Late Quaternary Deepwater Fan Depositional Cycles in the Gulf of Papua: Linking Sources, Dynamic Sedimentation Processes, and Depositional Architecture*

Erlangga Septama[1] and Samuel J. Bentley[1]

Search and Discovery Article #50283 (2010)
Posted August 10, 2010

* Adapted from an oral presentation at AAPG Annual Convention and Exhibition, New Orleans, Louisiana, USA, April 11-14, 2010

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Abstract

We have studied a Late Quaternary deepwater channel-fan system in the Gulf of Papua for relationships among sediment supply, transport processes, and depositional architecture over centennial to millennial timescales. Our study focuses on two contrasting depocenters, Pandora and Moresby Troughs in the Gulf of Papua, and incorporates observations from 3.5 KHz seismic profiles, groundtruthed by jumbo piston core analyses.

The age model of Pandora Trough core MV-23 (2,068 m depth) shows a period of rapid sedimentation (41.3 cm/ka) from 44-19 Ka Bp, slowing to 20 cm/ka afterward, through the end of Marine Isotope Stage (MIS)-2. The turbidite succession observed in core, tied with the seismic profiles, suggests multiple point sources for the fan system, which appears to have shifted oceanward during periods of falling sea level. Sand provenance in this core ranges from dissected arc to recycled orogen, with quartz and litho-volcanic proportion increasing upward, and suggests the increased supply through time from extrusive volcanic terranes in the southern Fly Highlands. A contrasting story is told in the Moresby Trough, through cores MV-22 (2,058 m depth) and 27 (2,071 m depth). The age model for core MV-27 shows a lower average depositional rate of 17 cm/Ka. The core is composed primarily of thin sheet sands, with provenance varying widely from undissected arc to transitional arc (resembling sources from the Papuan Peninsula) to recycled orogen, with upward increasing textural maturity, suggesting additional allochthonous input from drainage systems to the northwest (e.g. Fly-Strickland and Kumalo, Kikori, and Purari Rivers).

We propose two elements in the source-to-sink narrative for our study area during this period. (1) In the Pandora Trough, turbidite sedimentation dominated from late MIS-3 to MIS-2 (>40 Ka - 12.5 Ka), and ceased by early Holocene due to rising sea level and associated shelf trapping of sediment. (2) Turbidite sedimentation continued in the Moresby Trough, although at a slower rate, into the Holocene transgression. Sediment sources to deep water included reworked shelf edge deposits, and more direct river-mouth supply entrained by coastal currents on the flooding continental shelf (<~15 Ka Bp). This flooding and current system enabled coalescence of multiple river sources to supply fan aggradation in the Moresby Trough.

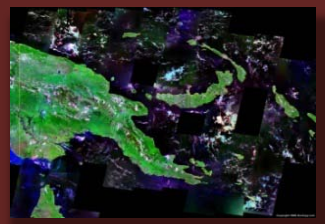
2010 AAPG Annual conference, New Orleans, LA

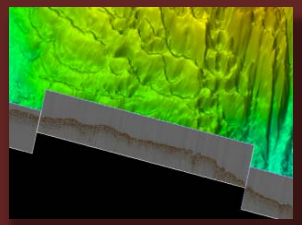
Late Quaternary Deepwater Fan Depositional Cycles in the Gulf of Papua :

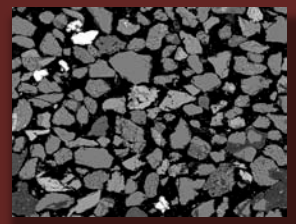
Linking Sources, Sedimentation Processes and Depositional Architecture

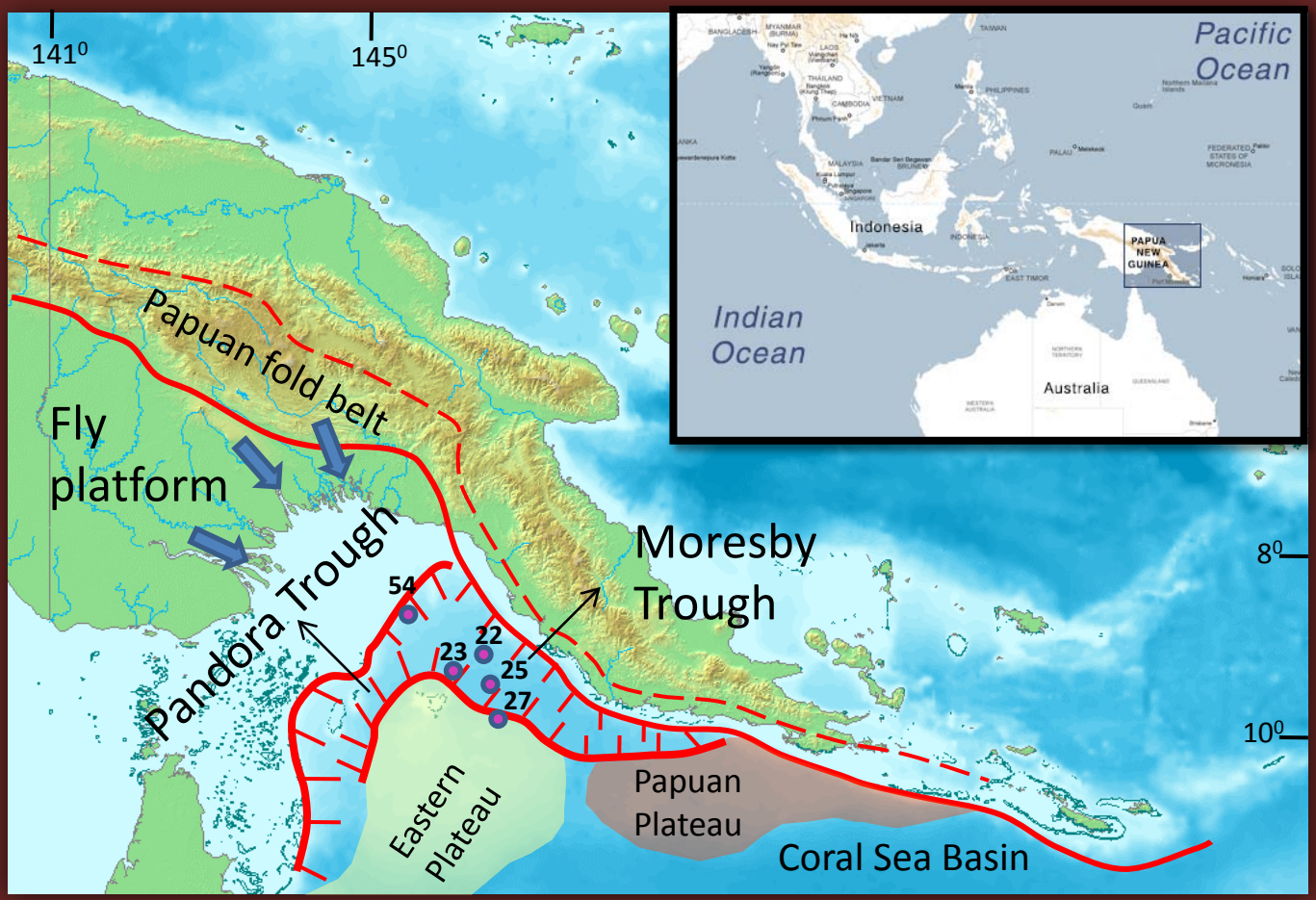
By

Erlangga Septama and Samuel J. Bentley









A Quick Perspective

GOP

Why GoP ?

Why Quaternary system ?

Research Motivation

3D visualization

3.5 Khz seismic interpretation

Core analysis

SEM-based provenance

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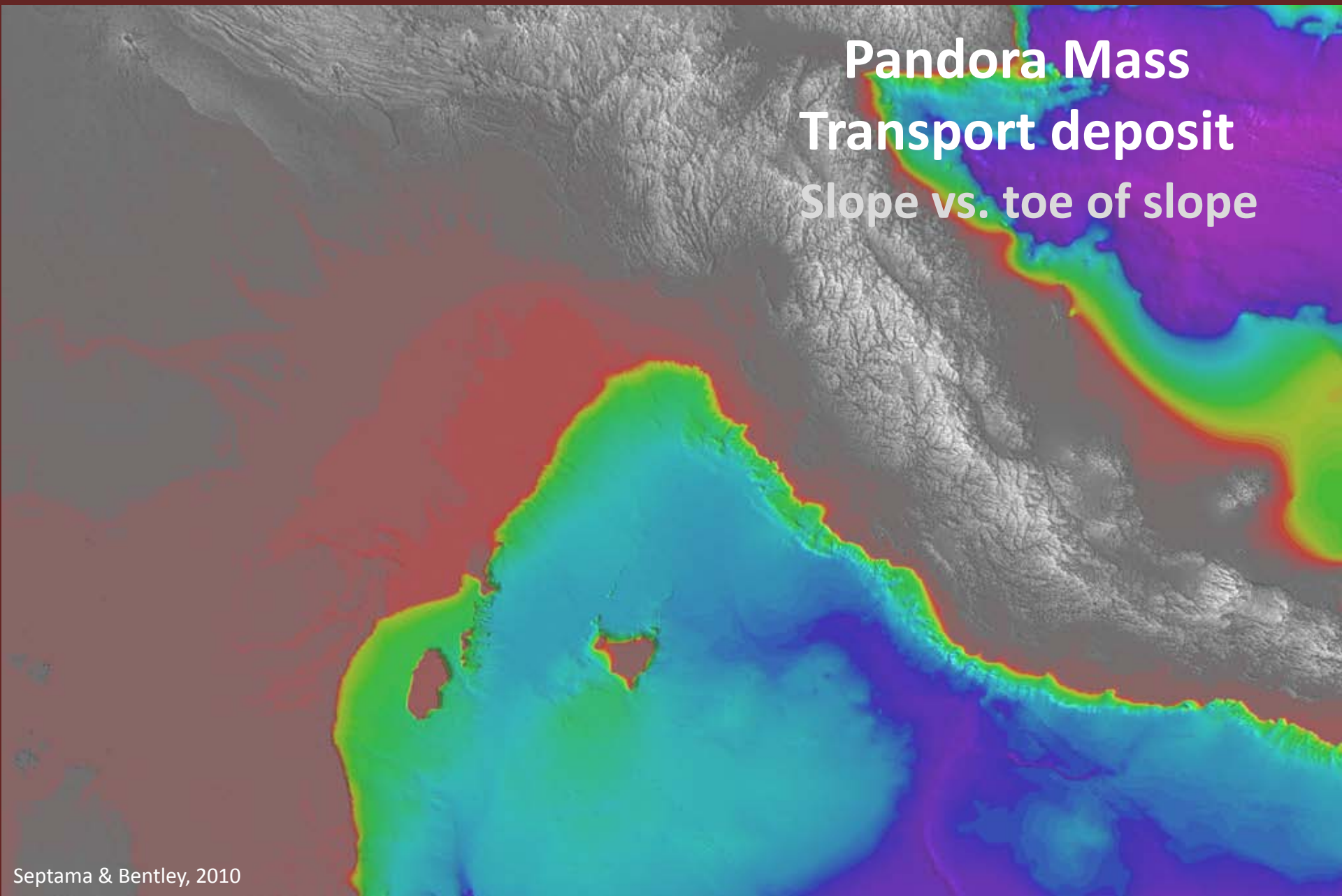

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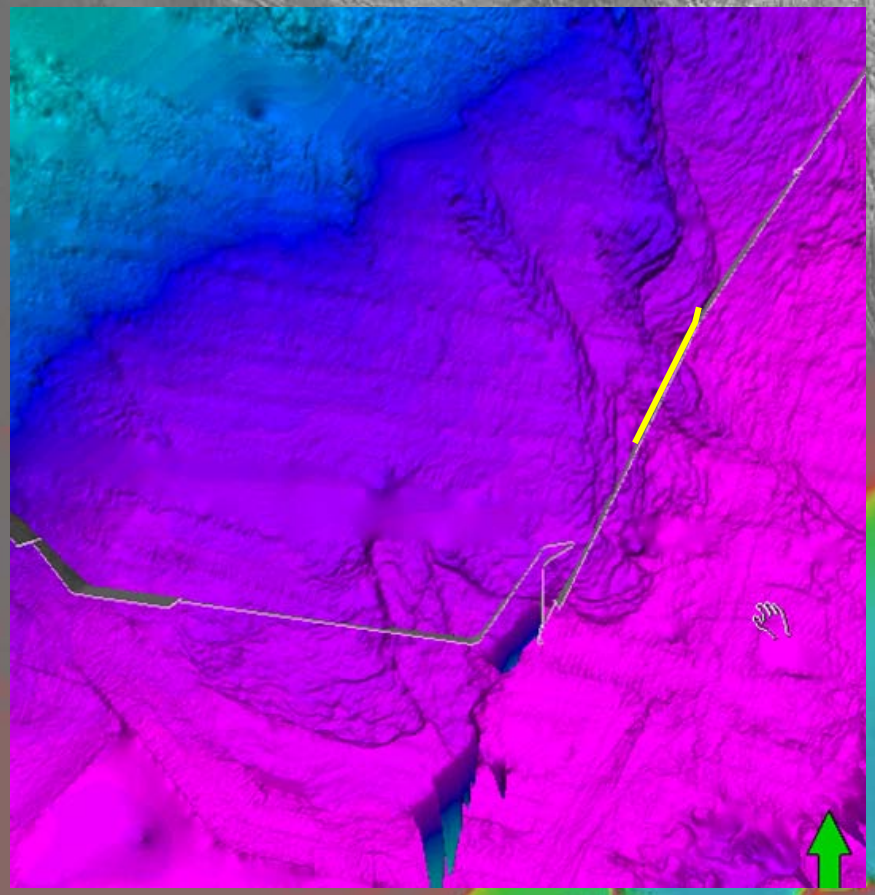
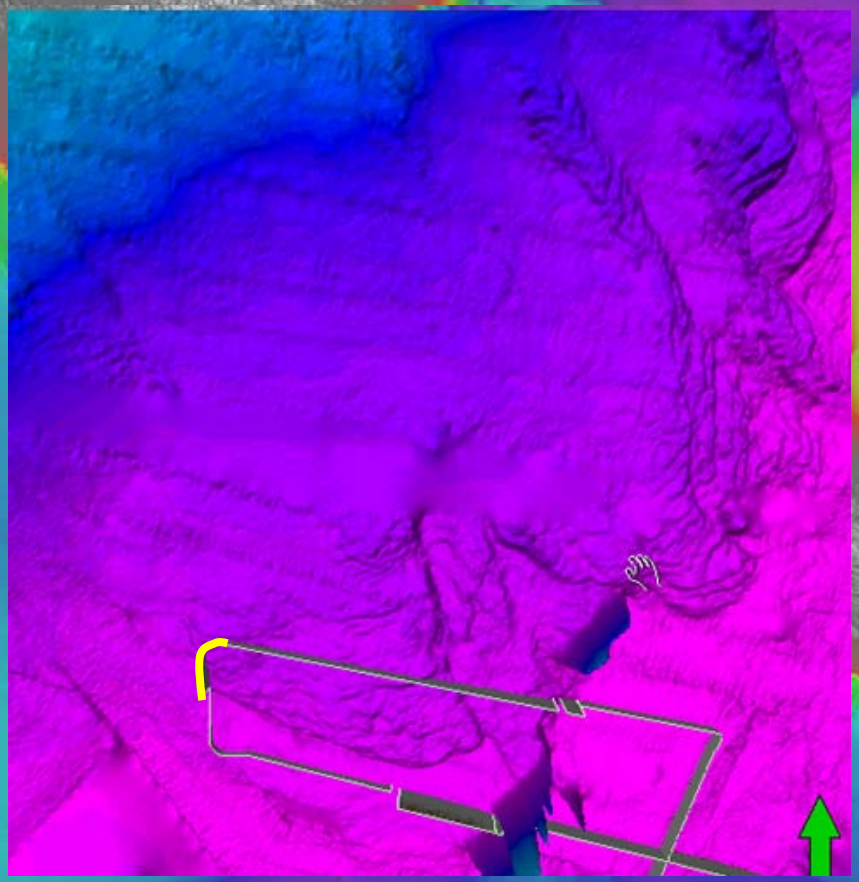
Pandora Mass Transport deposit

Slope vs. toe of slope





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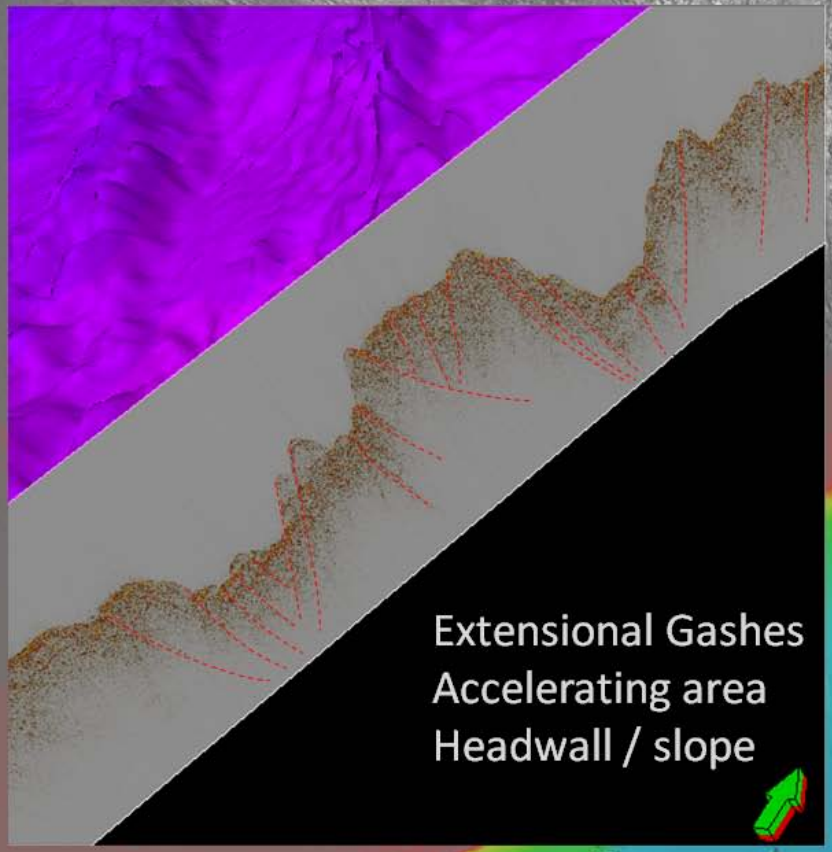
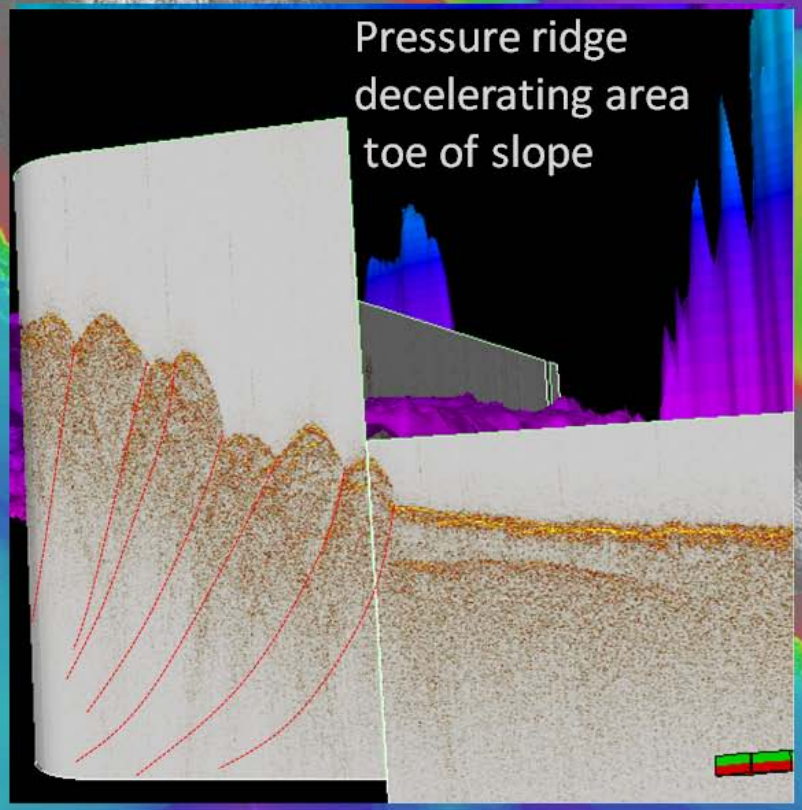
Pandora Mass Transport deposit

Slope vs. toe of slope





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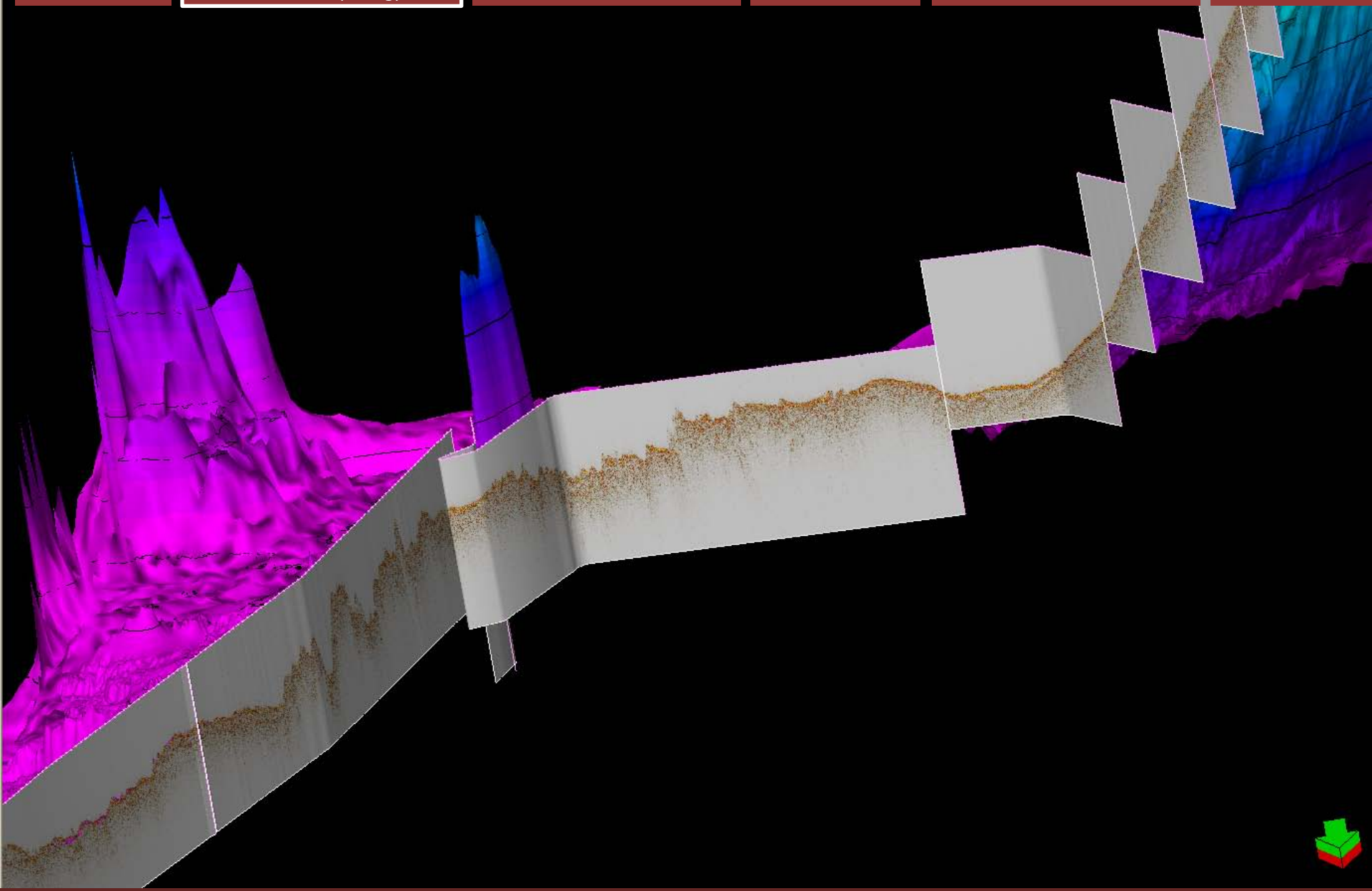

Modern Pandora seafloor depositional elements

Toe of Slope – Slope - Headwall, view from NW to SE

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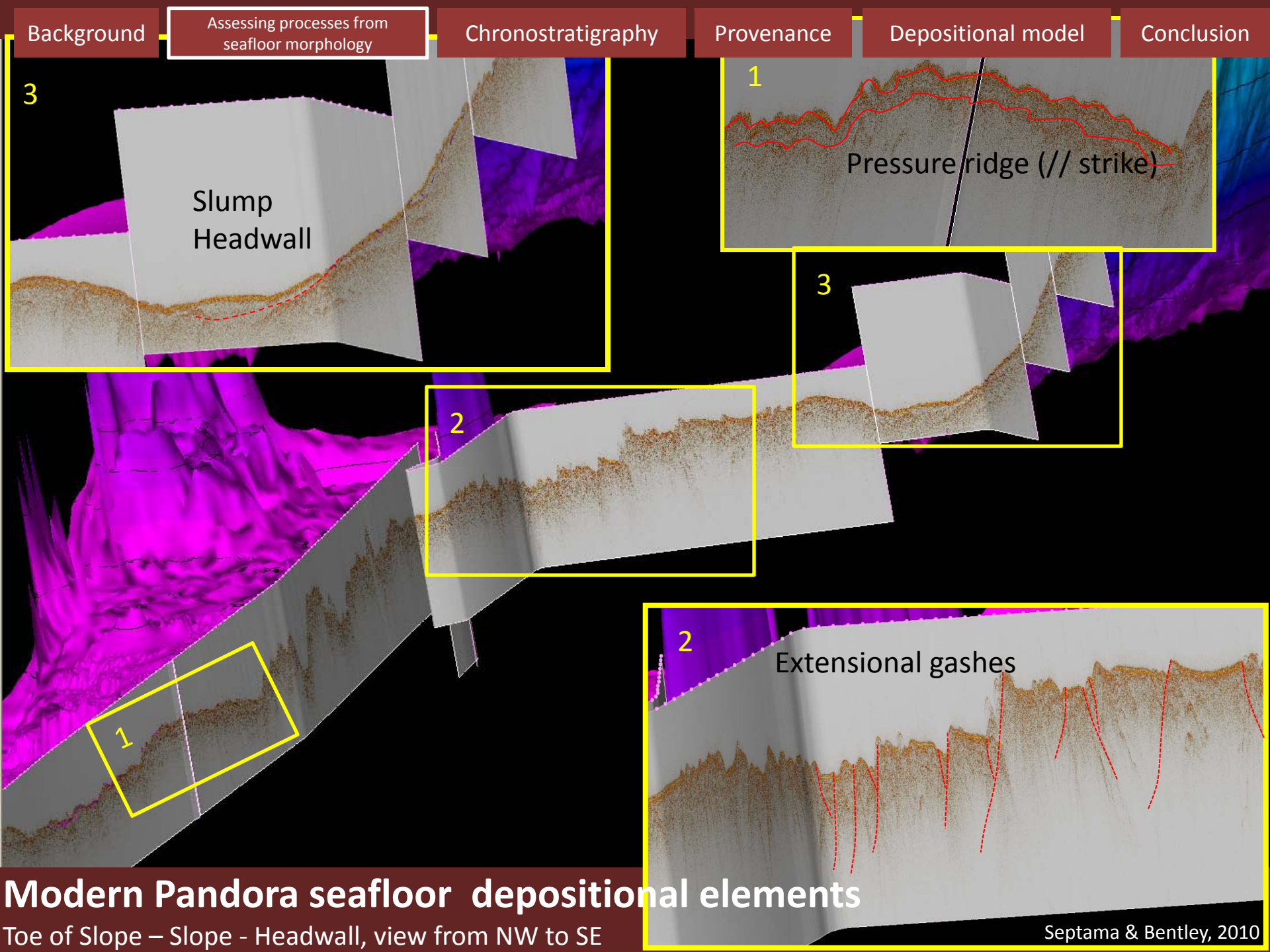

Modern Pandora seafloor depositional elements

Toe of Slope – Slope - Headwall, view from NW to SE

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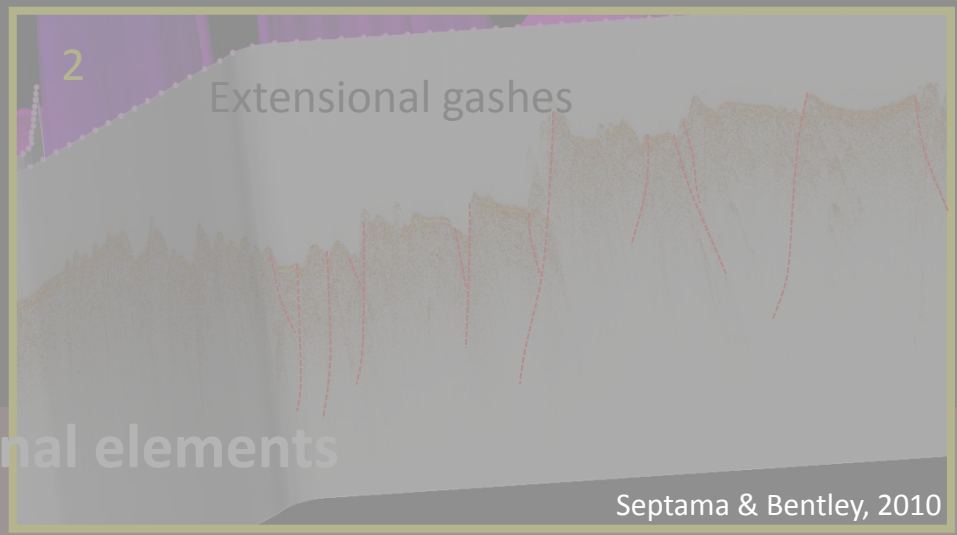
Modern Pandora Trough Seafloor

- 42 % was covered by mass transport deposits (18,000 km^2 or 43,000 km^3)

- No indication of presently active channel-fan system

Degraded seafloor



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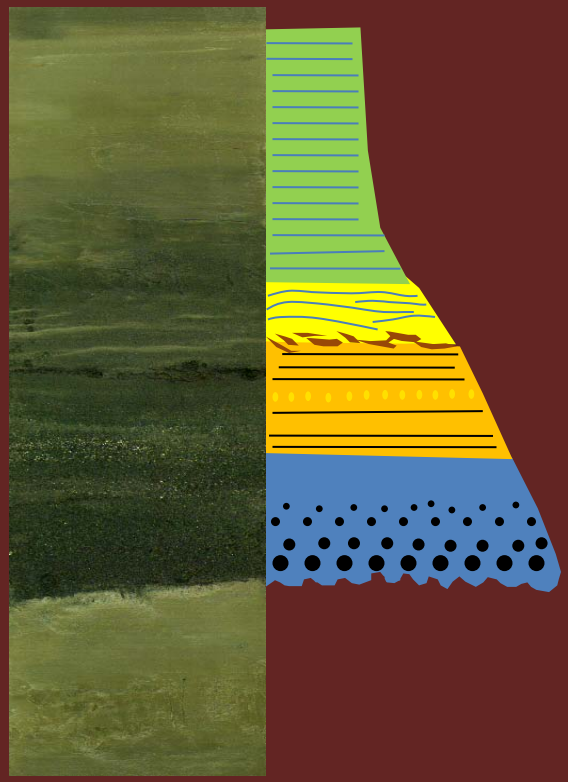
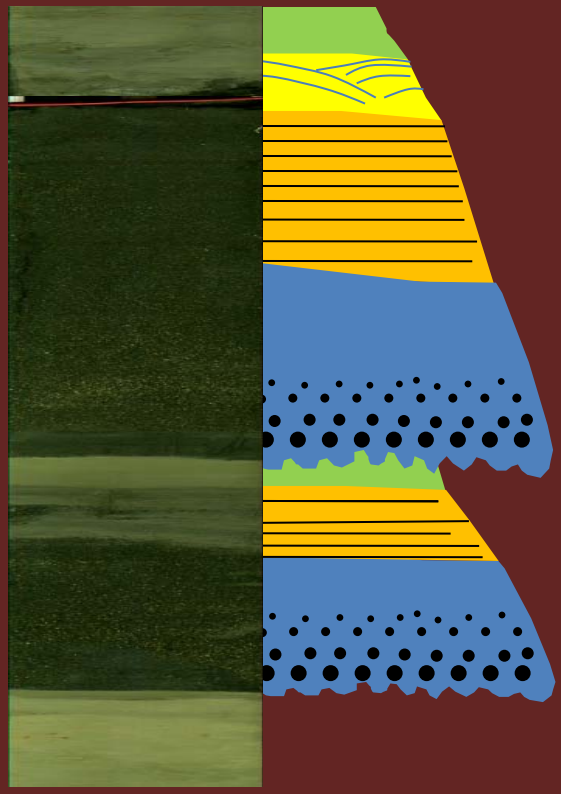
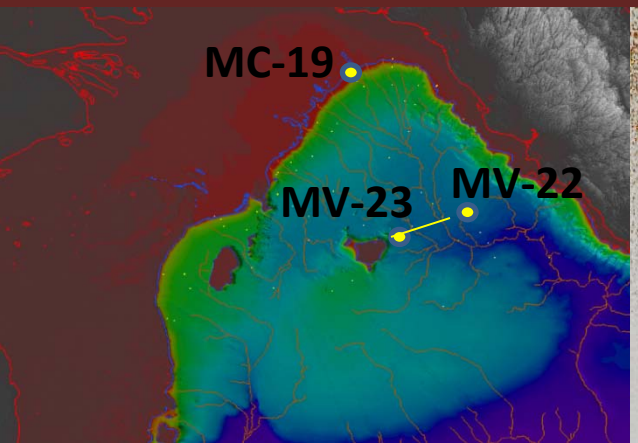


2.1 – 2.43 m

7.9 - 8.3 m



9.3 - 10 m



Late Quaternary Pandora Fan

Evidence from core MV-23

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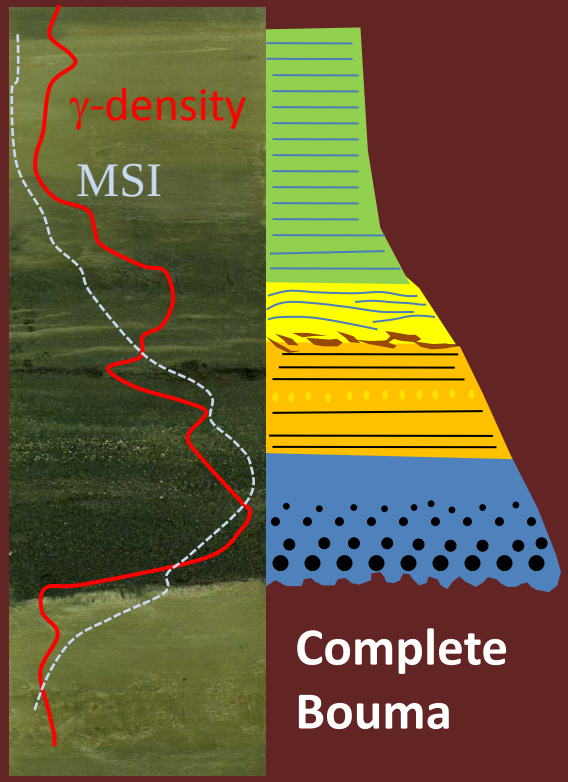
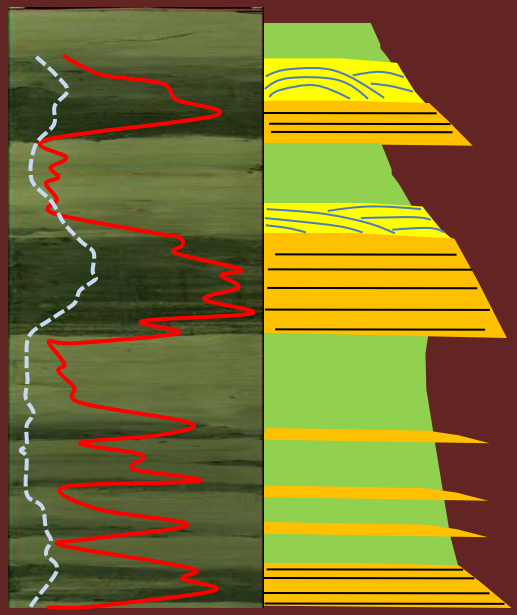
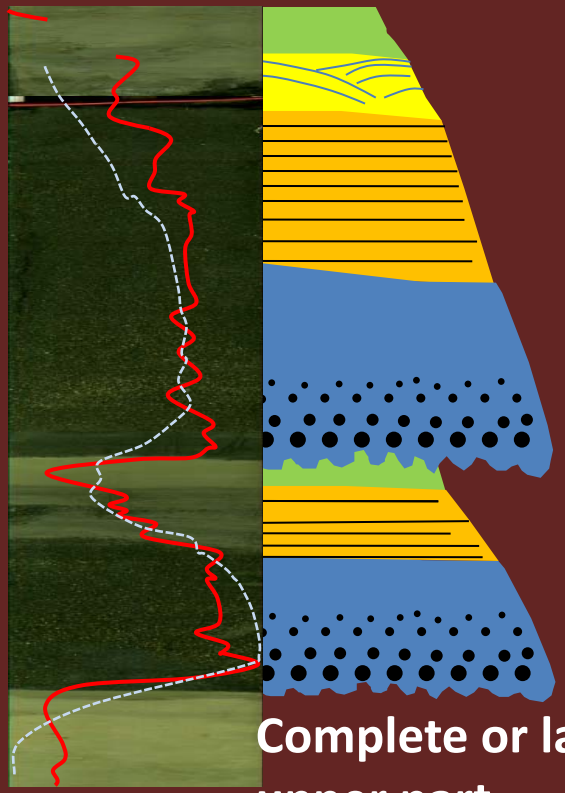


Complete Bouma

2.1 – 2.43 m

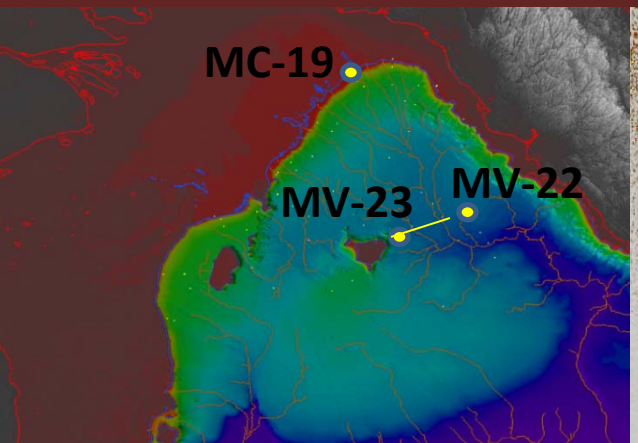


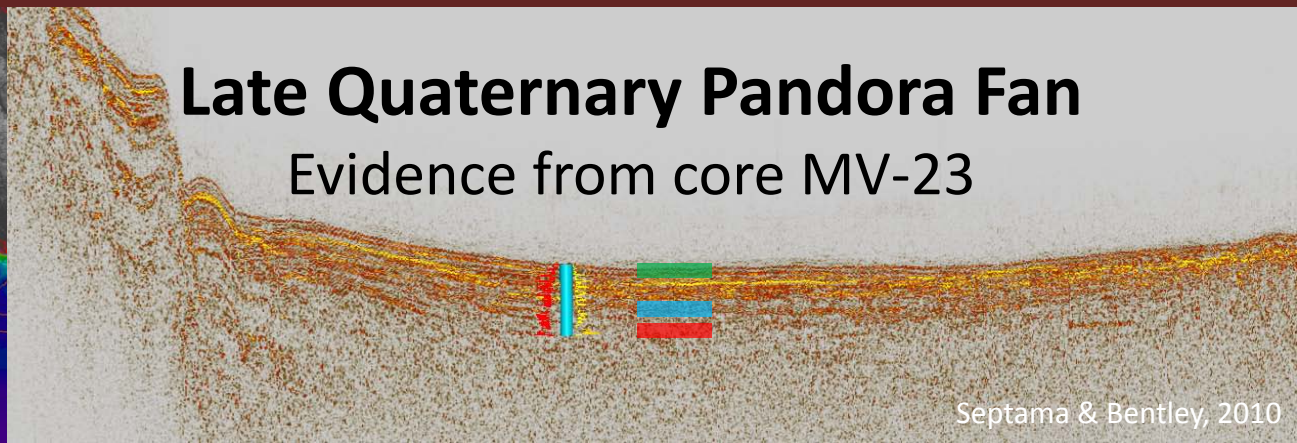
7.9 - 8.3 m
Lacks lower part

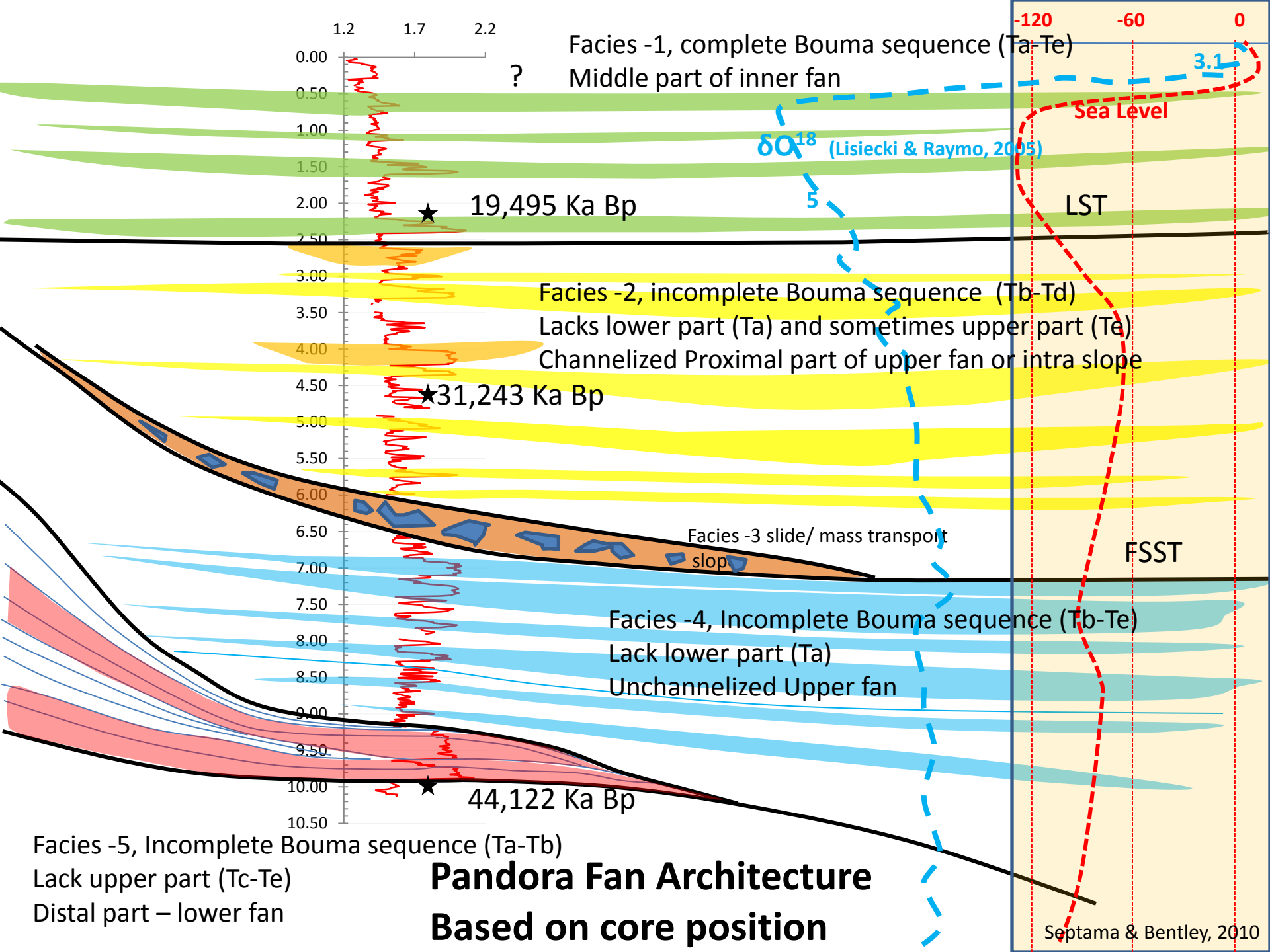


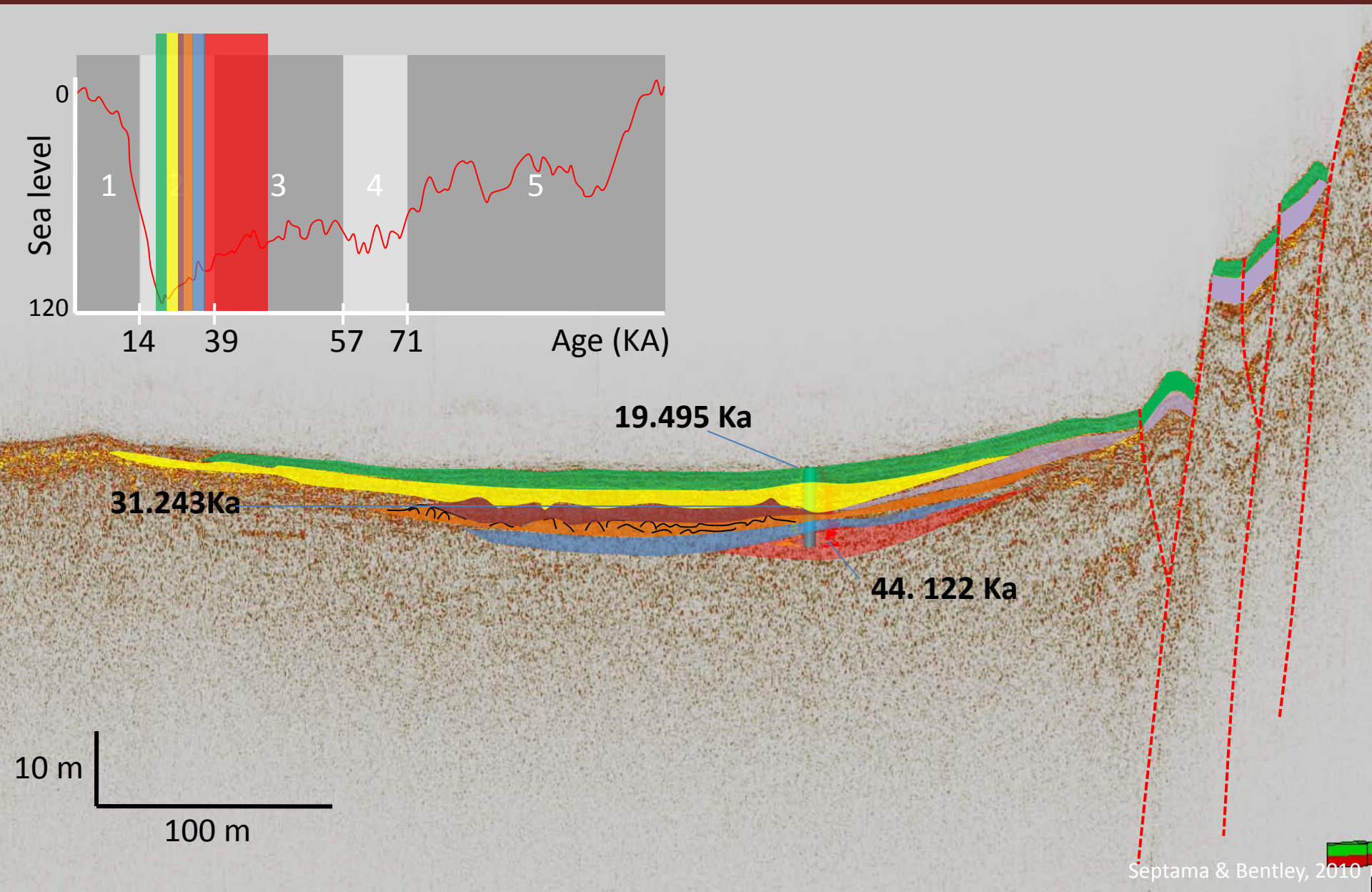
Complete or lacks upper part

9.3 - 10 m






1.2
1.7
2.2
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
10.00
10.50
?
Facies -1, complete Bouma sequence (Ta-Te)
Middle part of inner fan
19,495 Ka Bp
Facies -2, incomplete Bouma sequence (Tb-Td)
Lacks lower part (Ta) and sometimes upper part (Te)
Channelized Proximal part of upper fan or intra slope
31,243 Ka Bp
Facies -3 slide/ mass transport
slop
Facies -4, Incomplete Bouma sequence (Tb-Te)
Lack lower part (Ta)
Unchannelized Upper fan
44,122 Ka Bp
Facies -5, Incomplete Bouma sequence (Ta-Tb)
Lack upper part (Tc-Te)
Distal part – lower fan
δO18 (Lisiecki & Raymo, 2005)
5
-120
-60
0
3.1
Sea Level
LST
FSST
Pandora Fan Architecture
Based on core position
Septama & Bentley, 2010


0
120
Sea level
1
2
3
4
5
14
39
57
71
Age (KA)
19.495 Ka
31.243Ka
44. 122 Ka
10 m
100 m
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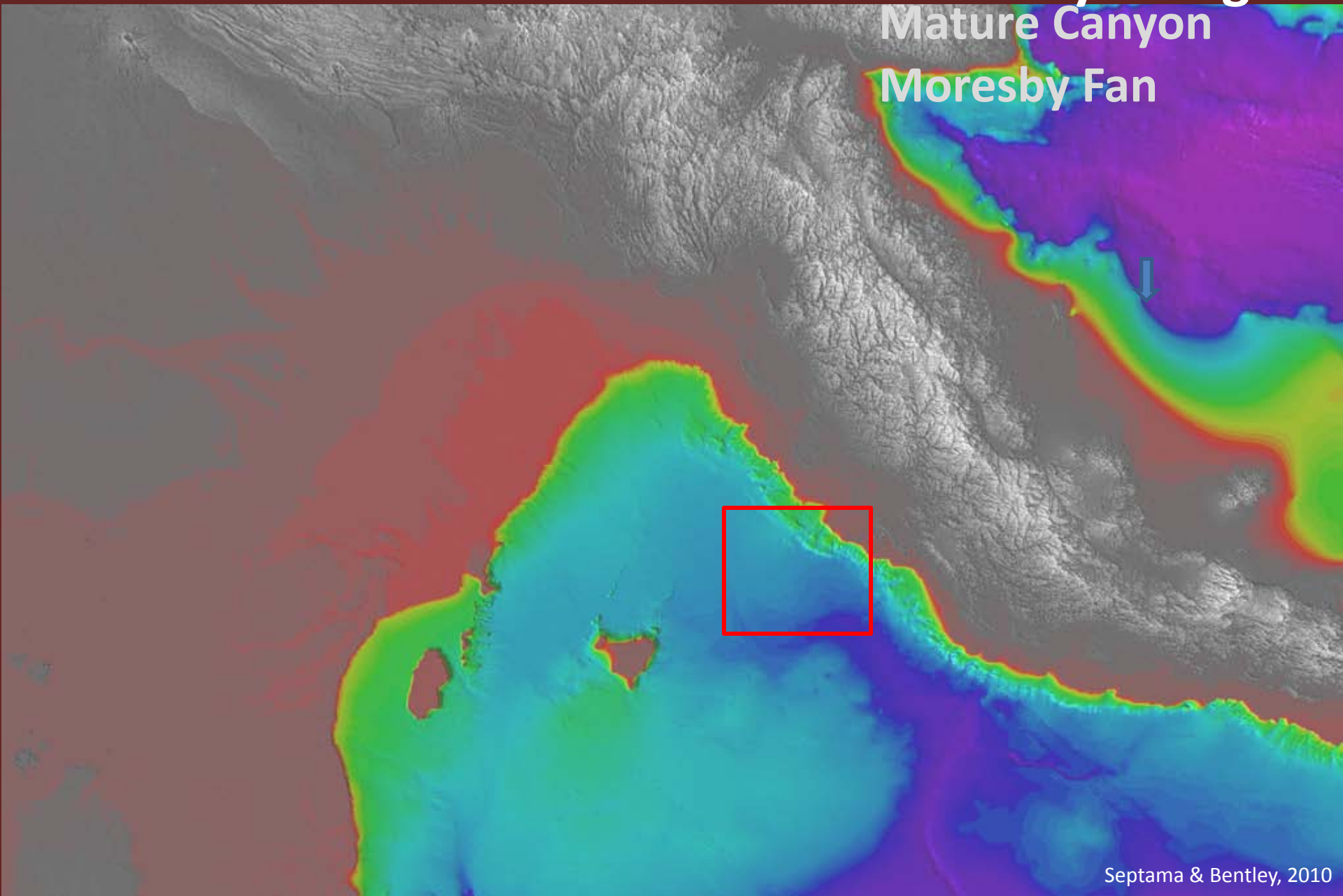
Moresby Trough



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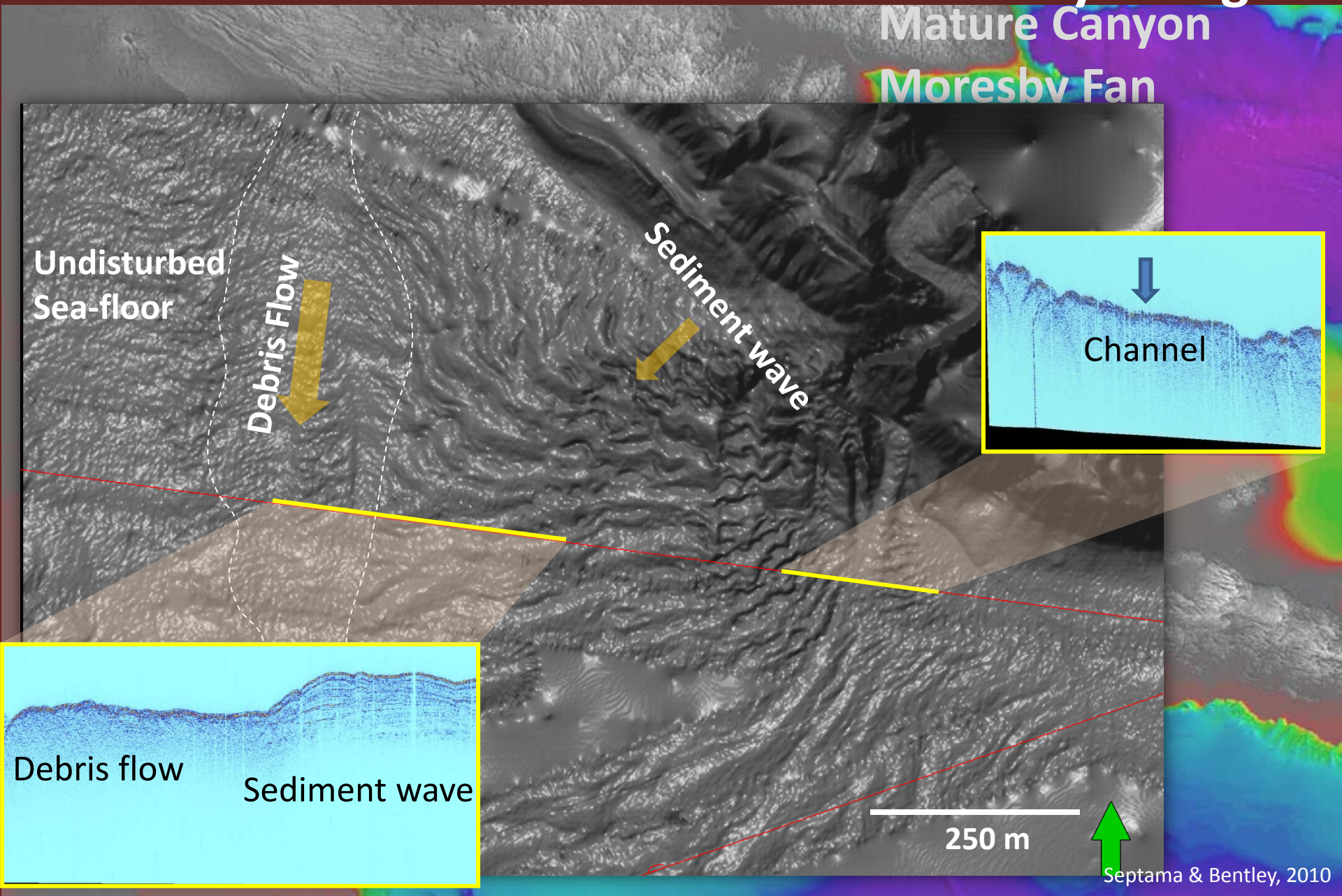
Moresby Trough



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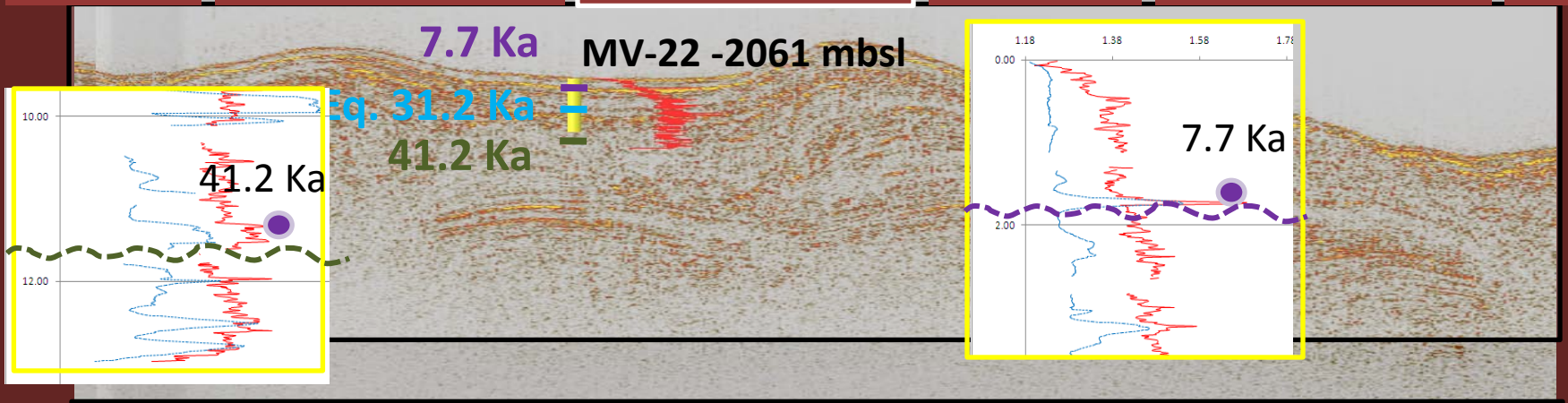
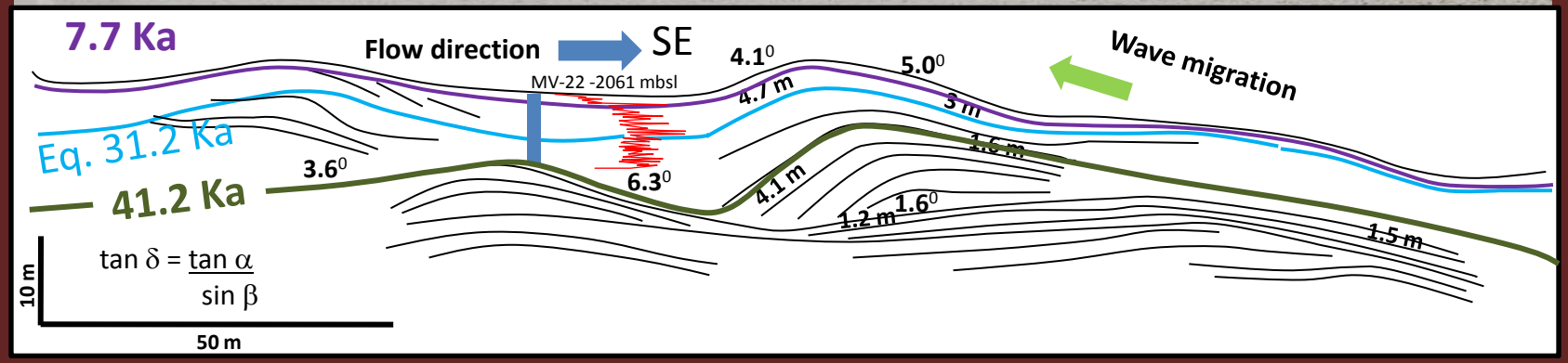
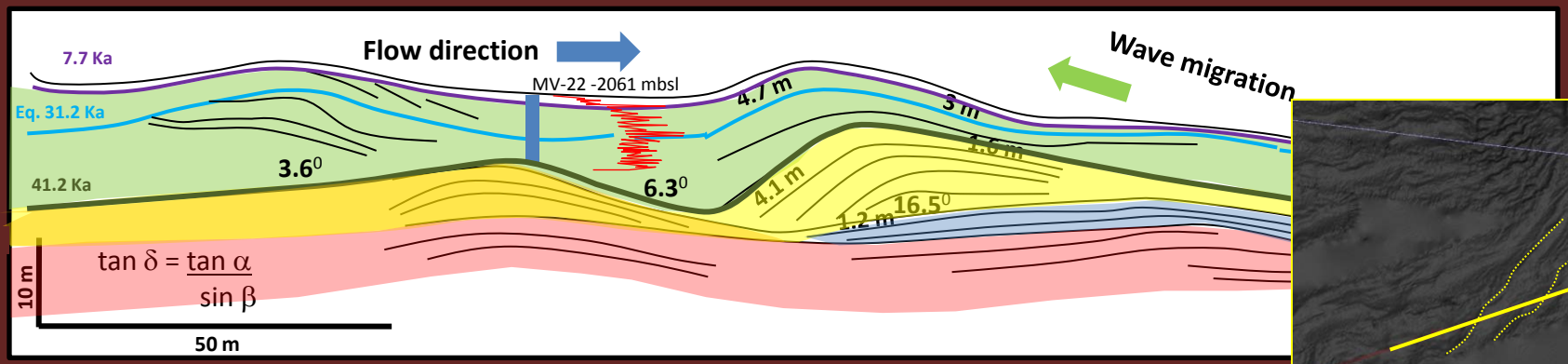
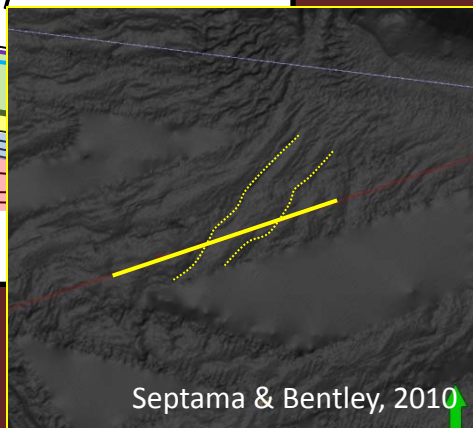
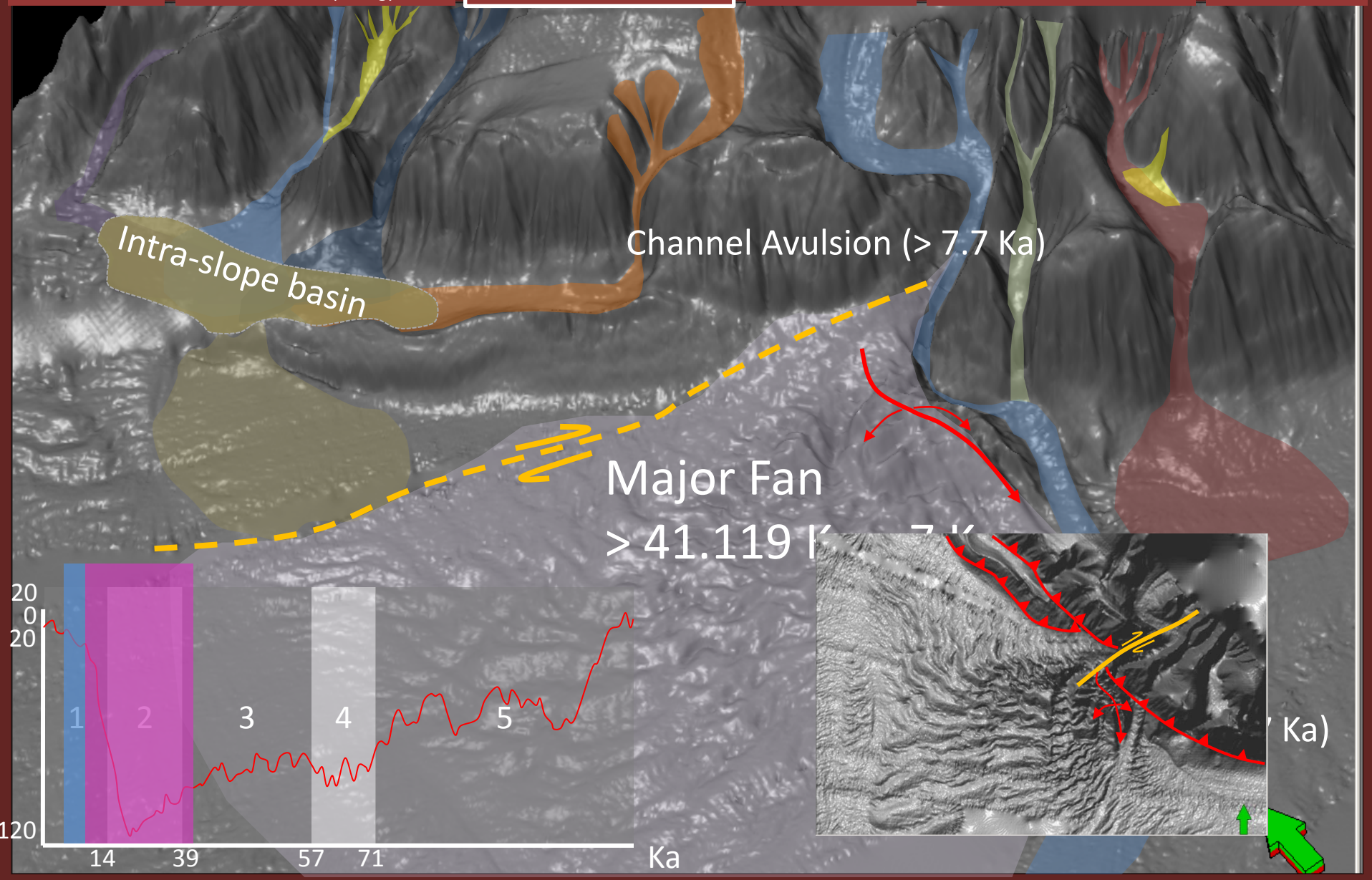








Moresby Fan Depositional Architecture



Moresby Trough- Fan Complex, View from SSW-ENE

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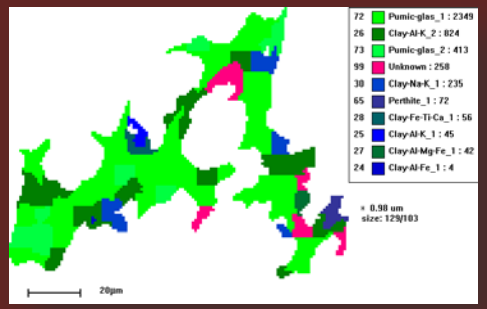

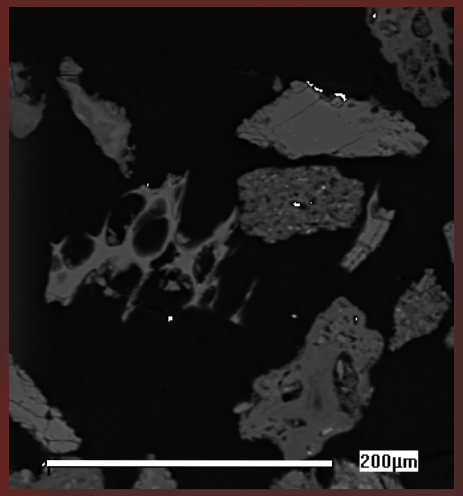

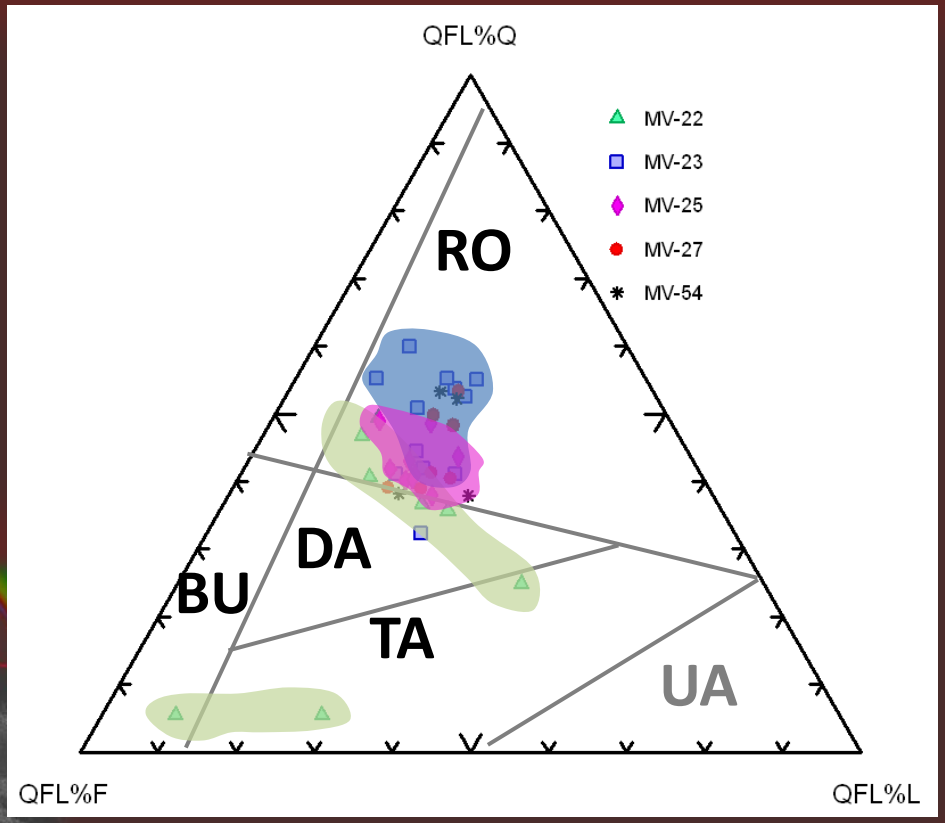

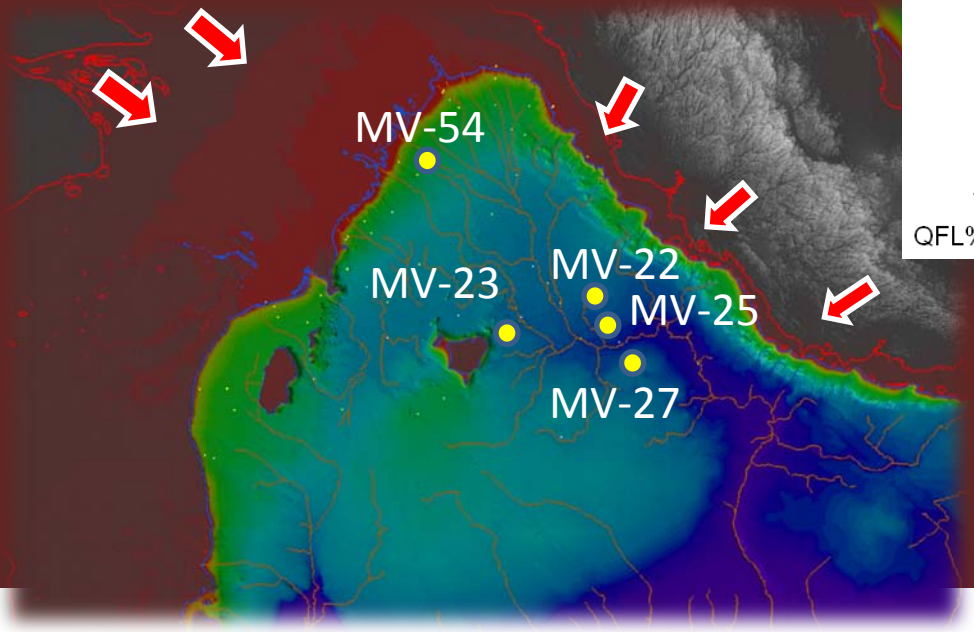

SEM-MLA, >62.5 micron

4000-6000 grains/sample

Altered minerals are excluded

Insight from sediment sources

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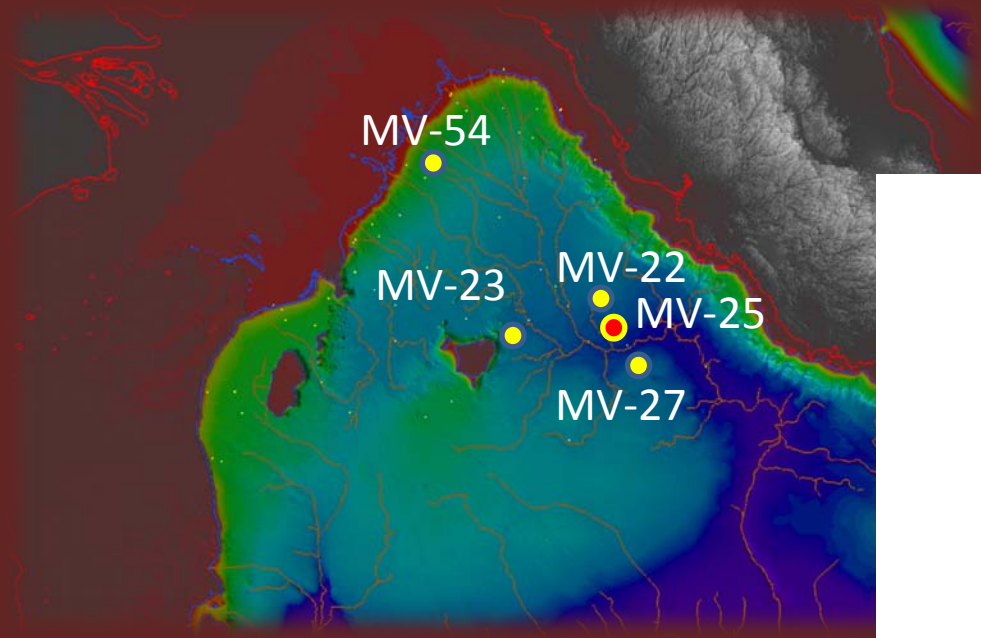
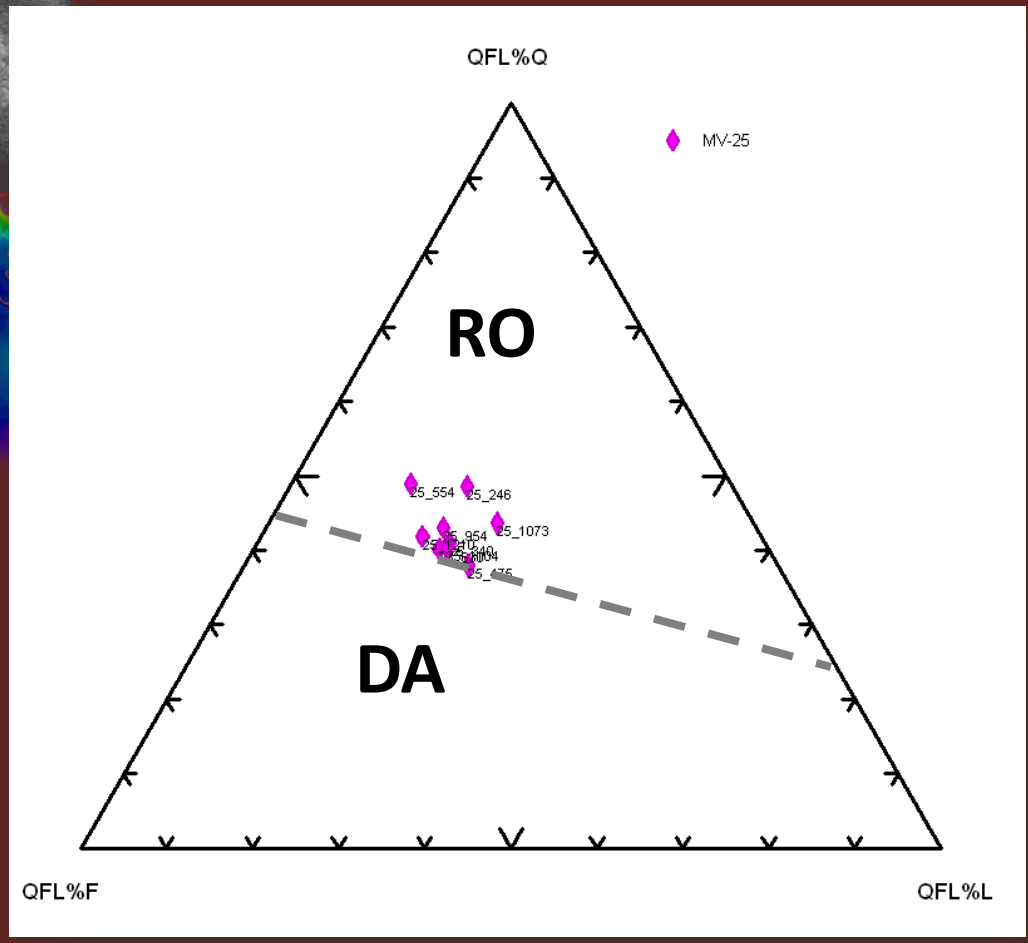


Homogeneous composition (Recycled Orogen)

Pristine Fan with single source



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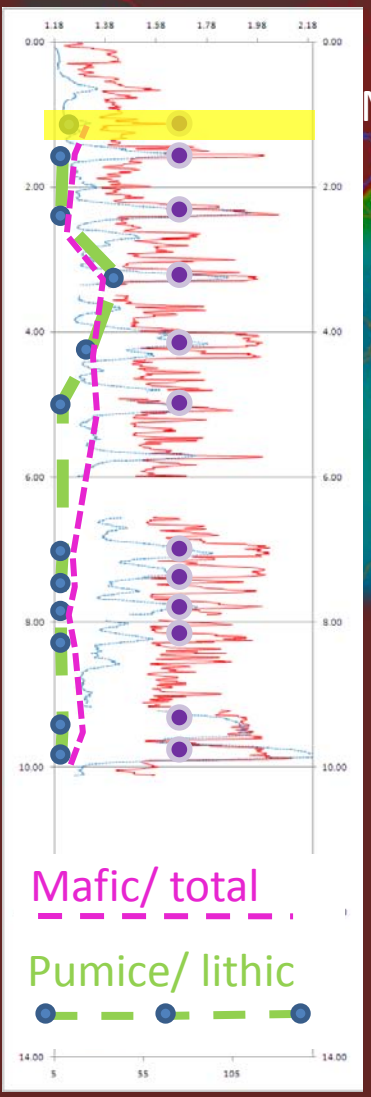

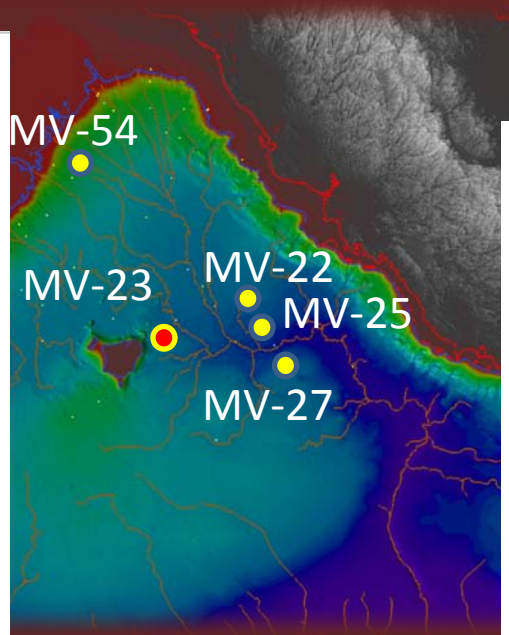

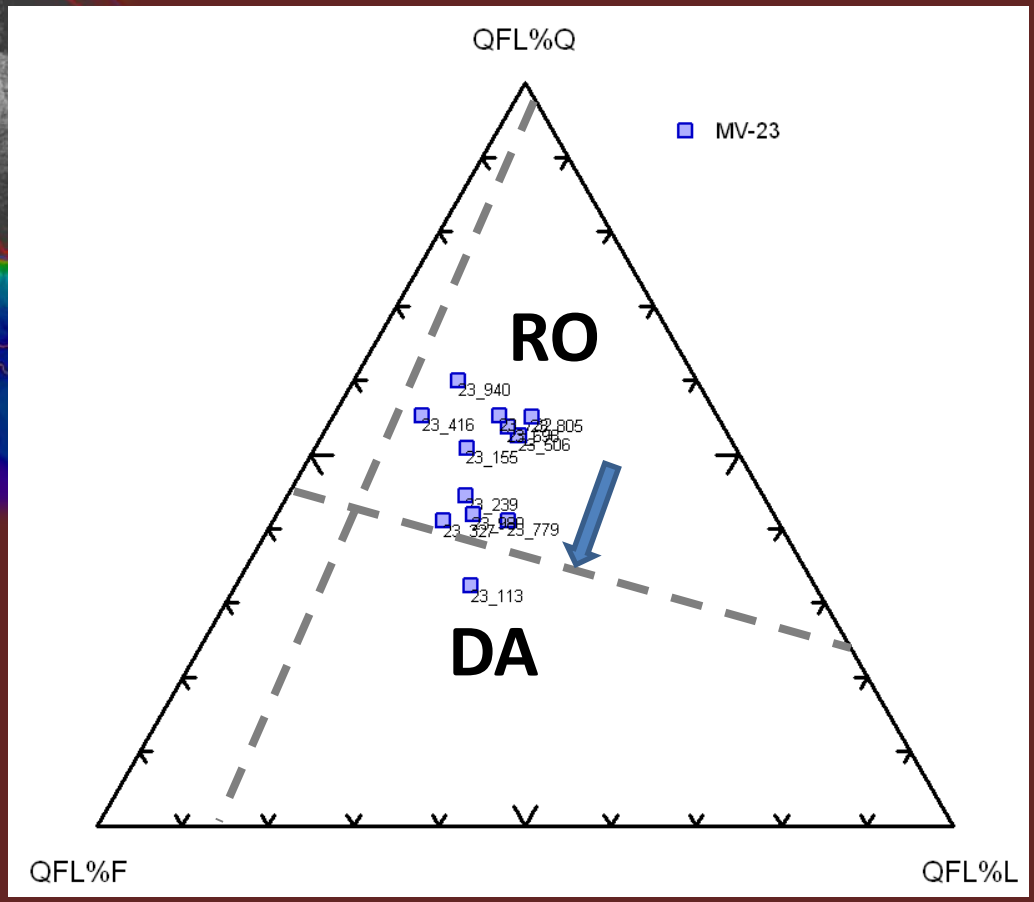

Decreased maturity upward

apparently single source except at 1.13 m

Most likely sources: shelfal shedding/reworking

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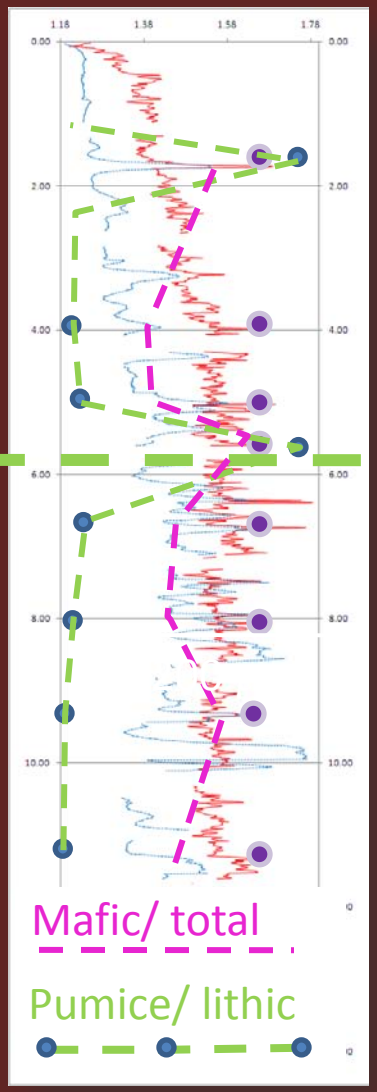
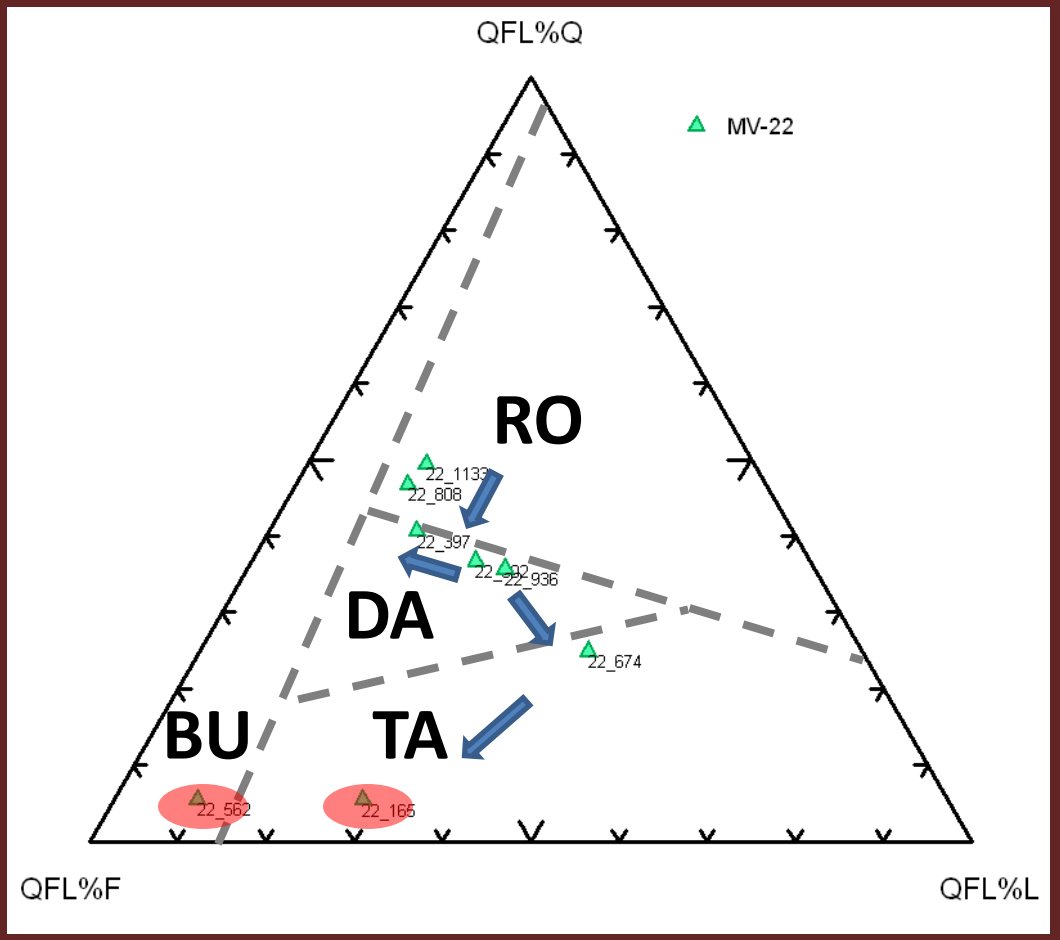


Sources contamination



Inconsistency in maturity trend

Pumice/total ratio suggests the feldspar enrichment from volcanic activity

Pumice ratio correlable with Mafic/total ratio : Mafic phenocryst associated with feldspar

Enrichment in felsic minerals 5.02 m upward suggest source mixing

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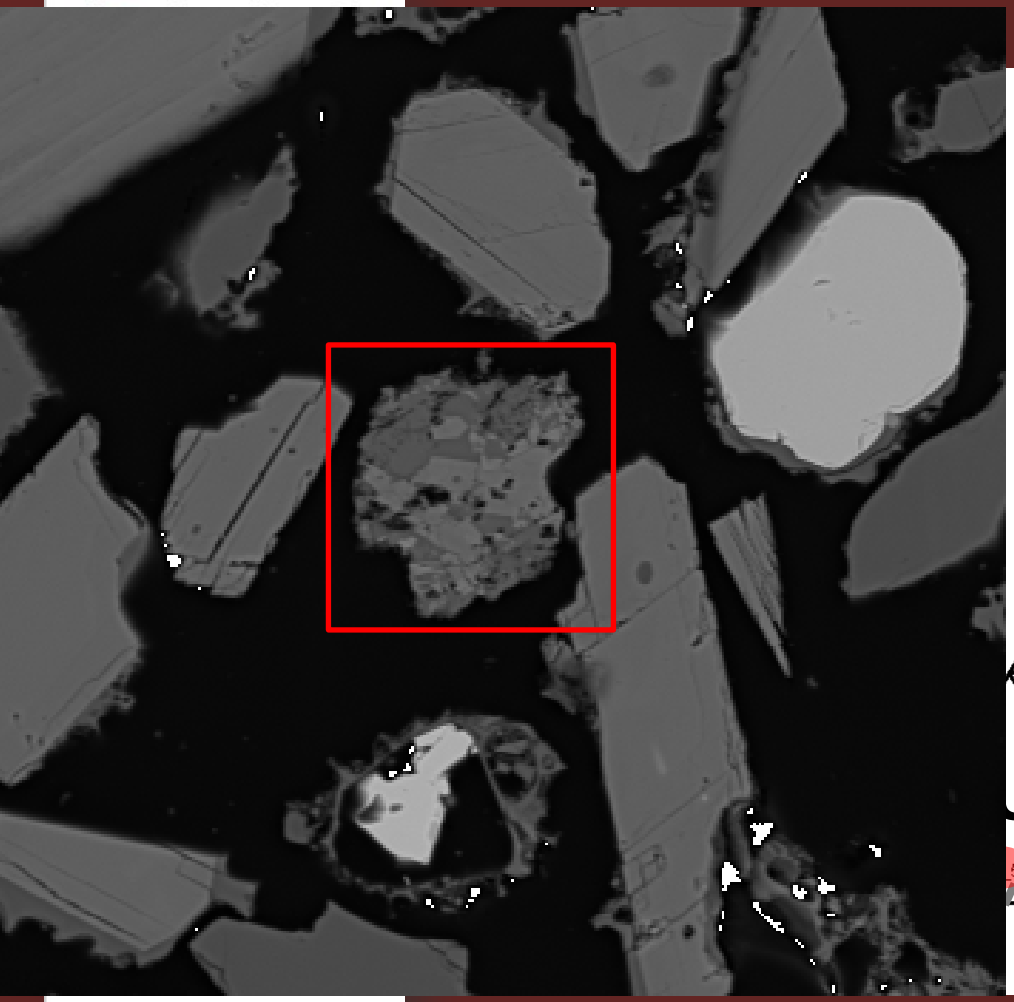

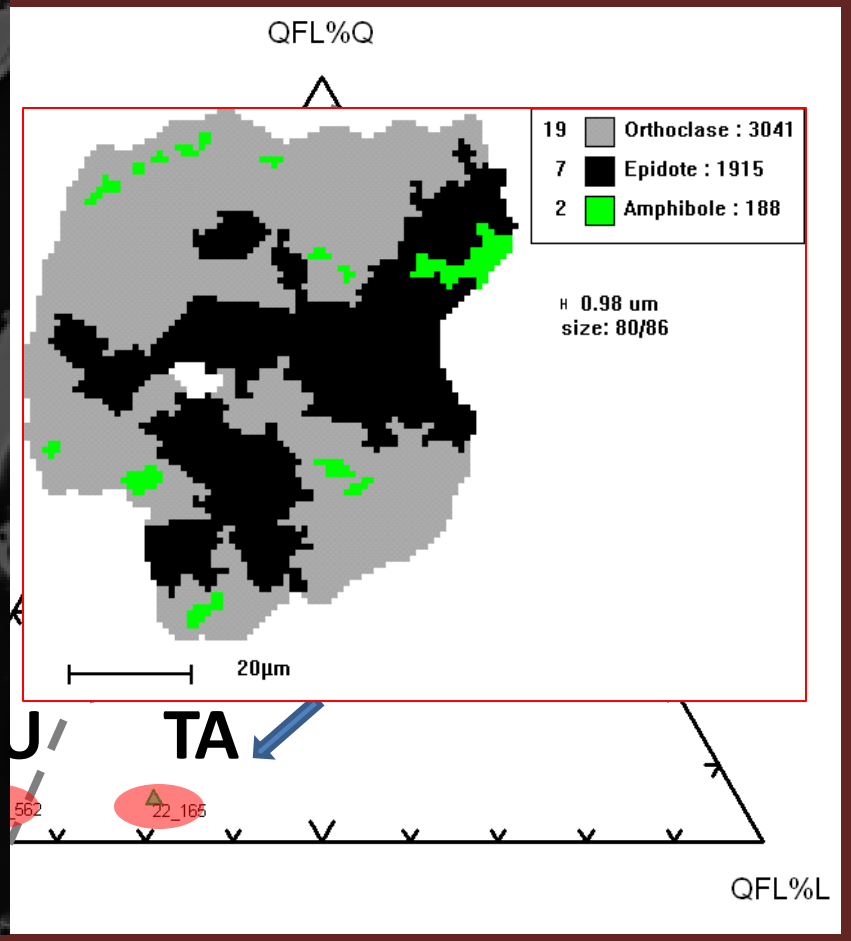

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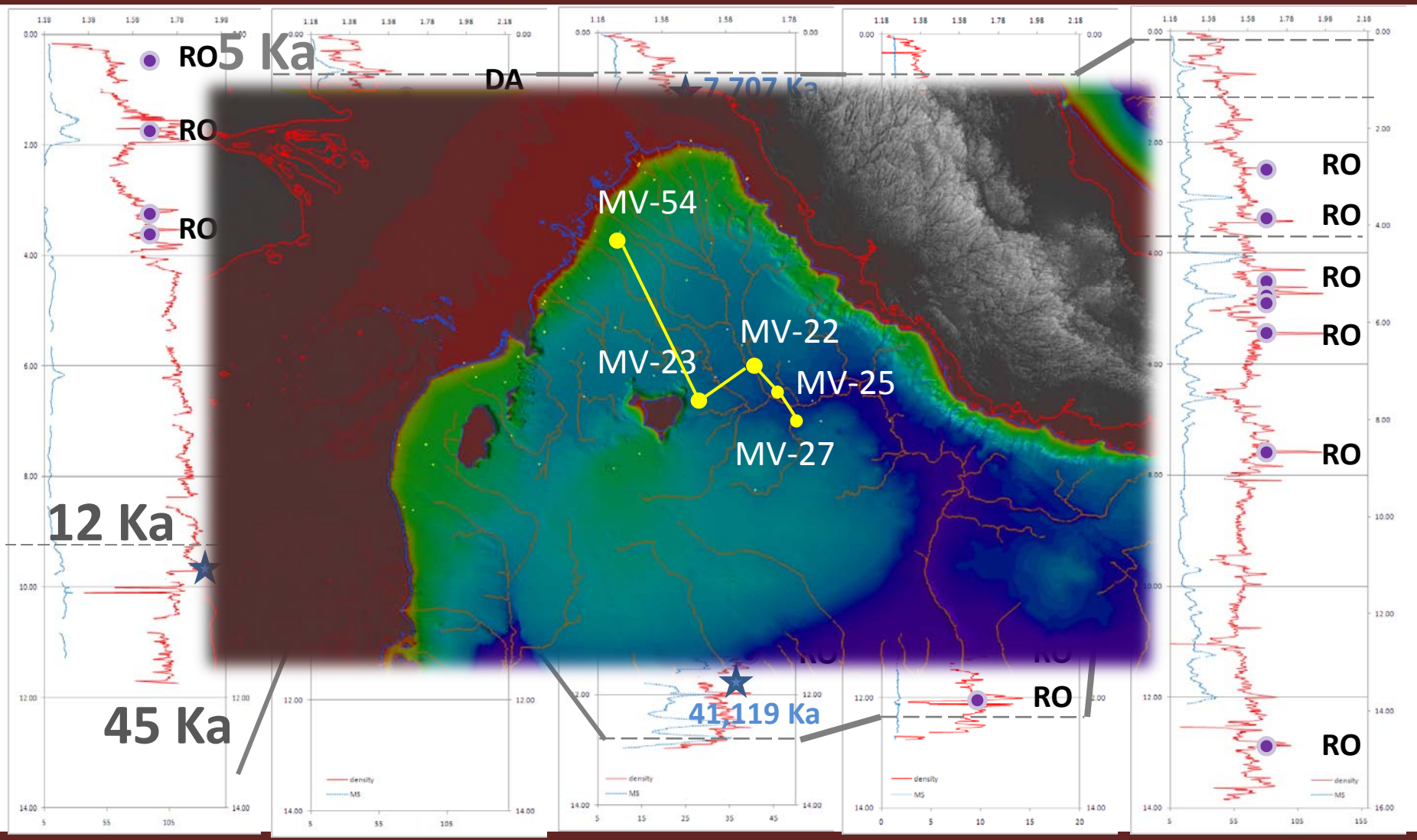

Pandora Trough (mid-slope – seafloor) | Moresby Fan | Moresby Canyon | Eastern Plateau

MV-54 (924 mbsl) | **MV-23** (2068 mbsl) | **MV-22** (2058 mbsl) | **MV-25** (2193 mbsl) | **MV-27** (2071 mbsl)

Reworks clinoform (?) | Channel | Highstand amalgamated fan | Volcanogenic Input

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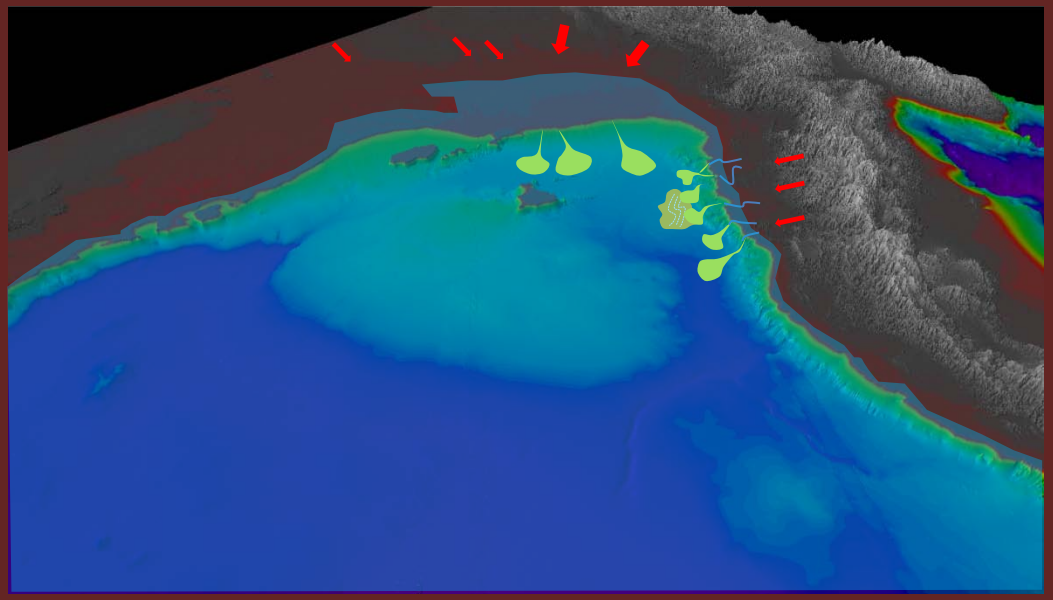
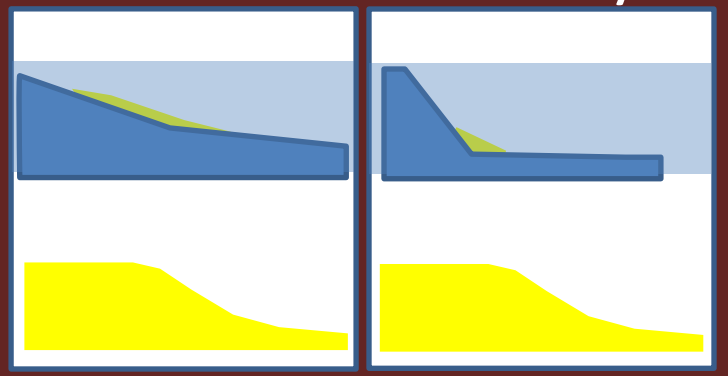
1st stage (44 -19 Ka)

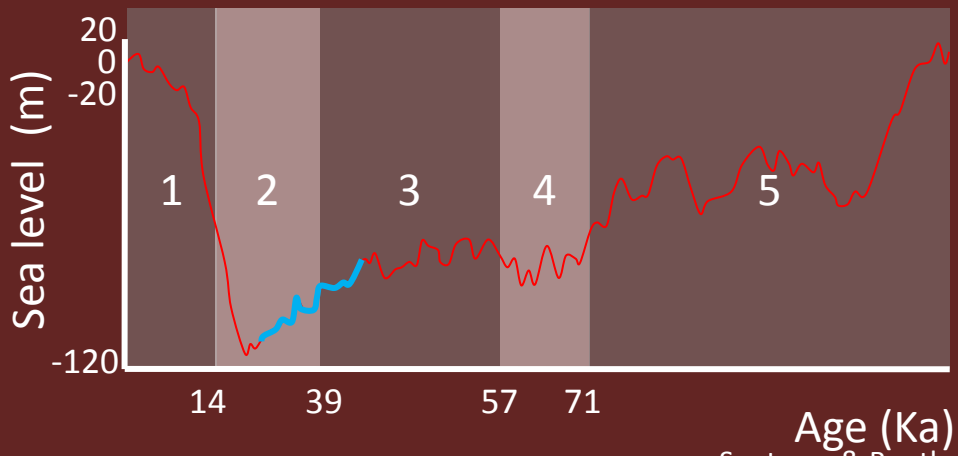


Pandora Moresby



Sea Level -80 to -100 m

- Fan development in toe of slope
- Single sources for both depocenters



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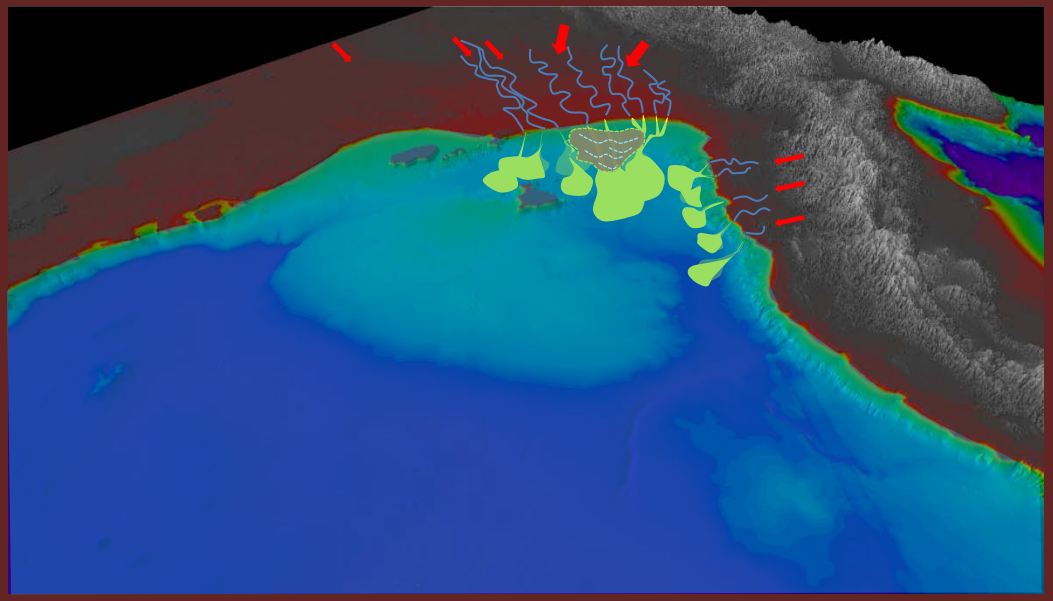
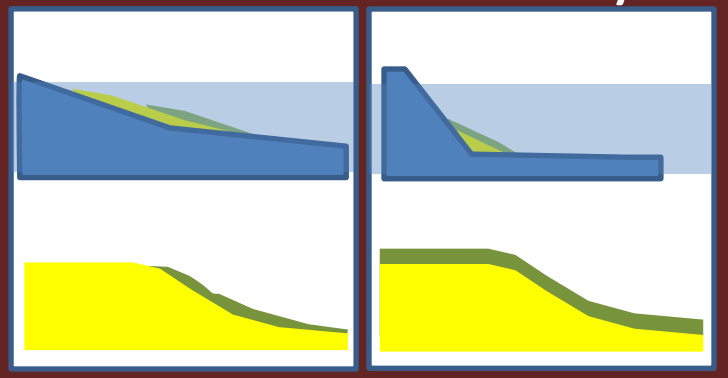
2nd stage (19 -17 Ka)

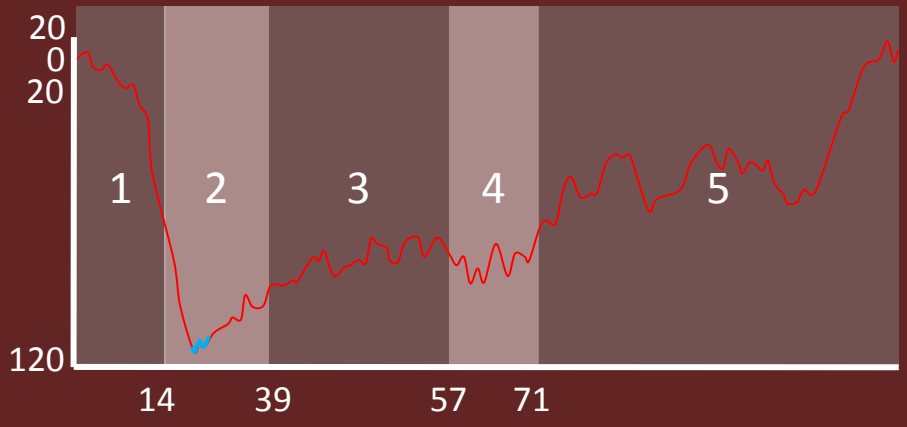


Pandora Moresby



Sea Level -100 to -120 m

- Peak fan deposition
- Shelf exposed and incised by river
- Single sources to fans
- Period ended by MTC in Pandora



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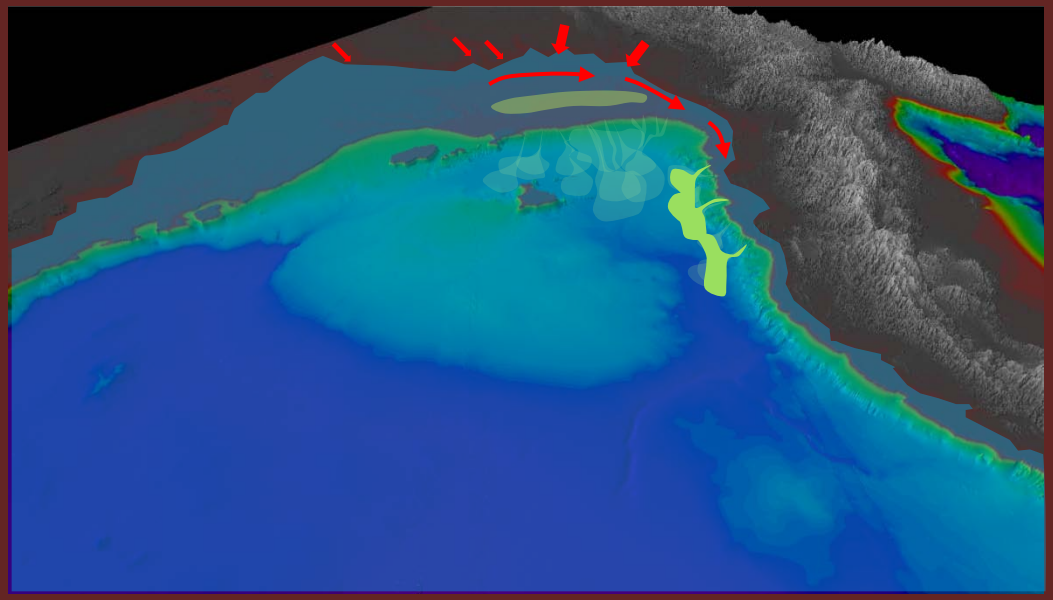
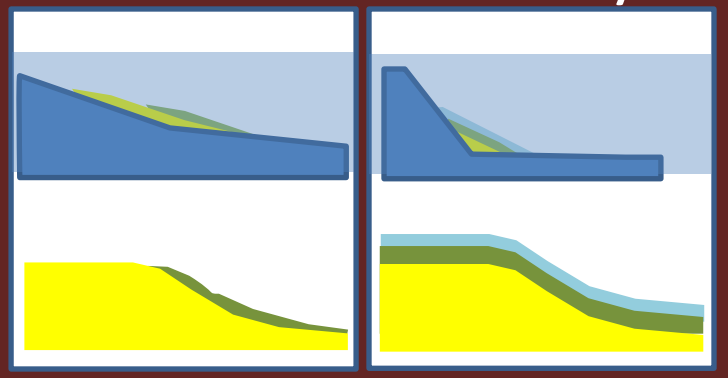
3rd stage (17 -7 Ka)



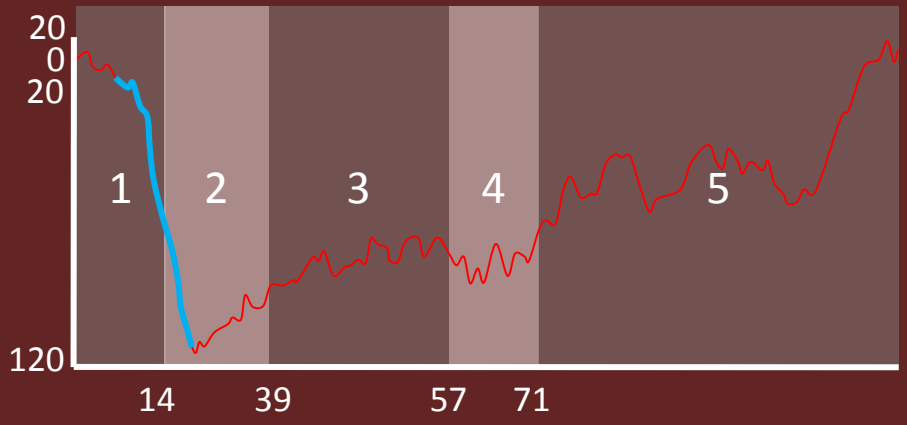
Pandora

Moresby



Sea Level -20 m

- Dormant Pandora Fan
- Multiple sources to Moresby Fan



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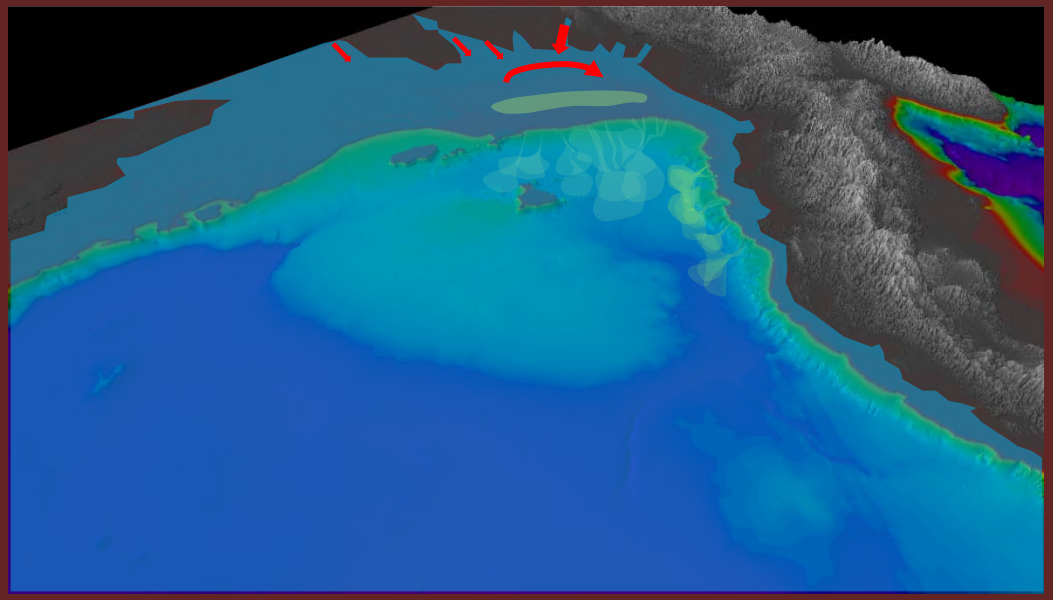
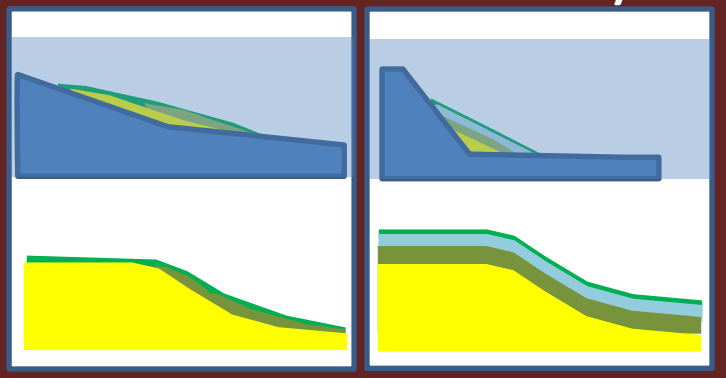
4th stage (7 Ka- present)

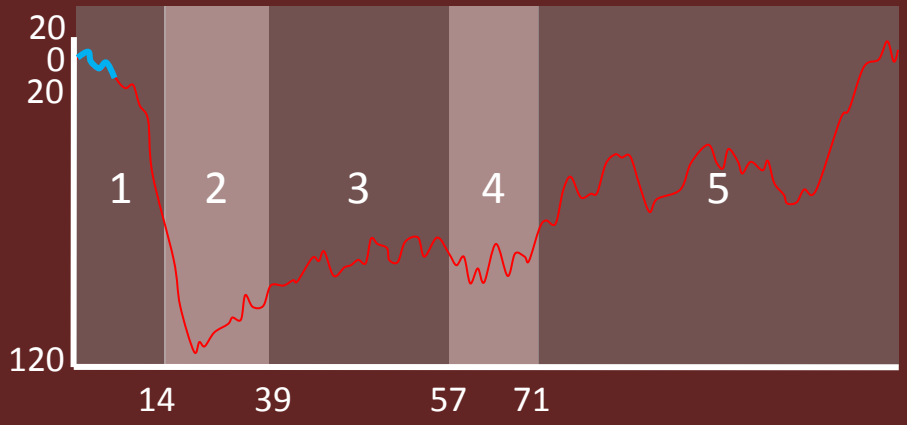


Pandora Moresby



Sea Level 0

- most sediment captured on the shelf
- Dormant Moresby Fan



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Summary

Pandora Trough:

- Feed by single source from Fly highland and Papuan mainland (relatively felsic composition).
- Fan development dormant since early sea level rise (17 Ka) (landward coastal migration and sediment trapping in shelf).
- Pandora slope degraded without any evidence of active channel fan system.

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Summary (continued)

Moresby Trough:

- Feed by single source (Papuan Peninsula) in Lowstand period continued with additional sources in transgressive period from Papuan Mainland and Fly Highland (44-7 Ka)
- The distance between river mouth and shelf-break is too short to provides an effective shelf trapping mechanism.
- Moresby fan avulsion due to local lateral faulting.
- The sediment supply ceased when most of the sediment trapped on the shelf

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Conclusion

- The **depositional style in GOP is** strongly controlled by:

Shelfal width – vicinity to sources – sediment flux and **oceanography**

- **Submarine fan** could developed in any system tract given the sources, shelf morphology and oceanographic processes provided.

- **Highstand** and/or **Transgressive Fan** could potentially create larger volume, more interconnected deposits compare to that of **Lowstand Fan.**

- Our model in **Moresby Fan** could be used as an analog for a depositional model in narrow shelf setting.

- **Implication to geoscience** : encouragement to re-visit and re-interpretation transgressive and highstand window to search for “forgotten” Fan

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Thank You

Acknowledgement:

- Ali Aksu, Rick Hiscott, George Jenner and Michael Shaffer of MUN

- NSERC-Discovery Grant to Sam Bentley

- NSF-Margins-S2S

- Pertamina-EP Indonesia

- Schlumberger Petrel