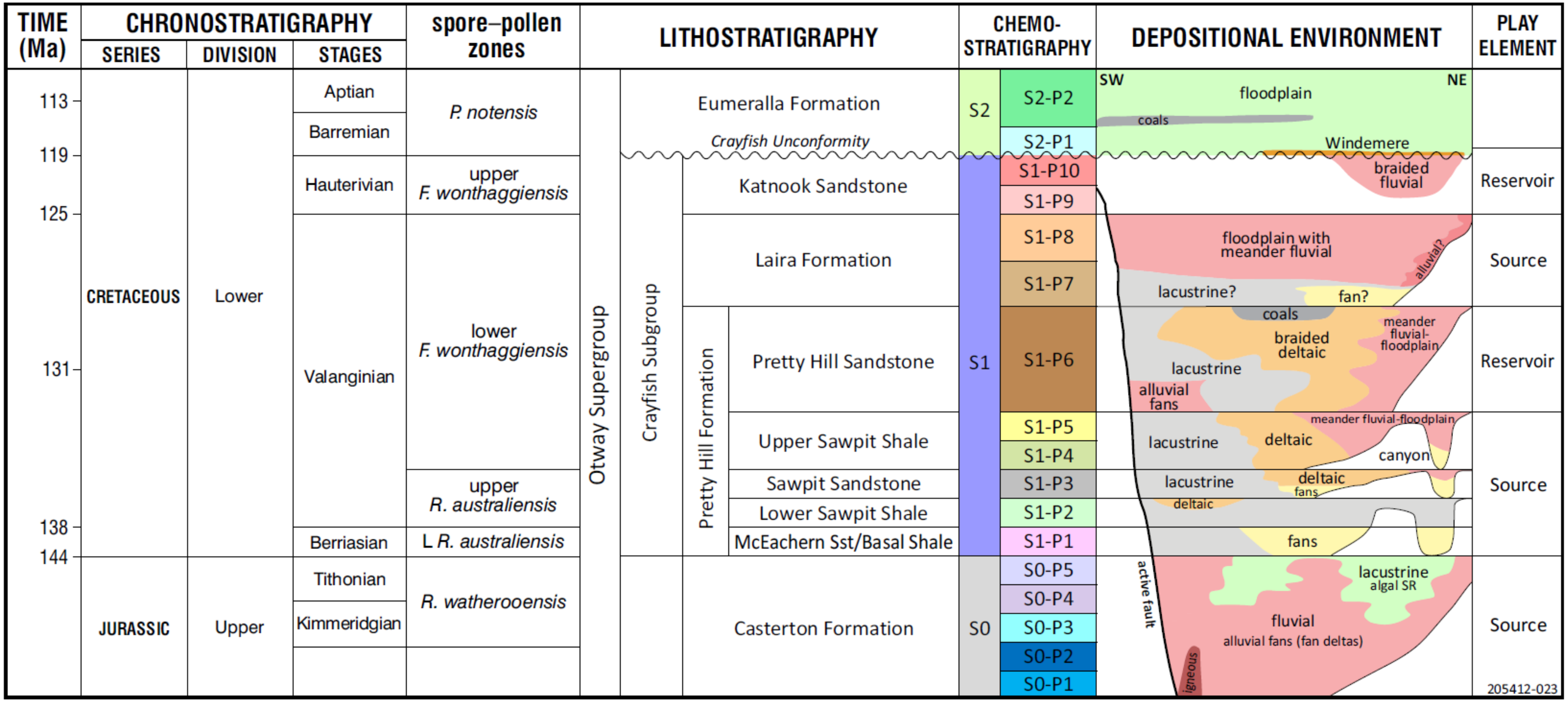
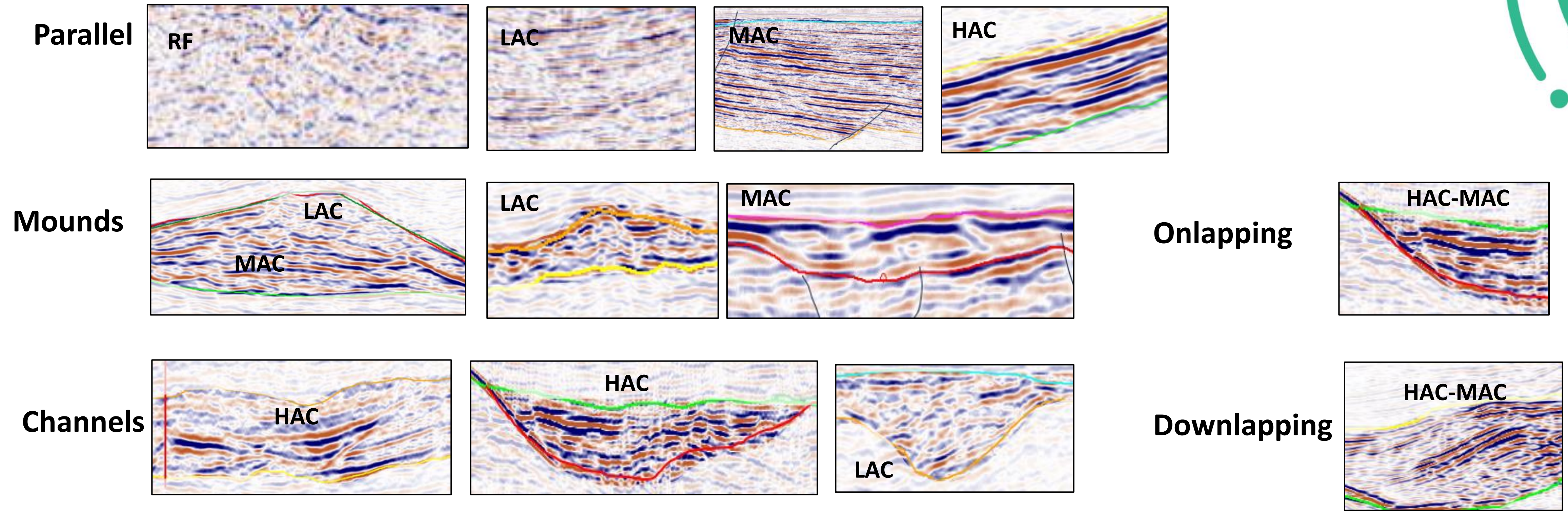
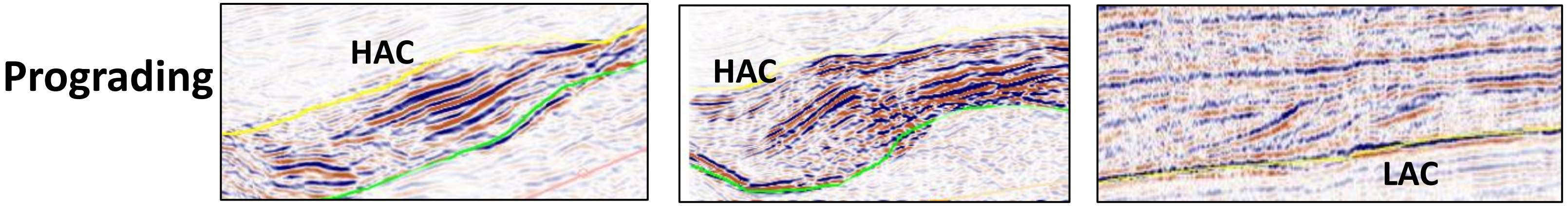
Photos from PESA core workshop 23/11/2023

Stratigraphy | Wheeler diagram



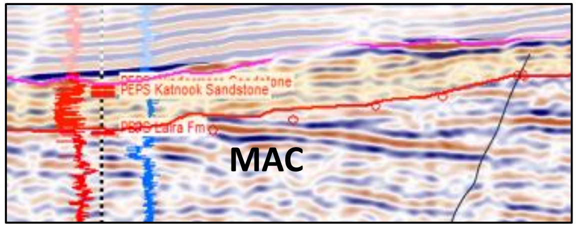
After Kirk 2024 in prep





Onshore Otway Basin Seismic Facies Variations.

Truncation



RF-reflection free-chaotic
LAC-low amplitude, discontinuous
MAC-moderate amplitude and continuity
HAC-high amplitude and continuity

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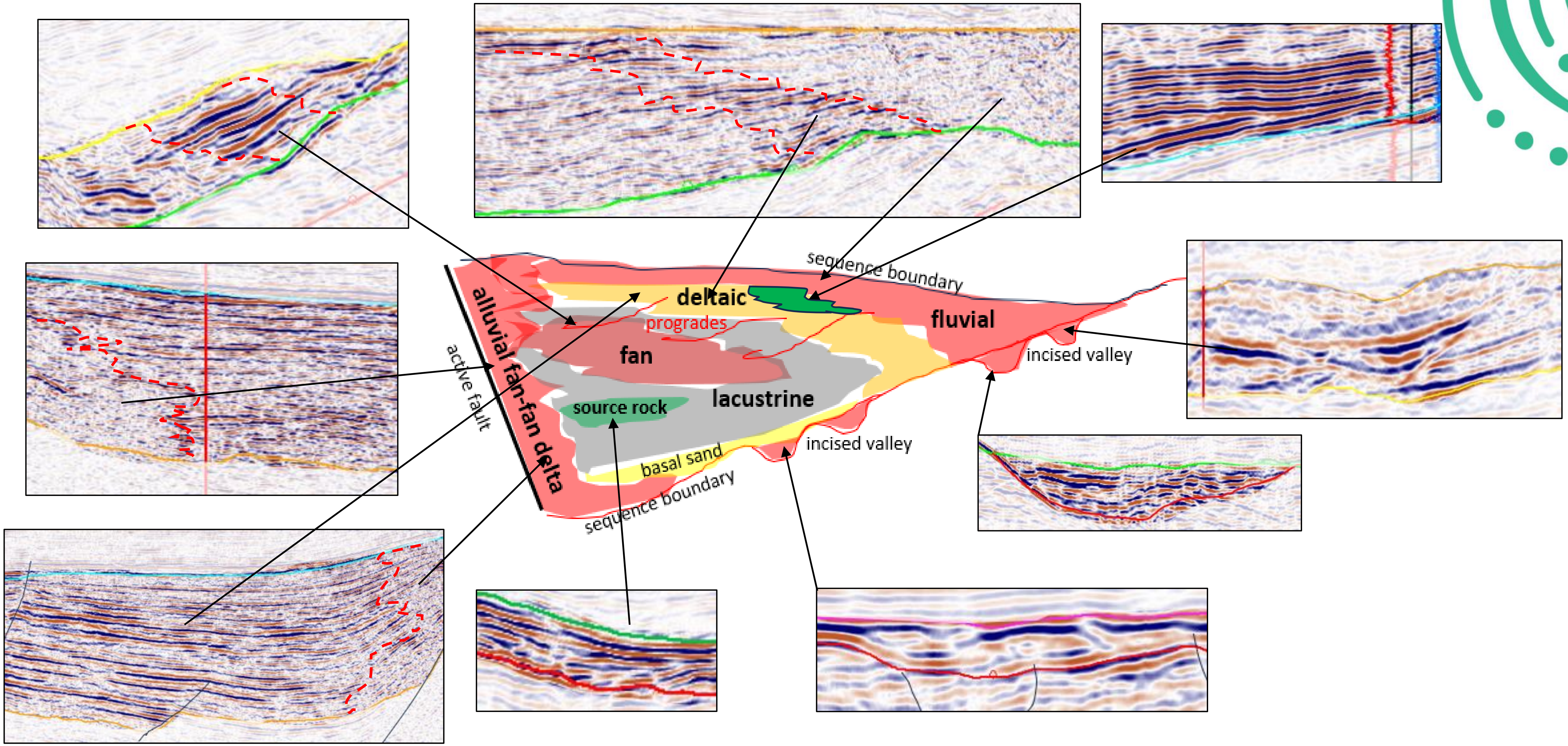
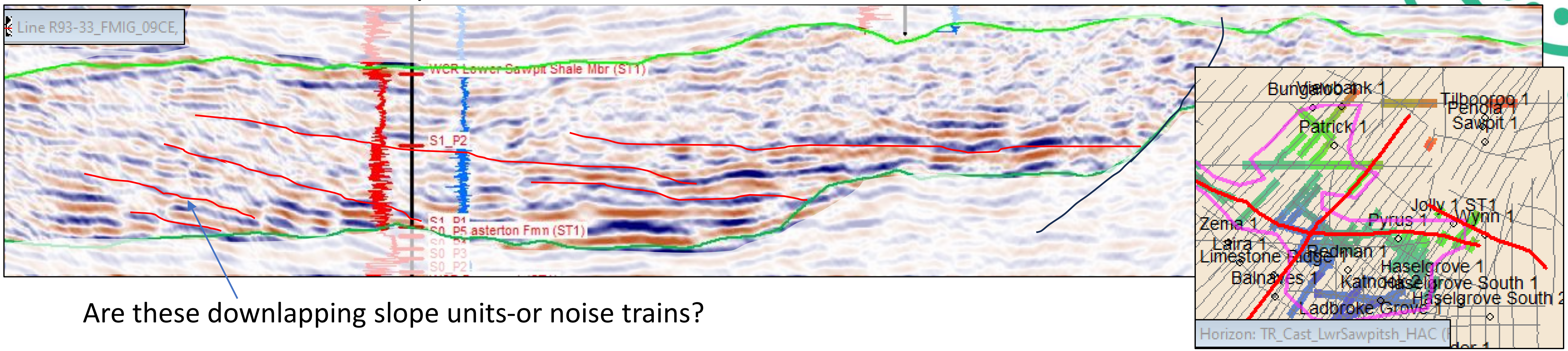
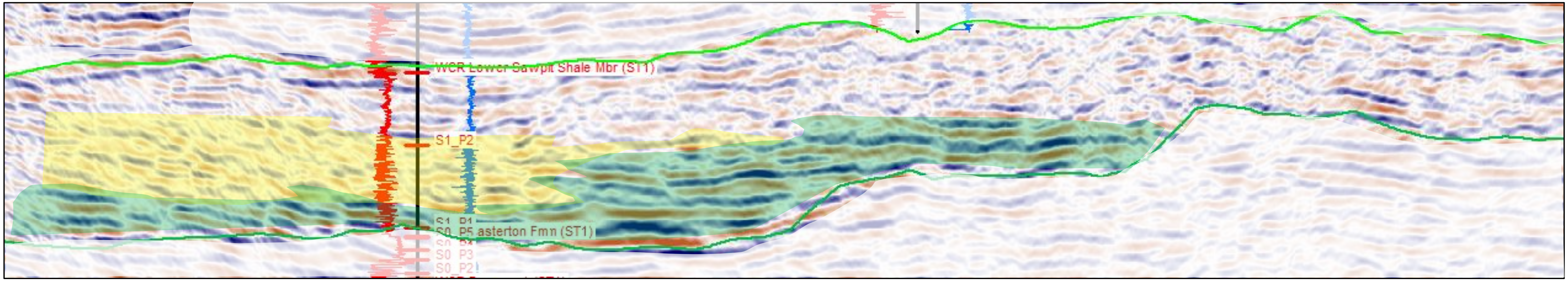


Onshore Otway Basin Model Seismic Facies Variations.

McEachen, Lower Sawpit Shale.



Are these downlapping slope units-or noise trains?



These geometries at Jolly look like geology. How we interpret the "downlaps" affects reservoir N/G and distribution-a fan or thin slope turbidites?

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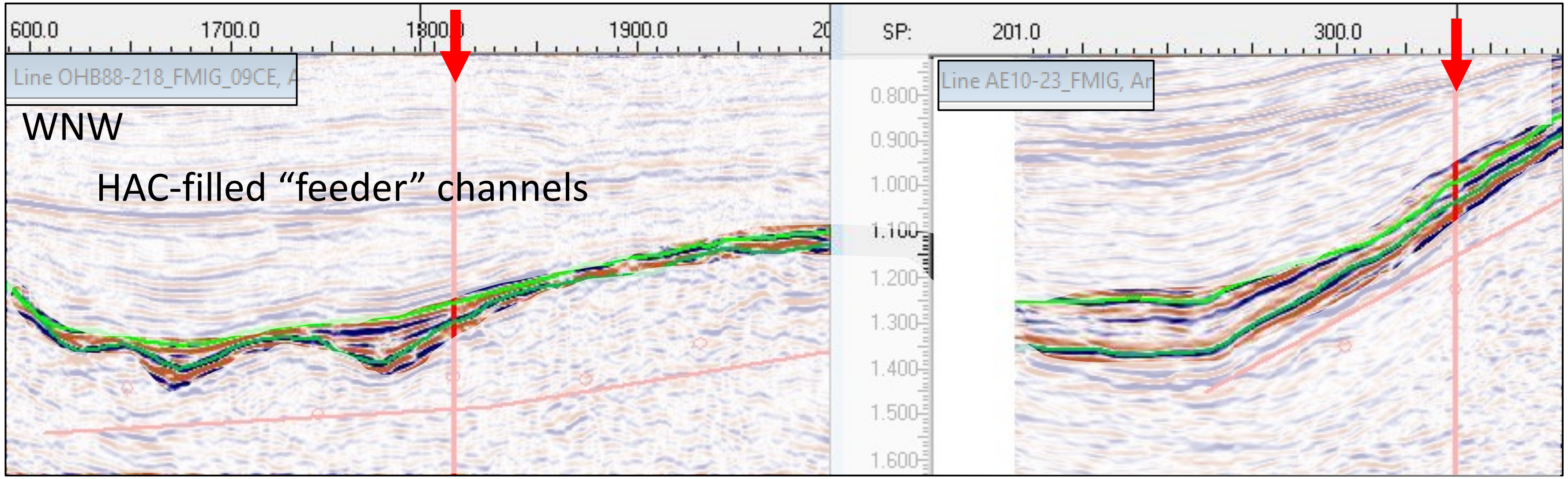
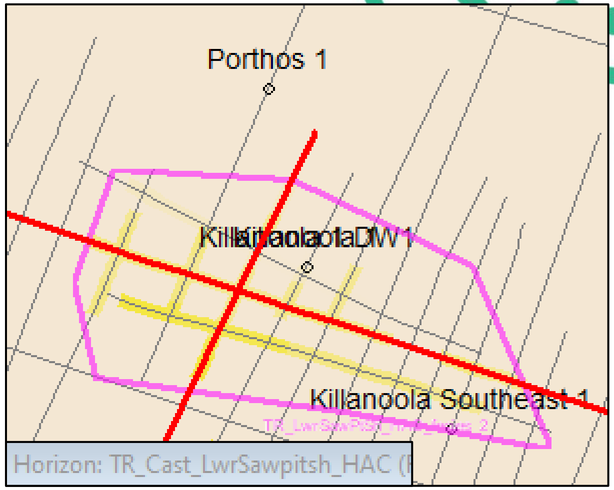
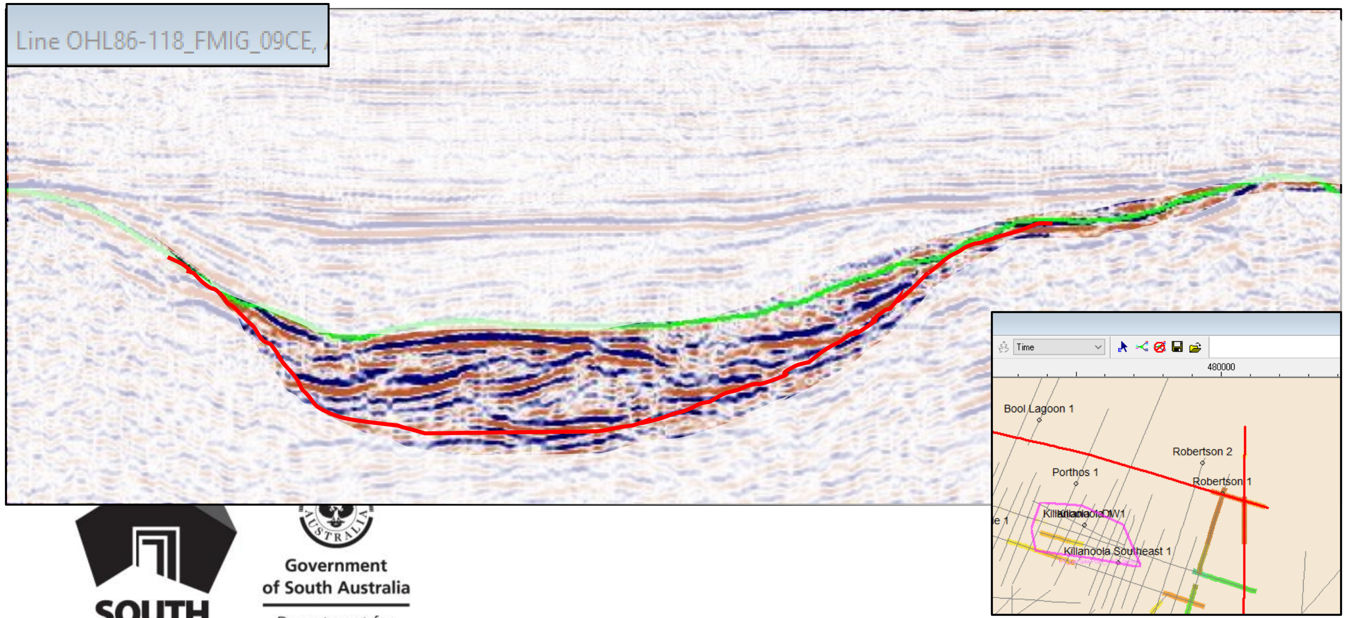
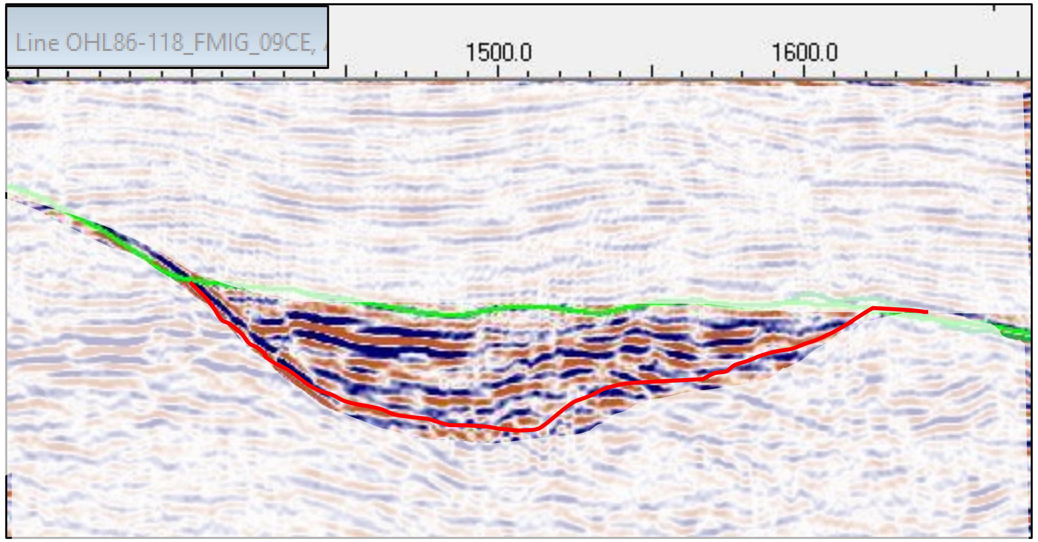
McEachen, Lower Sawpit Shale.









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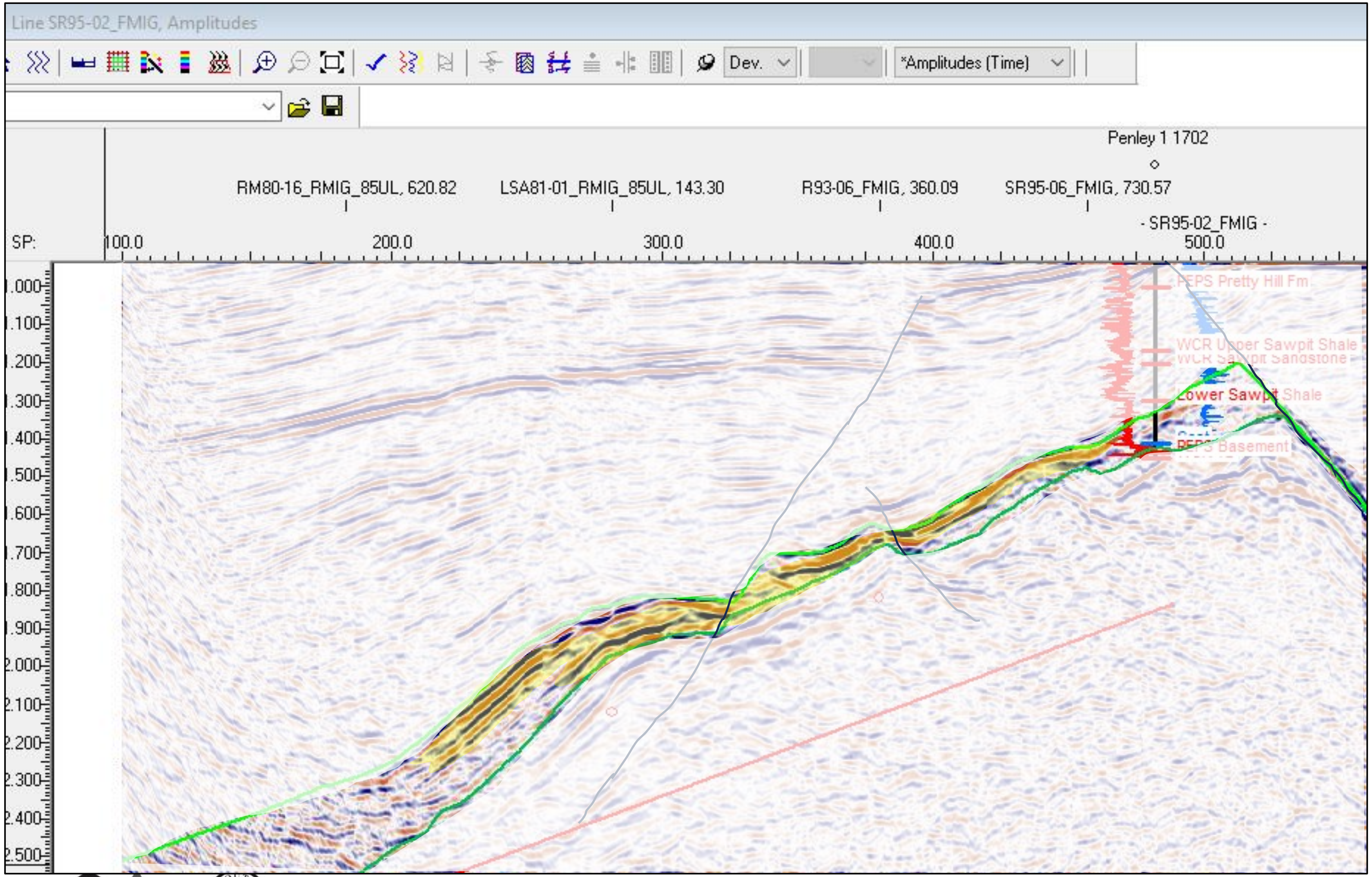
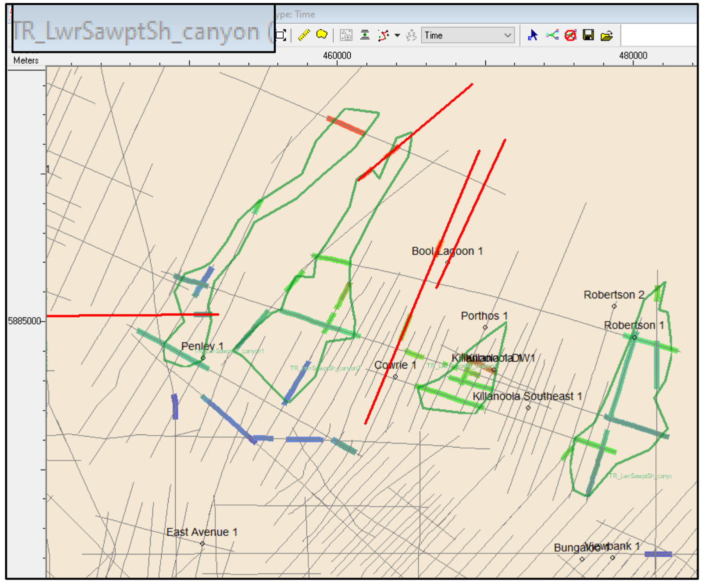
NB: minor picking changes could make more feeder canyons-geological versus structural picking!

McEachen, Lower Sawpit Shale.





Lower Sawpit Shale sands down dip from shale at Penley-1-intra-feeder canyon?

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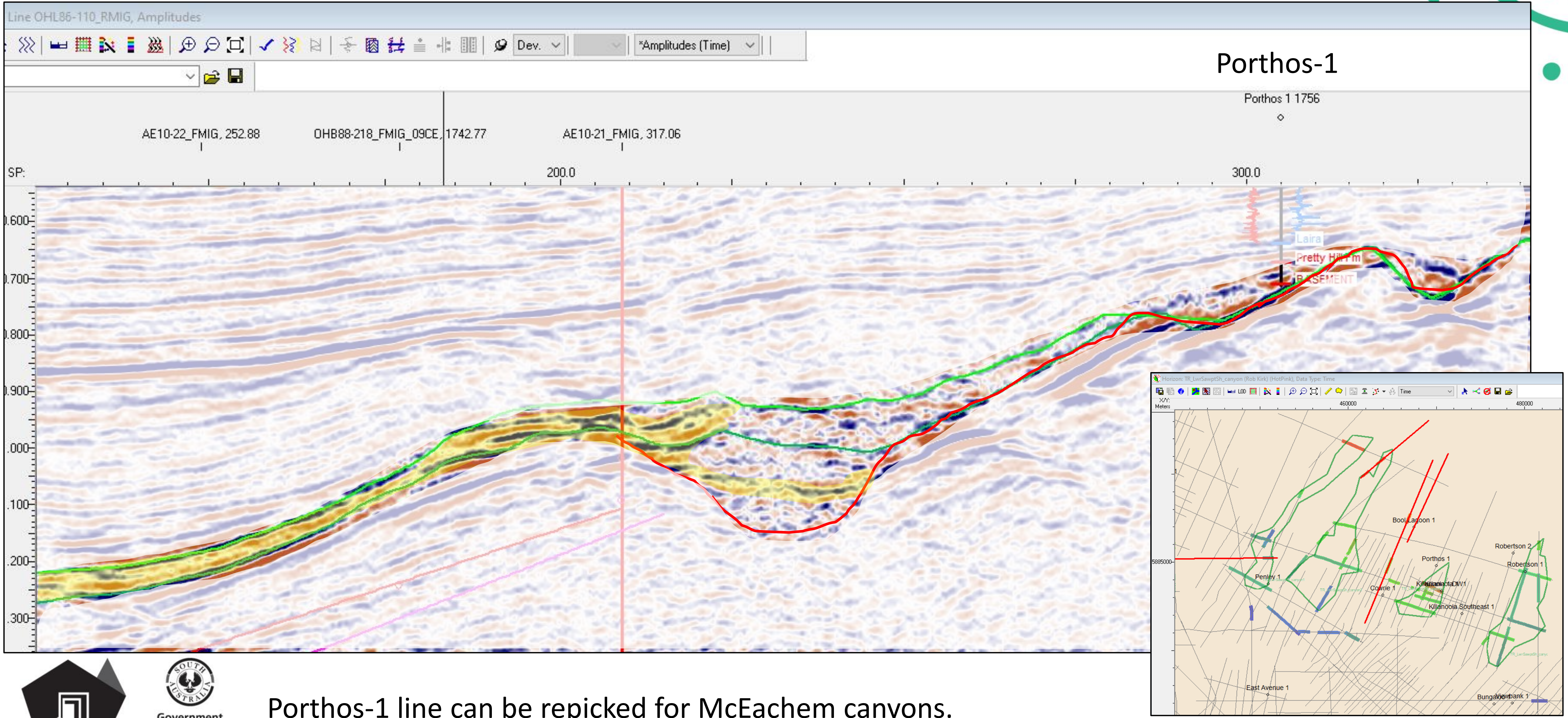
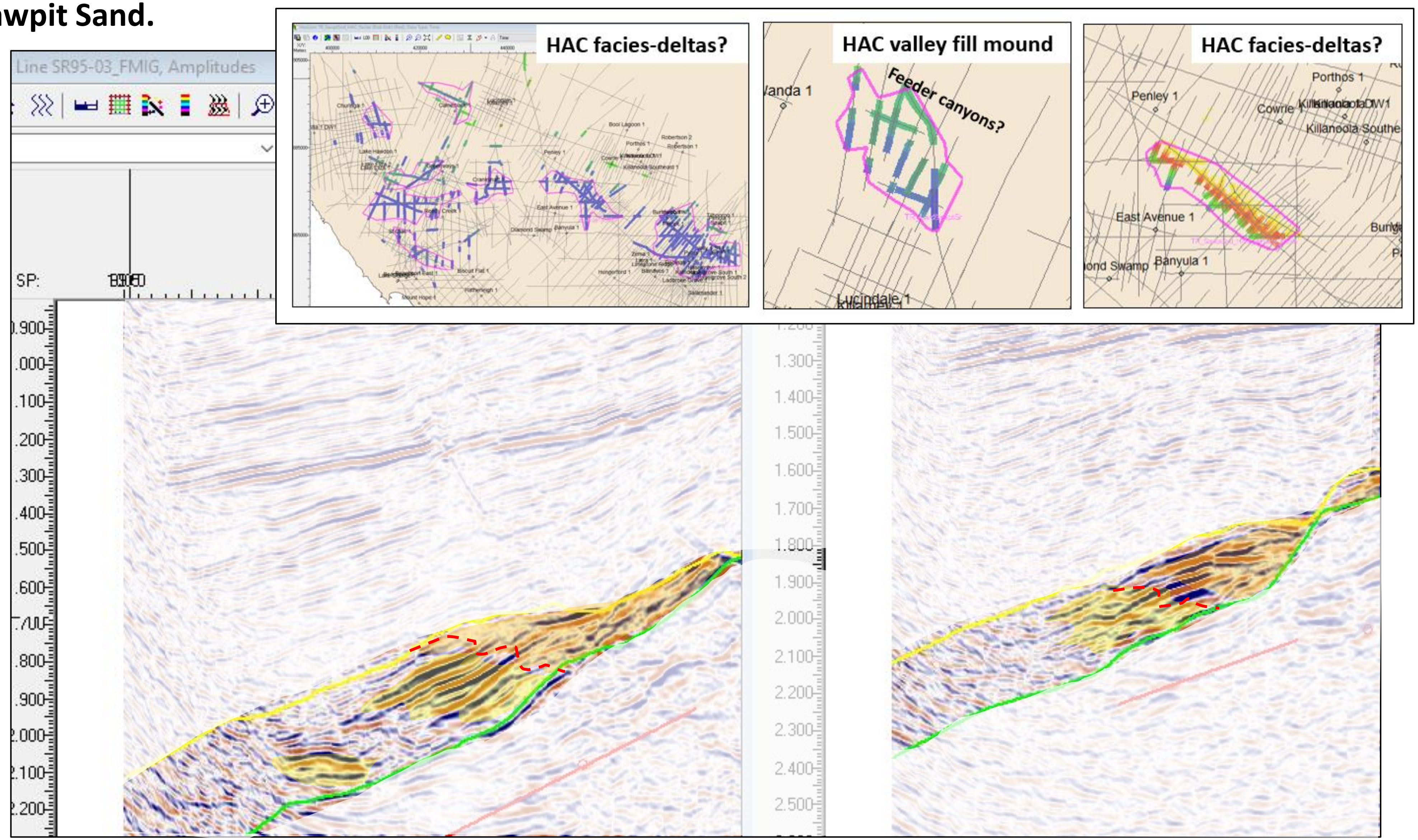
McEachen, Lower Sawpit Shale.



Porthos-1 line can be repicked for McEachem canyons.

Sawpit Sand.



Adjacent lines near Penley-1 show HAC “prograding” slope geometries (yellow-thin turbidites?)-maybe with fan down dip on SR95-03 (yellow)?

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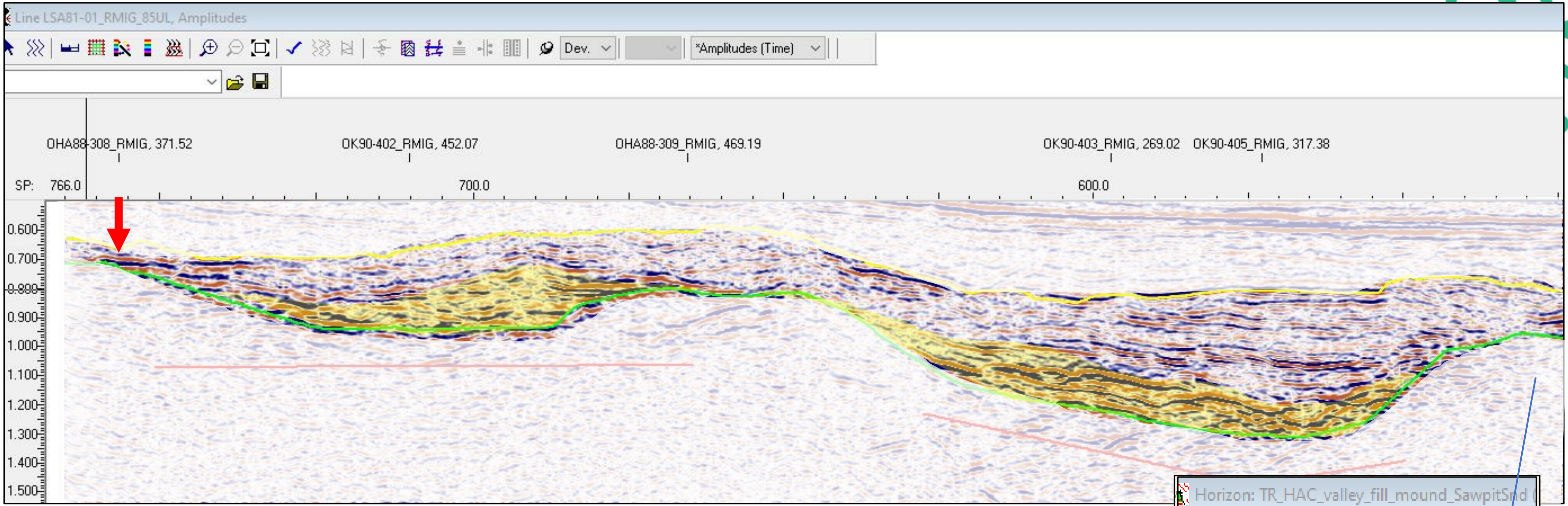
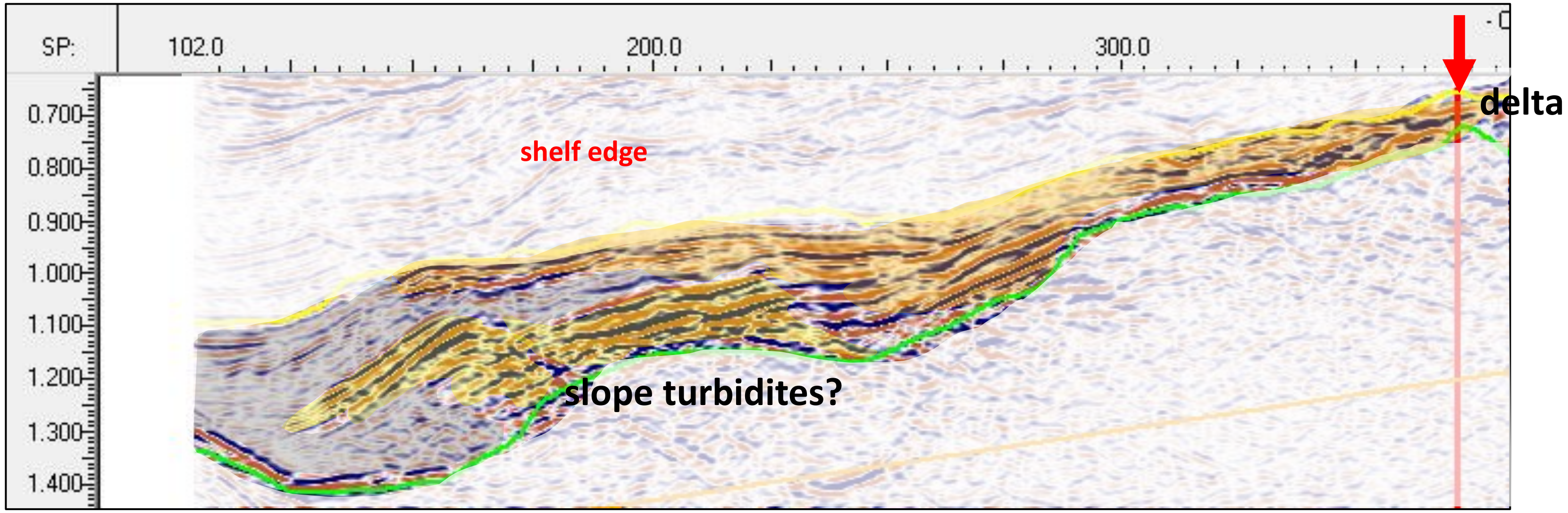
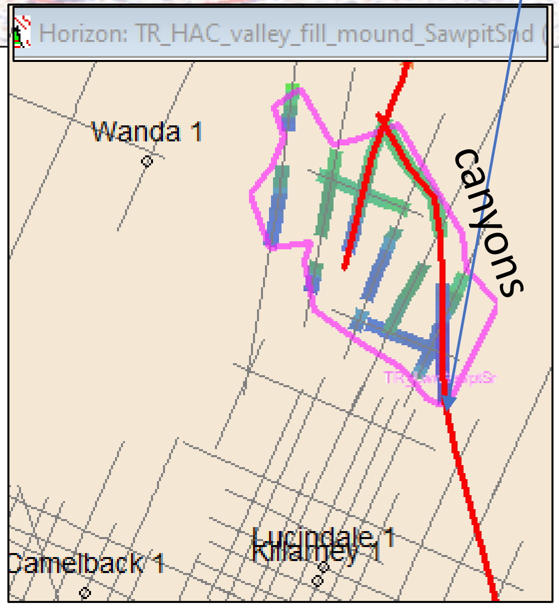
Sawpit Sand.



Line LSA81-01_RMIG_85UL, Amplitudes
Dev.
*Amplitudes (Time)
OHA88-308_RMIG, 371.52
OK90-402_RMIG, 452.07
OHA88-309_RMIG, 469.19
OK90-403_RMIG, 269.02
OK90-405_RMIG, 317.38
SP: 766.0
700.0
600.0
0.600
0.700
0.800
0.900
1.000
1.100
1.200
1.300
1.400
1.500

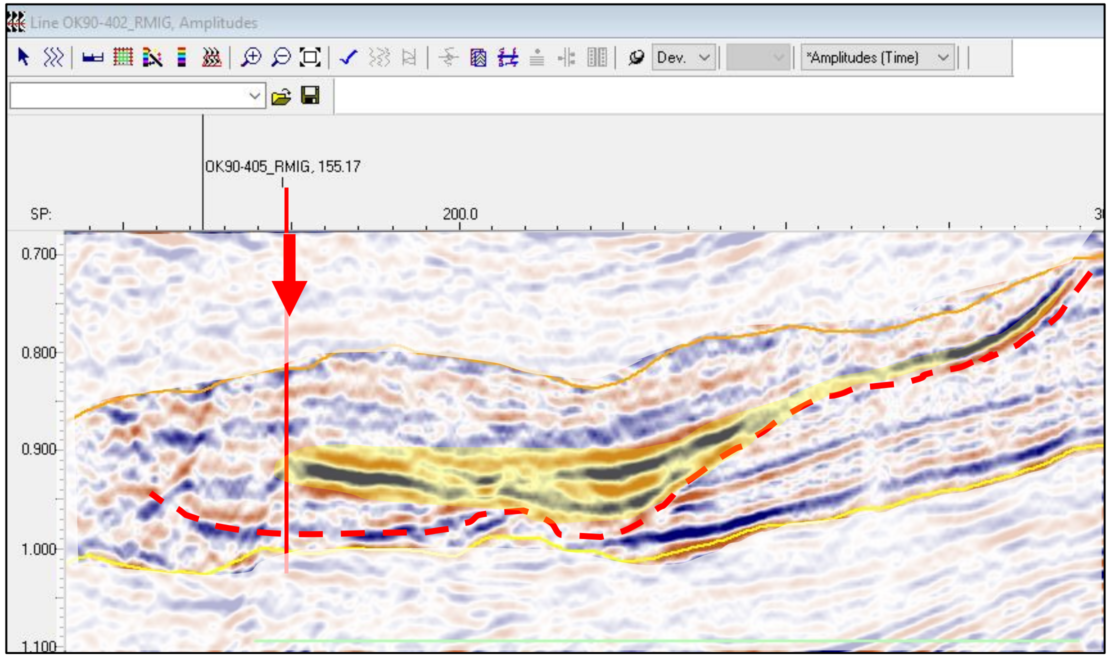


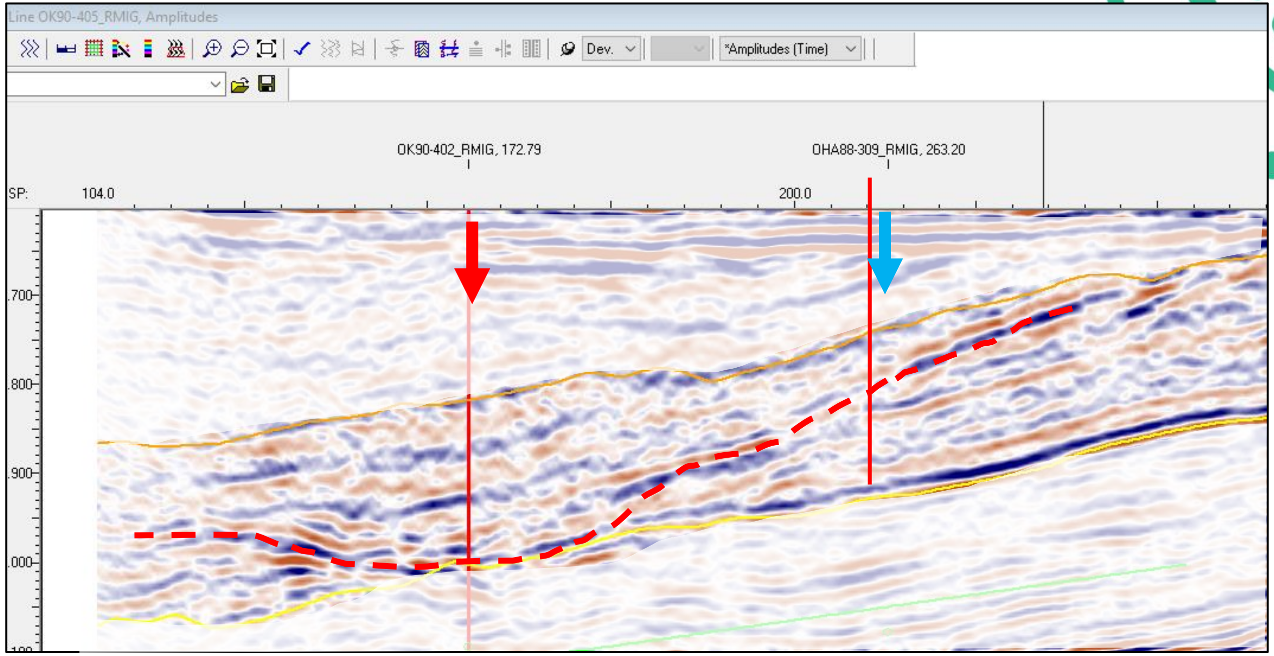
SP:
102.0
200.0
300.0
0.700
0.800
0.900
1.000
1.100
1.200
1.300
1.400
shelf edge
delta
slope turbidites?

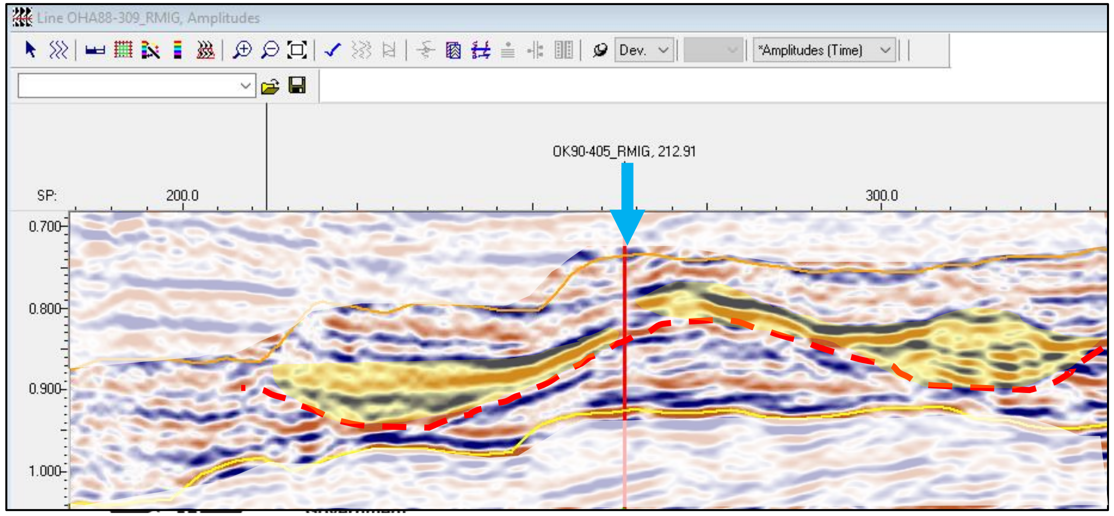


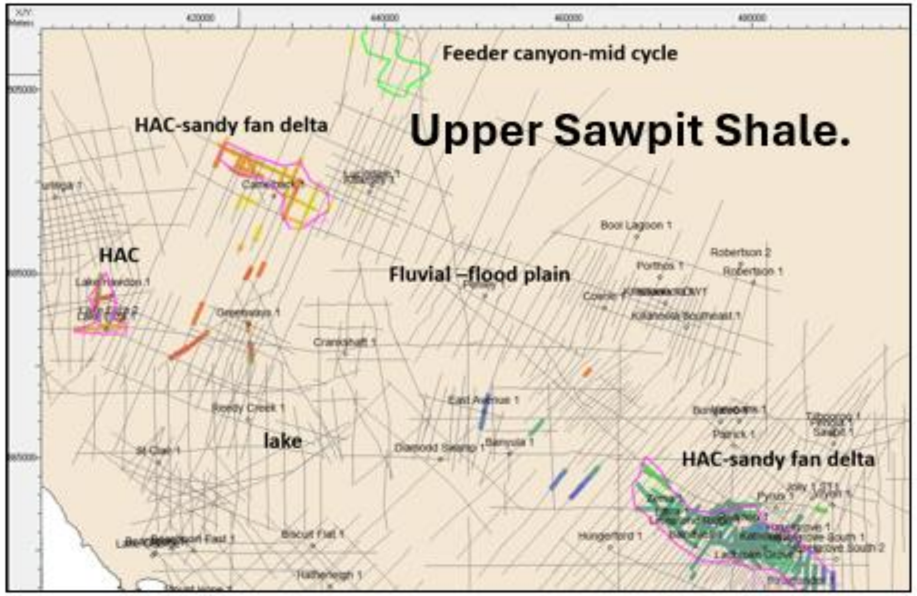
Horizon: TR_HAC_valley_fill_mound_SawpitSnd
Wanda 1
canyons
Camelback 1
Lucindale 1
Killarney 1

Upper Sawpit Shale.





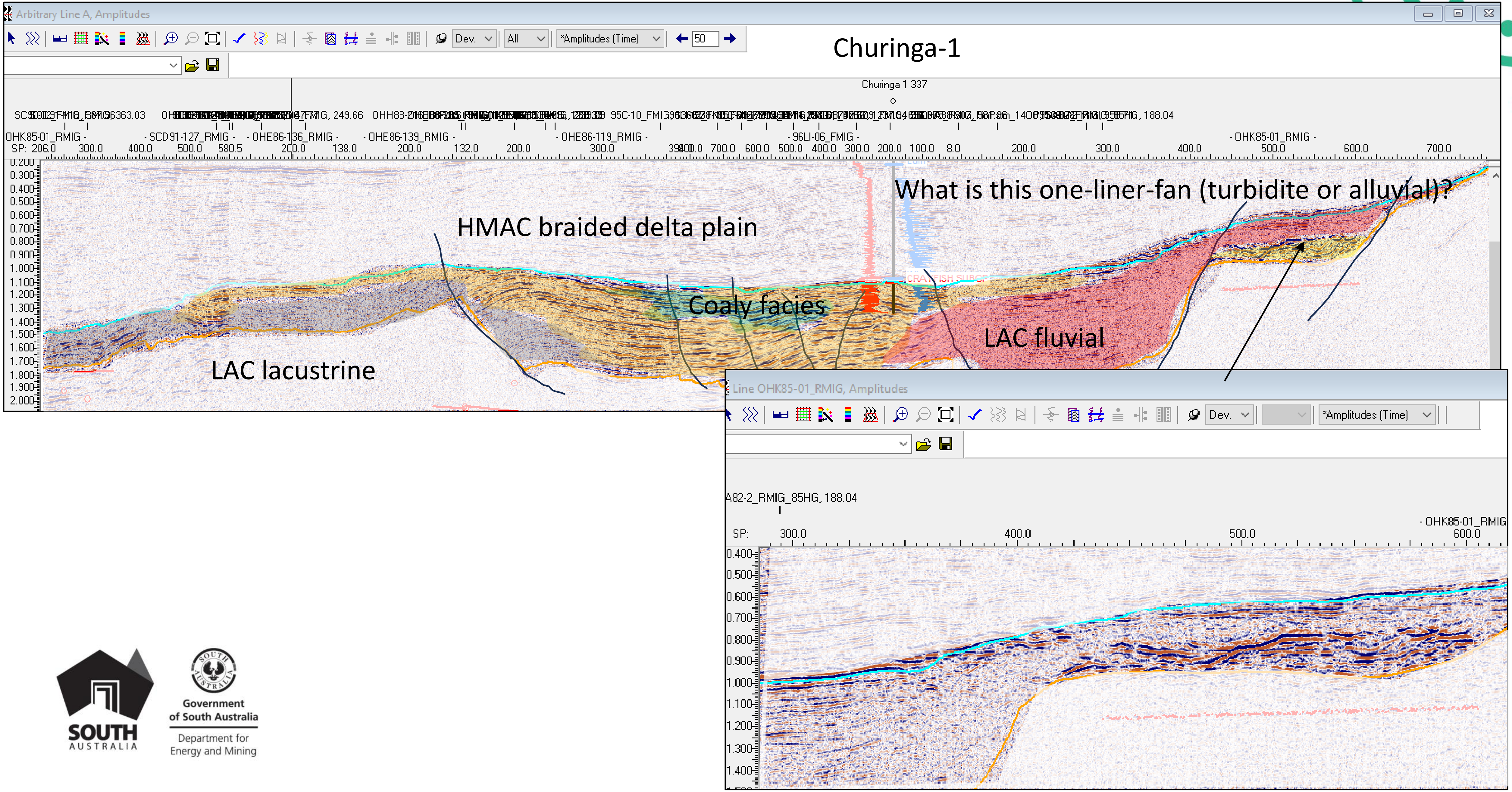




East of Wanda-1 we see an intra-sequence channeling event with variable, but occasional HAC canyon-fill facies.

Could this belong to a different sequence, or base event needs repicking?

Pretty Hill.



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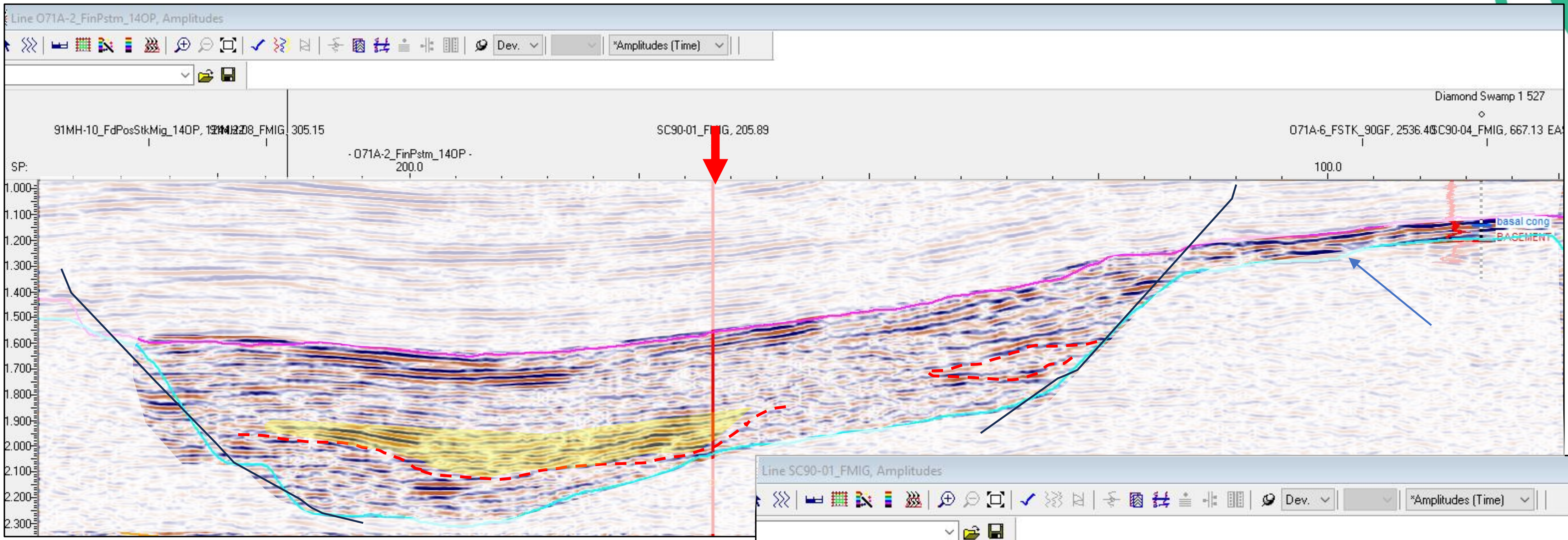
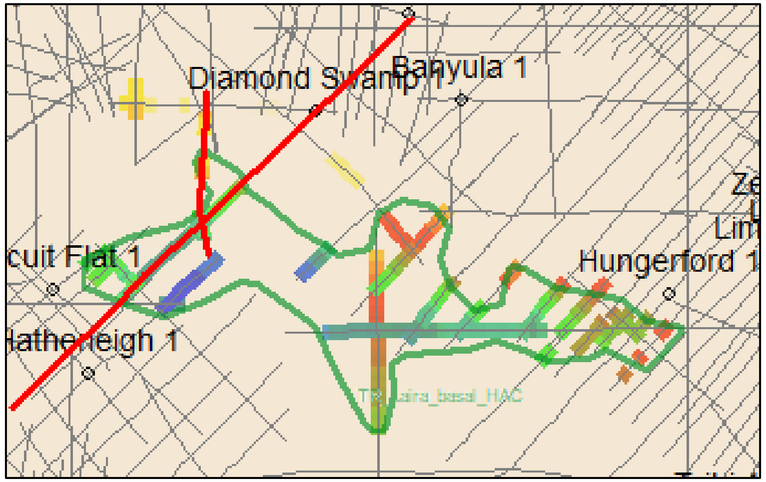
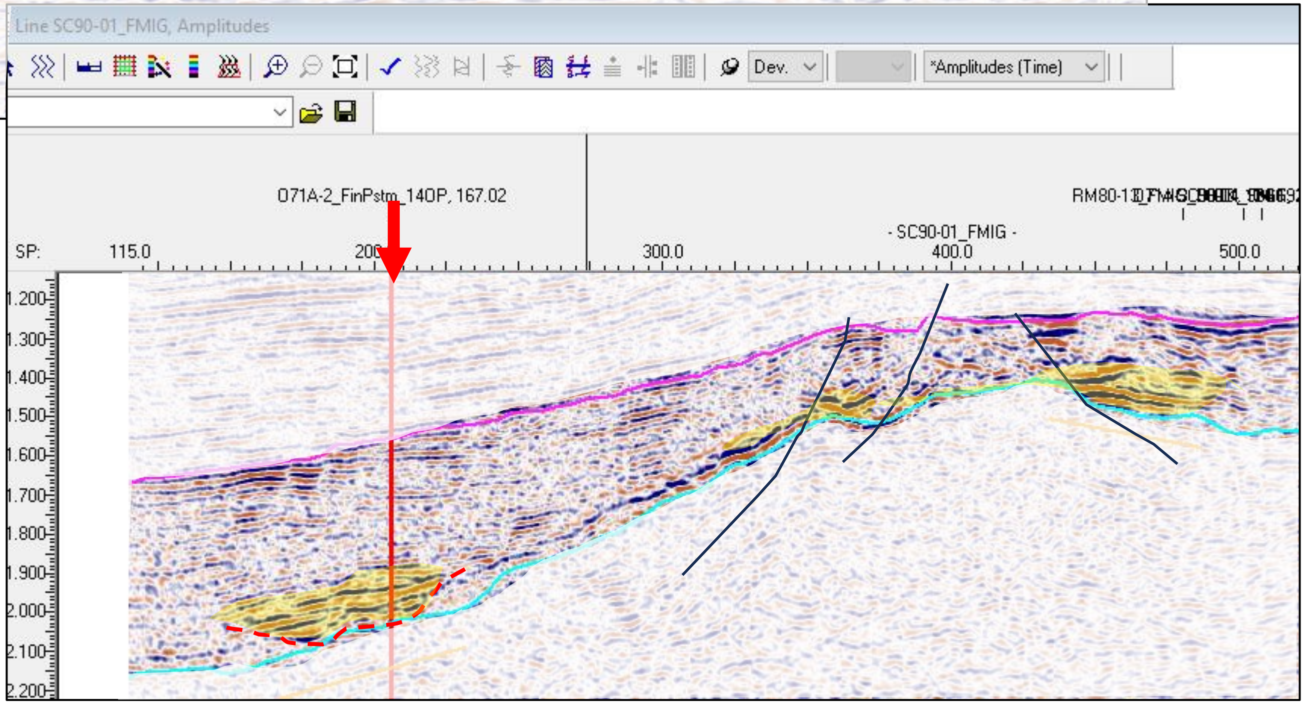
Laira.

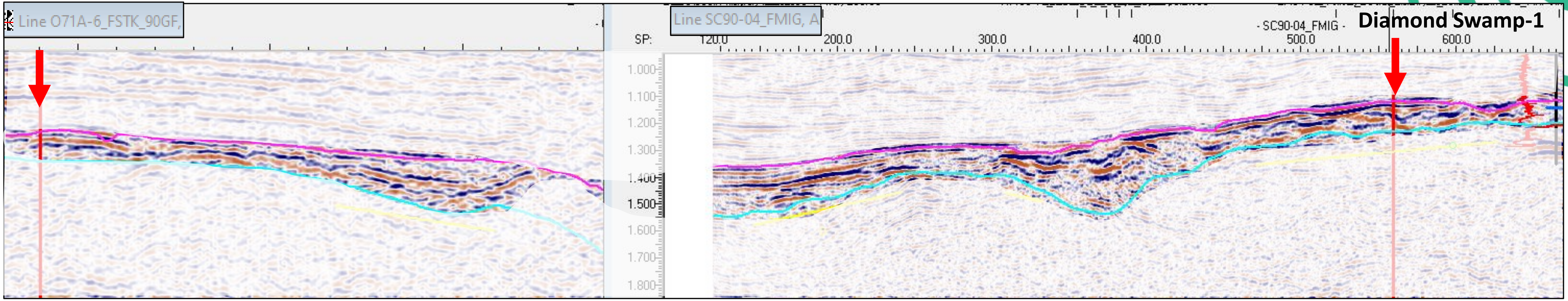


Intersecting lines suggest a deep Laira HAC-filled “canyon”.

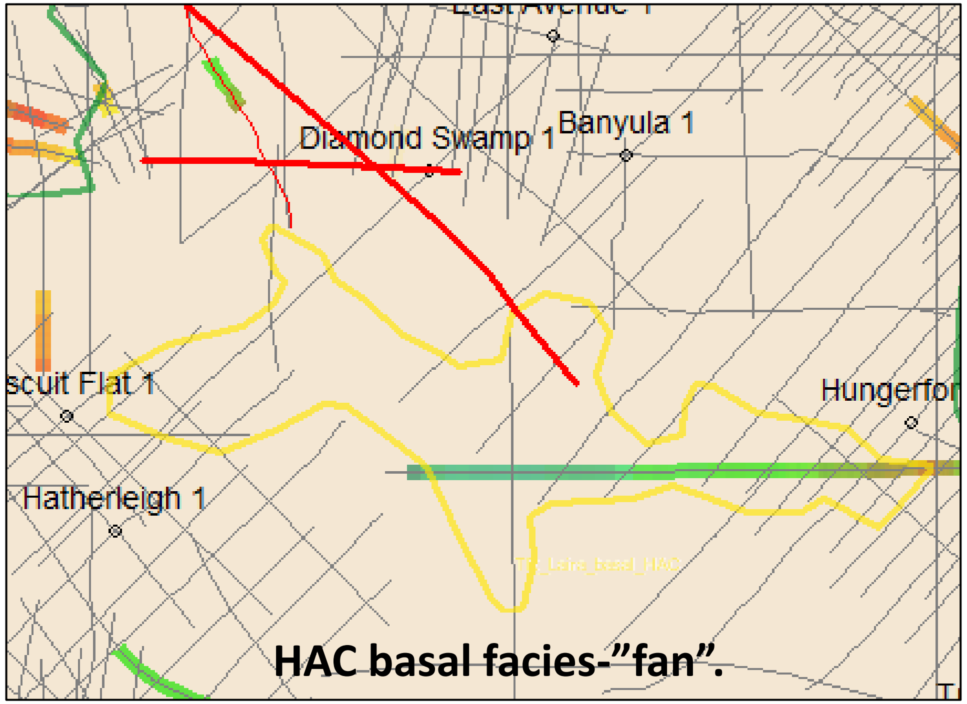




Laira.



Possible feeder channels for HAC basal sediments down dip.



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Summing up
New turbidite play in the Otway Basin

- Rock and seismic-based interpretation provides an alternative reservoir model for the McEachern to the current alluvial channel/crevasse splay model
- A new McEachern exploration play, lacustrine turbidites within a glacial system
- McEachern's immediate lateral association with gas/oil-prone source rocks and seals potentially provide for stratigraphic trapping, in addition to fault and/or dip-controlled structural traps
- Basin margin entry canyons (and possibly related down dip fan complexes) have been identified in the McEachern, Lower Sawpit, Sawpit Sand, Upper Sawpit, Pretty Hill and Laira intervals
- Away from limited core control, and relatively limited wireline control, robust, seismic facies have been mapped, which, when integrated, feed into multiple gross depositional environment (GDE) maps for the different stratigraphic intervals
- This study has shown the value of multi-disciplinary integration with iterative feedback as the interpretation matures using chemostratigraphic, core, wireline and structural and stratigraphic seismic data

Coming up

3 x AEP EAs, 2 x reports books and a second PESA talk …

Thank you!

Photos from PESA core workshop 23/11/2023

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