Towards the Development of an Integrated Central Atlantic Tectono-Stratigraphic Framework

Max Casson[1], Prof. Jonathan Redfern[1], Prof. Mads Huuse[1]
Jason Jeremiah[2], Dr. Luc Bulot[1], Dr. Gérôme Calves[3]

[1] University of Manchester, United Kingdom
[2] Golden Spike Geosolutions Ltd.
[3] University of Toulouse, France

Aims of Study

➢ *Define a new Central Atlantic stratigraphic framework*

- interpret regional sequence stratigraphic surfaces
- assess stratigraphic & geographical distribution of source rocks
- evidence for reservoir development

DSDP re-evaluation

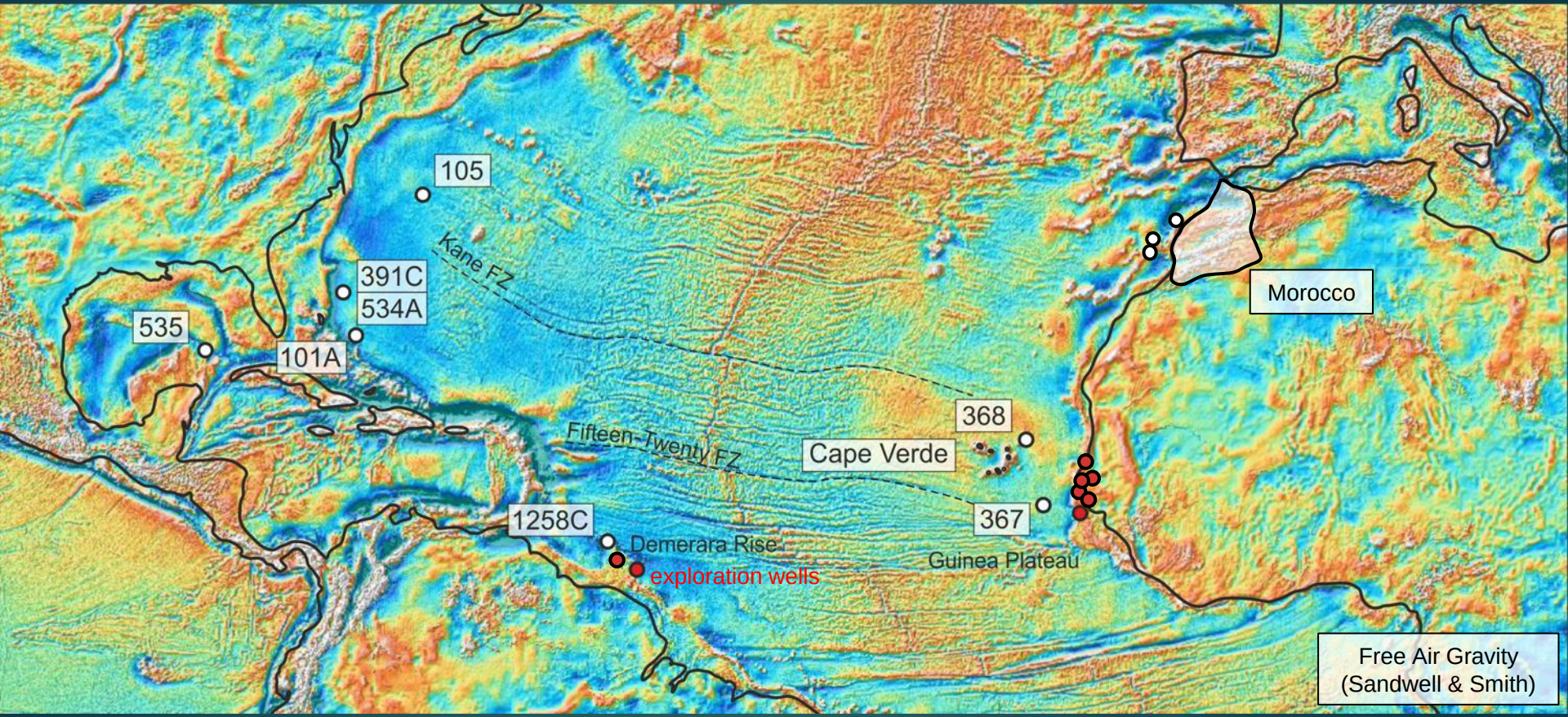
exploration wells

fieldwork

Holistic approach

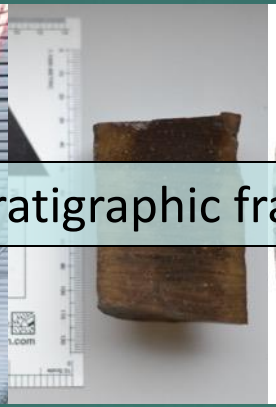
- ➢ Biostratigraphy
- ➢ Organic geochemistry
- ➢ Provenance
- ➢ Sedimentology
- ➢ Sequence stratigraphy

Database

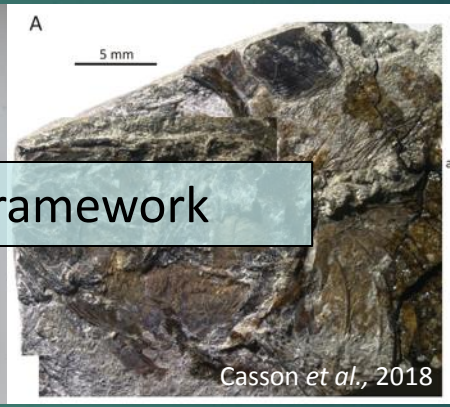

105
391C
534A
535
101A
Kane FZ
Fifteen-Twenty FZ
368
Cape Verde
367
1258C
Demerara Rise
exploration wells
Guinea Plateau
Morocco
Free Air Gravity
(Sandwell & Smith)

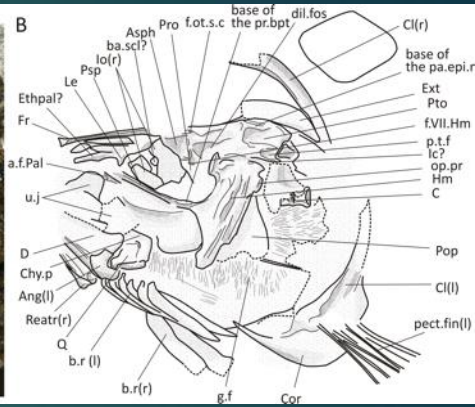
Endemic Zonation for the Central Atlantic

J/K Boundary
(Scotese, 2004)

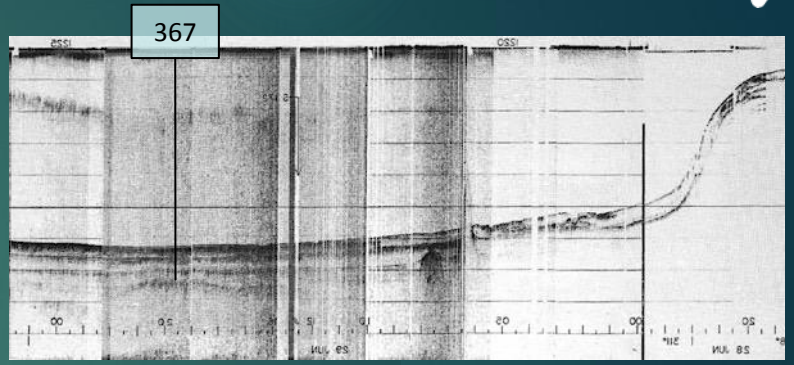


Stratigraphic framework





Key wells – DSDP Leg 41



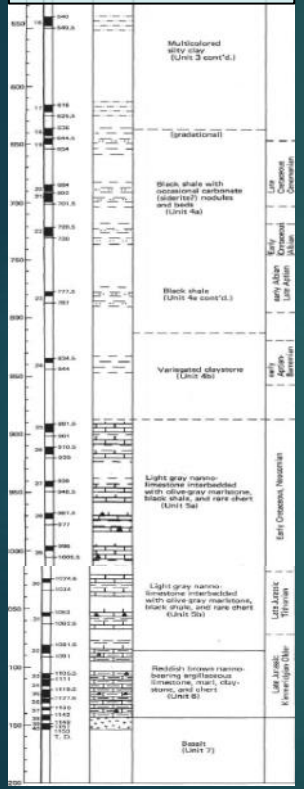
Lamont-Doherty VEMA 29 Seismic Profile (Lancelot *et al.,* 1976)

- 367 – full Mesozoic sequence penetrated, TD oceanic basement
- distal well tie in the basin
- difficult to correlate the stratigraphy onto the shelf due to **deep bank carbonate margin**

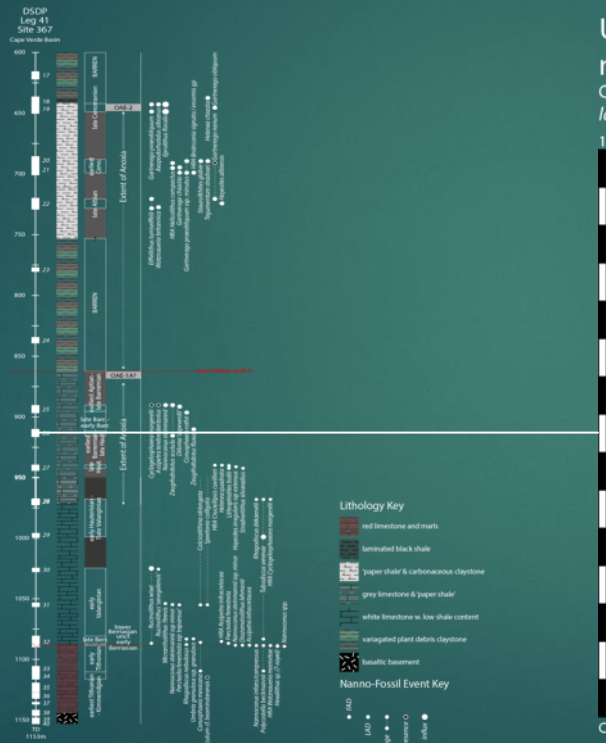
367: New Age Model

North Africa Research Group
www.narg.org.uk

Initial reports (Lancelot *et al.*, 1977)



NARG Model 2018



Example:
Previously – *early Cretaceous*

New – *early to late Barremian*

UNIT 5A: Light grey nanno-fossil limestone, olive marlstone and black shale

Core 25 through Core 27; 891.5 to 948.5m
late Hauterivian - earliest Aptian

Facies A
Light grey white massive limestone. Bioturbation present, organisms dragging *Facies D* into burrows. Occasional ripples at base of beds. Hard, slightly recrystalised. Calpionellids rare. Microsparite. Some microfractures filled with calcite.

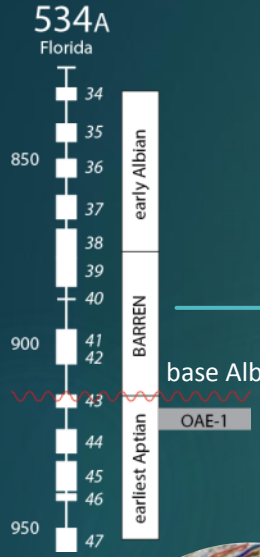
Facies B
Dark black carbonaceous shale, bituminous, gas-bearing and ignites.

Facies C
Olive light grey. Light grey clayey nanno-fossil marlstone. Fissile with abundant shelly debris on bedding planes. High nanno-fossil recovery. Aptychi present on bedding planes.

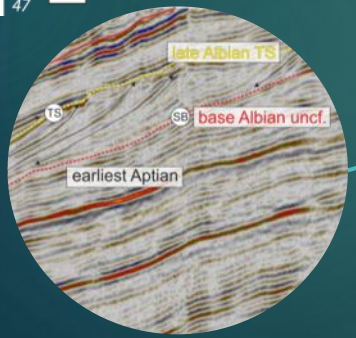
Av. TOC 5.6% — Max. 8.5% *n*=12 *

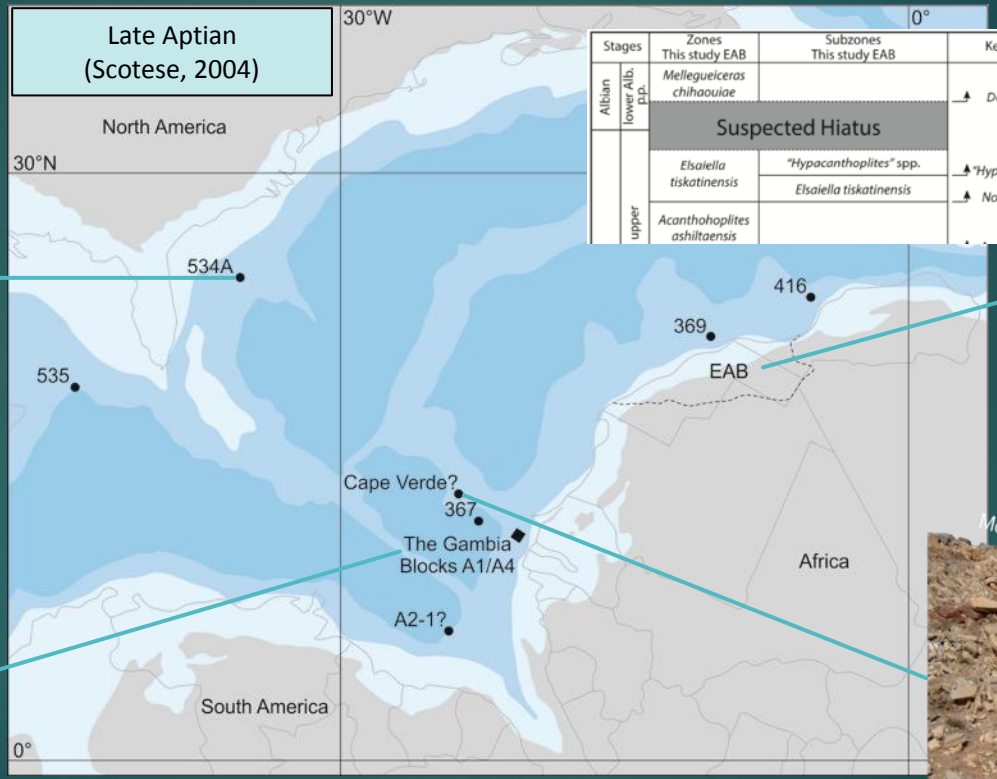
* of selected samples

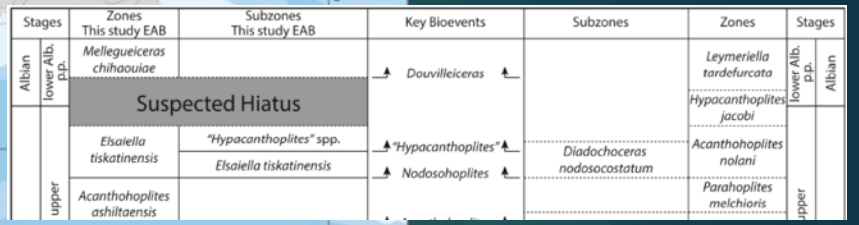
Extension to the Central Atlantic …



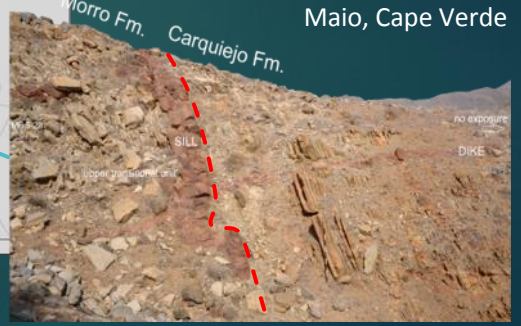
base Albian uncf.







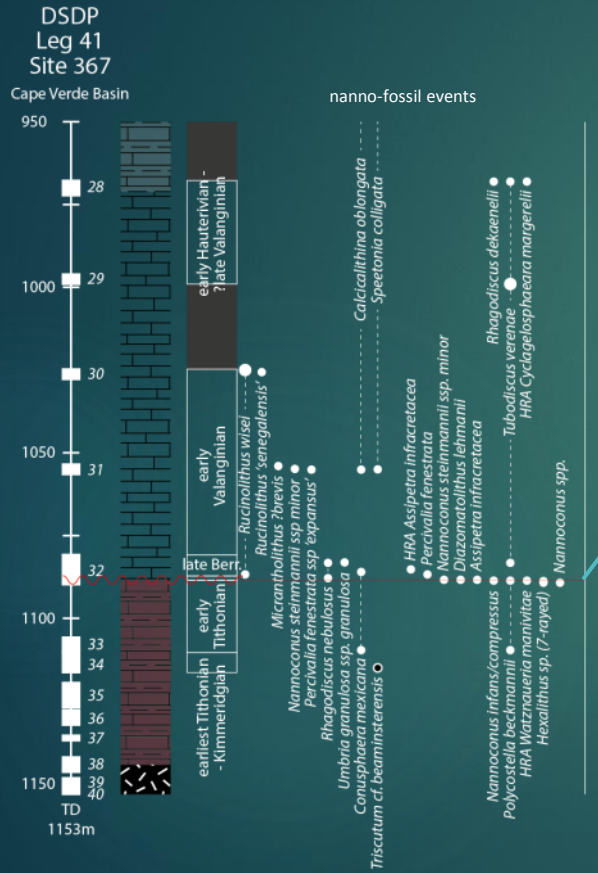
Essaouira Agadir Basin (EAB)
(Luber *et al.* 2017)



Maio, Cape Verde

Middle Berriasian Uncf.

North Africa Research Group
www.narg.org.uk



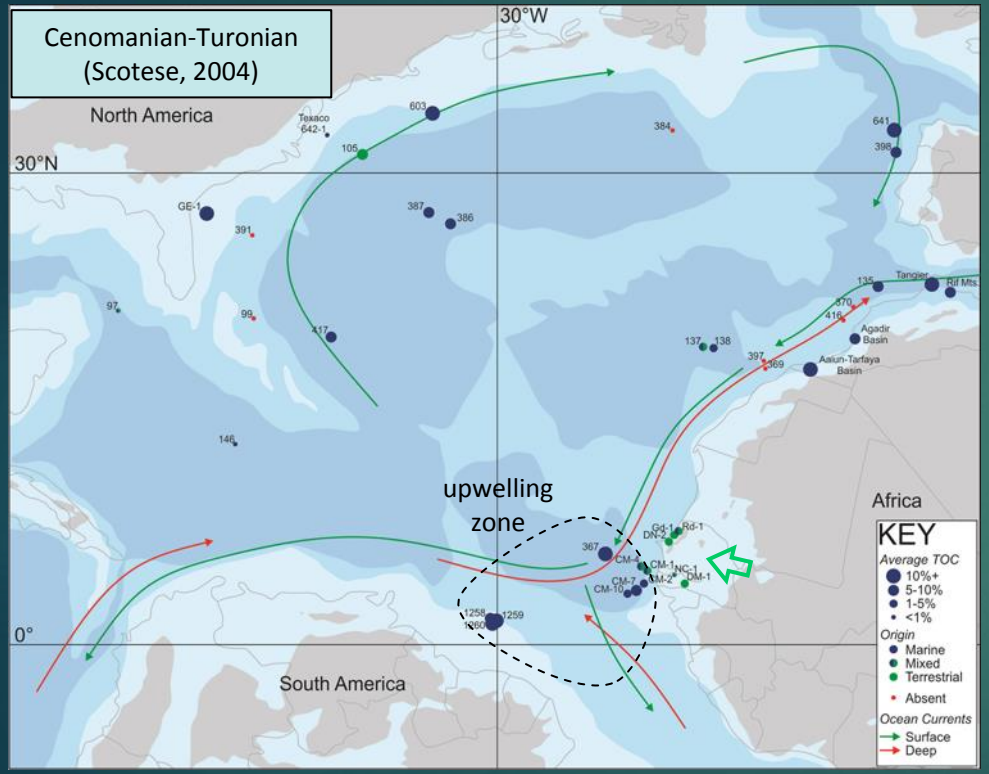
Leg 41 Site 367 Core 32-5

Unit 5B
Grey white nanno-fossil limestone, marl and chert
middle Berriasian to early Hauterivian

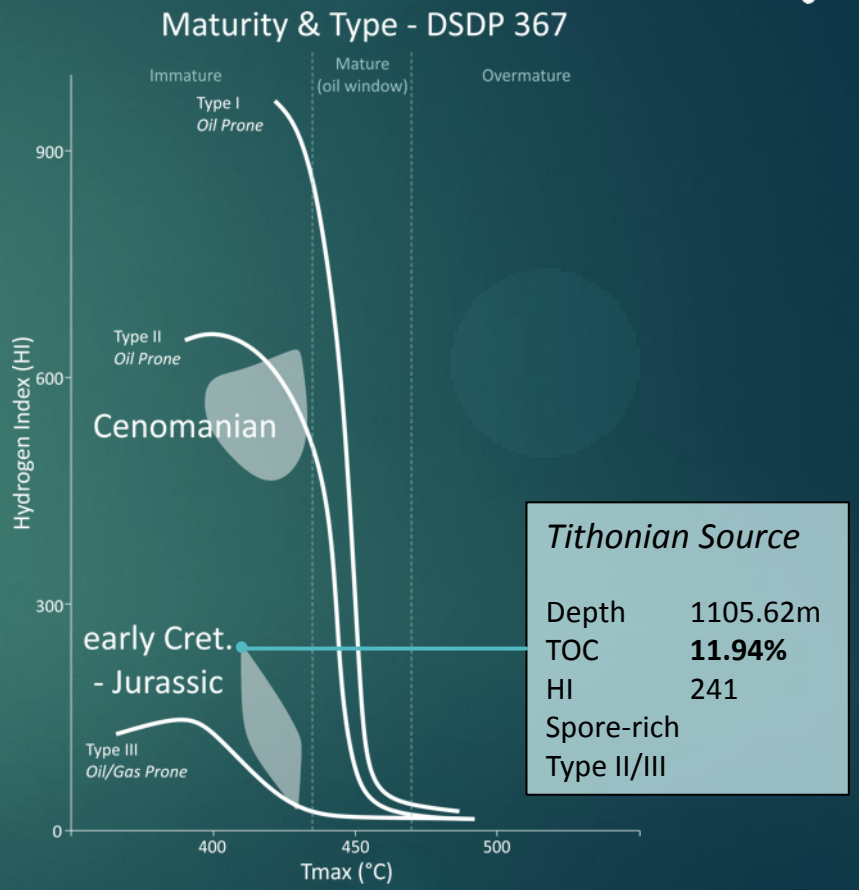
middle Berriasian unconformity

Unit 6
Reddish brown nanno-fossil bearing argillaceous limestone, marl, clays and chert
?Oxfordian to early Tithonian

Organic Geochemistry Results



TOC data (various sources); Ocean currents (Authur *et al.,* 1987)



Reservoir Distribution

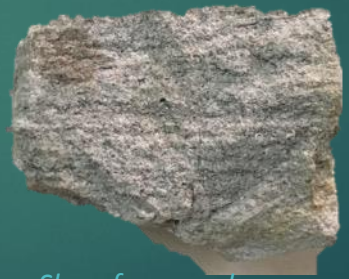
Albian Core Observations

1.

2.

Fluvial sands

(1) Asymmetric ripples in medium-to-fine-grained sandstone;
(2) Silty laminations and lag deposits; DL-1 Core 20

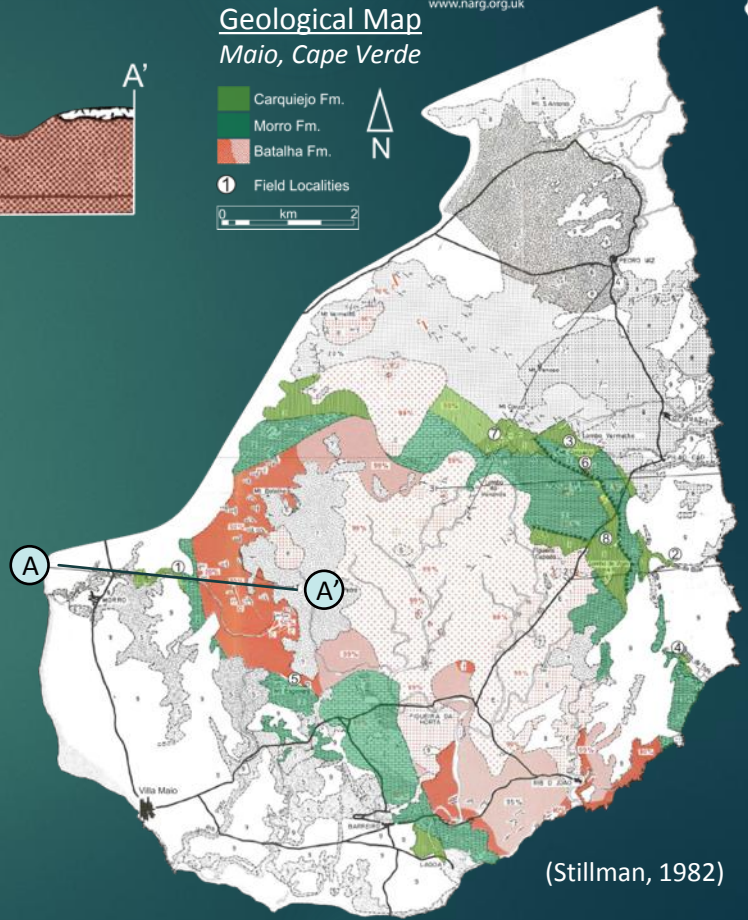


Shoreface sands

(3) Faint laminations, micaceous, fine-grained sandstone; Br-1 Core 22

Maio, Cape Verde

Geology



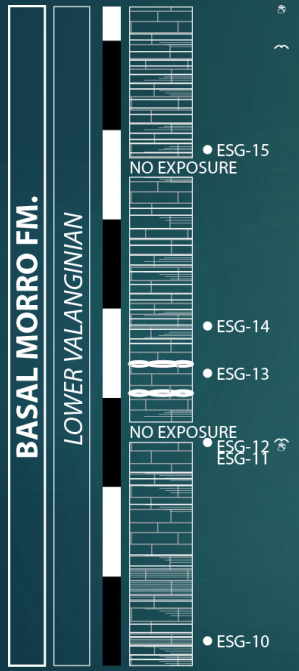
(Stillman, 1982)

Mt. Esgrovere – Basal Morro Fm.

ESG-3 – *Neolissoarus (Vergoligeras) sp. juv.*

ESG-9 – *Kilianella sp. juv*

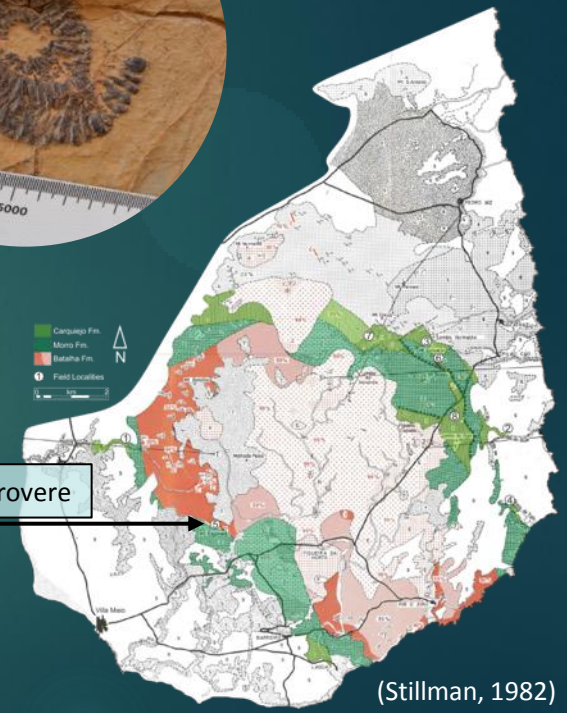
ESG-11 – Busnardoites sp. juv.



Mt. Esgrovere stratigraphy

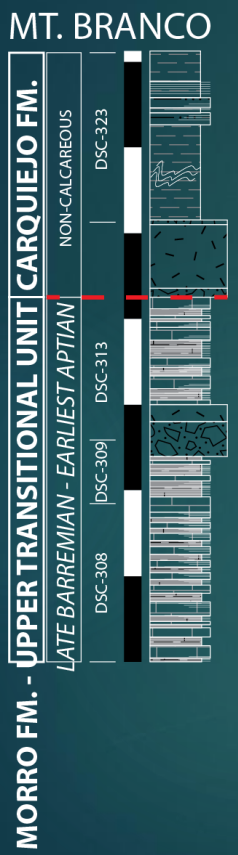
Mt. Esgrovere

Geological Map
Maio, Cape Verde



(Stillman, 1982)

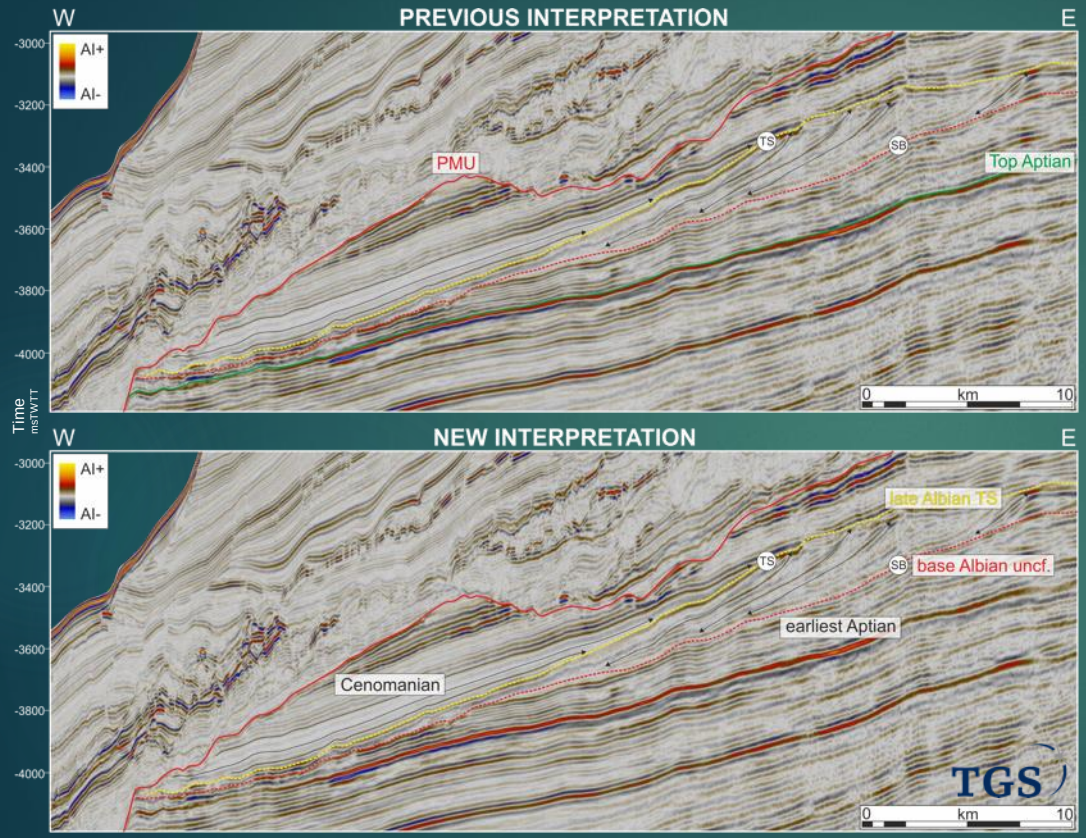
Reference section



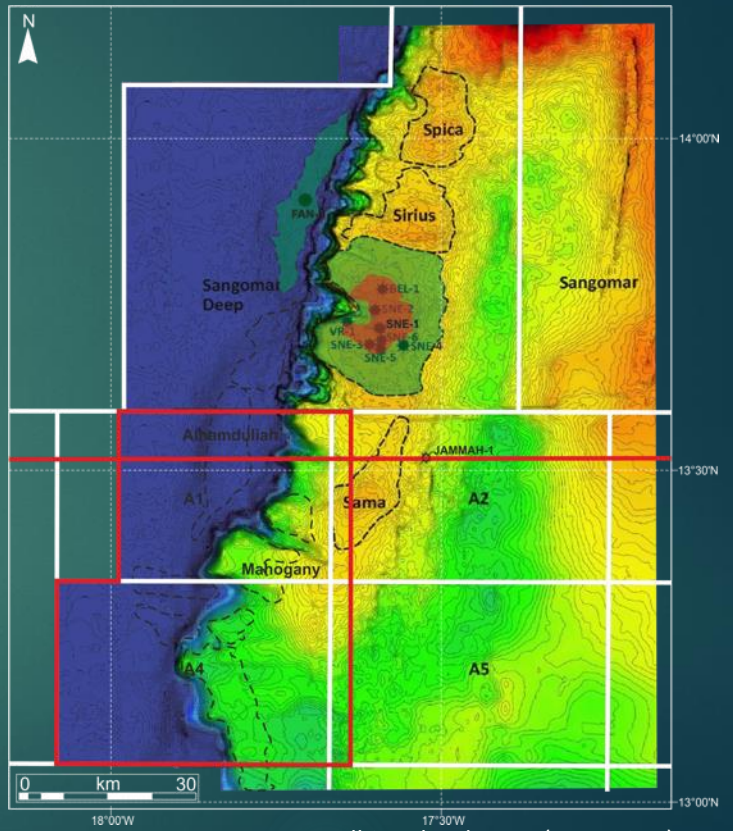
plant debris

- Morro Fm. – **carbonate**-dominated, thin-bedded limestones & marl
- Carquiejo Fm. – **siliciclastic**-dominated, distal mudstone turbidites

Application to Seismic Dataset

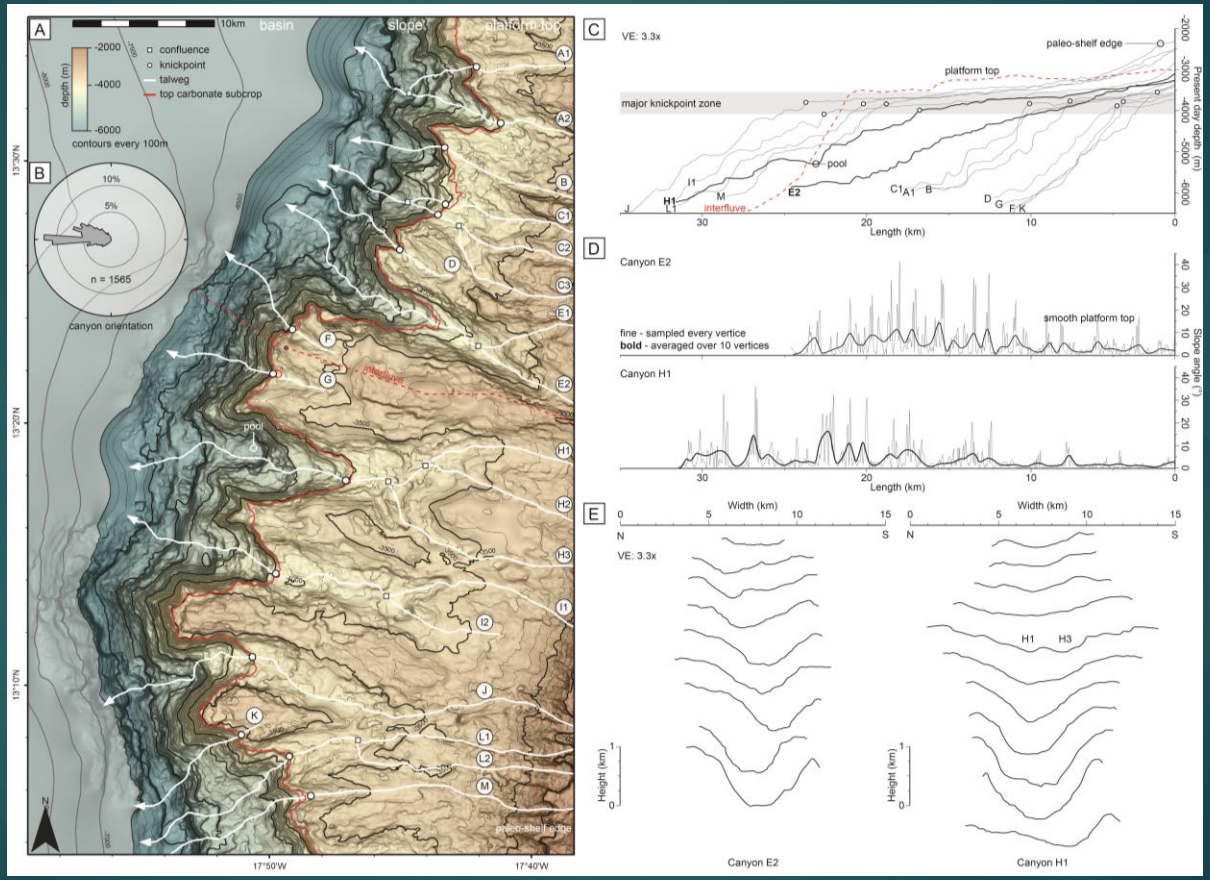


Courtesy of TGS, The Gambia Blocks A1/A4



Top Albian depth map (FAR, 2017)

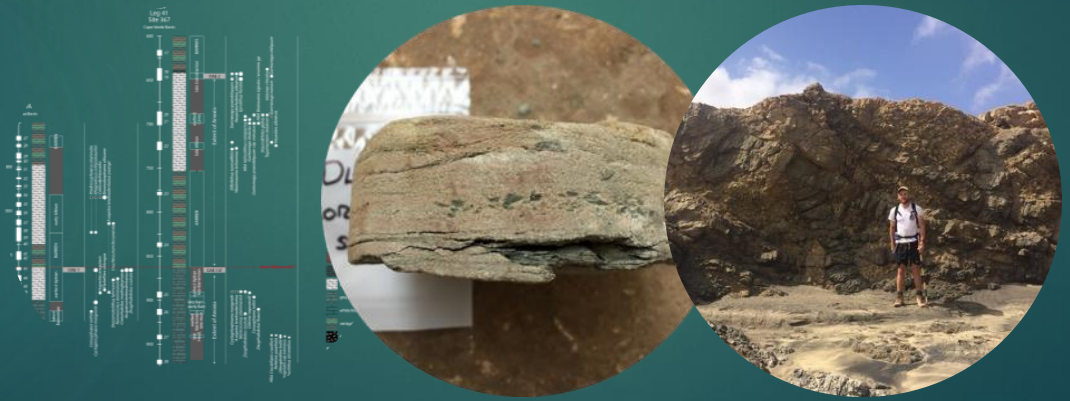
Application to Seismic Dataset



Conclusions

North Africa Research Group
www.narg.org.uk

- Central Atlantic shows clear endemism, requiring its own stratigraphic zonation
- Morocco outcrops onshore offer type sections – this study extends to the MSGBC offshore and conjugates
- 2 key unconformities recognised and constrained with new high resolution biostratigraphy
- identified potential Jurassic source
- future provenance and low-T geochronology will allow refined reservoir distribution models
- application to conjugate margin exploration



References

AUTHUR et al. (1984) Models for the deposition of Mesozoic-Cenozoic fine-grained organic-carbon-rich sediment in the deep sea. Geological Society London, Special Publications, 15, pp. 527 – 600.

CASSON et al. (2018) Fishing in the Central Atlantic, an earliest Cenomanian ichthyodectiform from DSDP Site 367, Cape Verde Basin. Journal of Vertebrate Paleontology, *in press*.

FAR (2017) Investor presentation: Credit Suisse 4th Annual Austrailian Energy Conference.

LANCELOT, Y., et al. (1977) The evolution of the central Northeastern Atlantic – summary of results of DSDP Leg 41 site 367: Cape Verde Basin. In: Y. Lancelot, E. Seibold et al., Initial Reports of the DSDP, 41, U.S. Government Printing Office, Washington, D.C., pp. 1215 – 1245.

LAWRENCE, S. (2017) Maio chrono-stratigraphy, *per comms*.

LUBER, T.L., et al. (2017) A revised ammonoid biostratigraphy for the Aptian of NW Africa: Essaouira-Agadir Basin, Morocco. Journal of Cretaceous Research.

SCOTESE, C.R. (2004) PALEOMAP PaleoAtlas for Gplates And The PaleoData Plotter Program, PALEOMAP Project.

STILLMAN. C.J., et al. (1982) The geological history of Maio, Cape Verde Islands. Journal of the Geological Society, 139, pp. 347 – 369.

Contact - max.casson@manchester.ac.uk

NARG Sponsors