Paleoenvironments and Organic Geochemical Evaluation of the Cenomanian to Coniacian Afowo Formation in the Dahomey Basin, Nigeria.

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1. Introduction
2. Objectives of the Study
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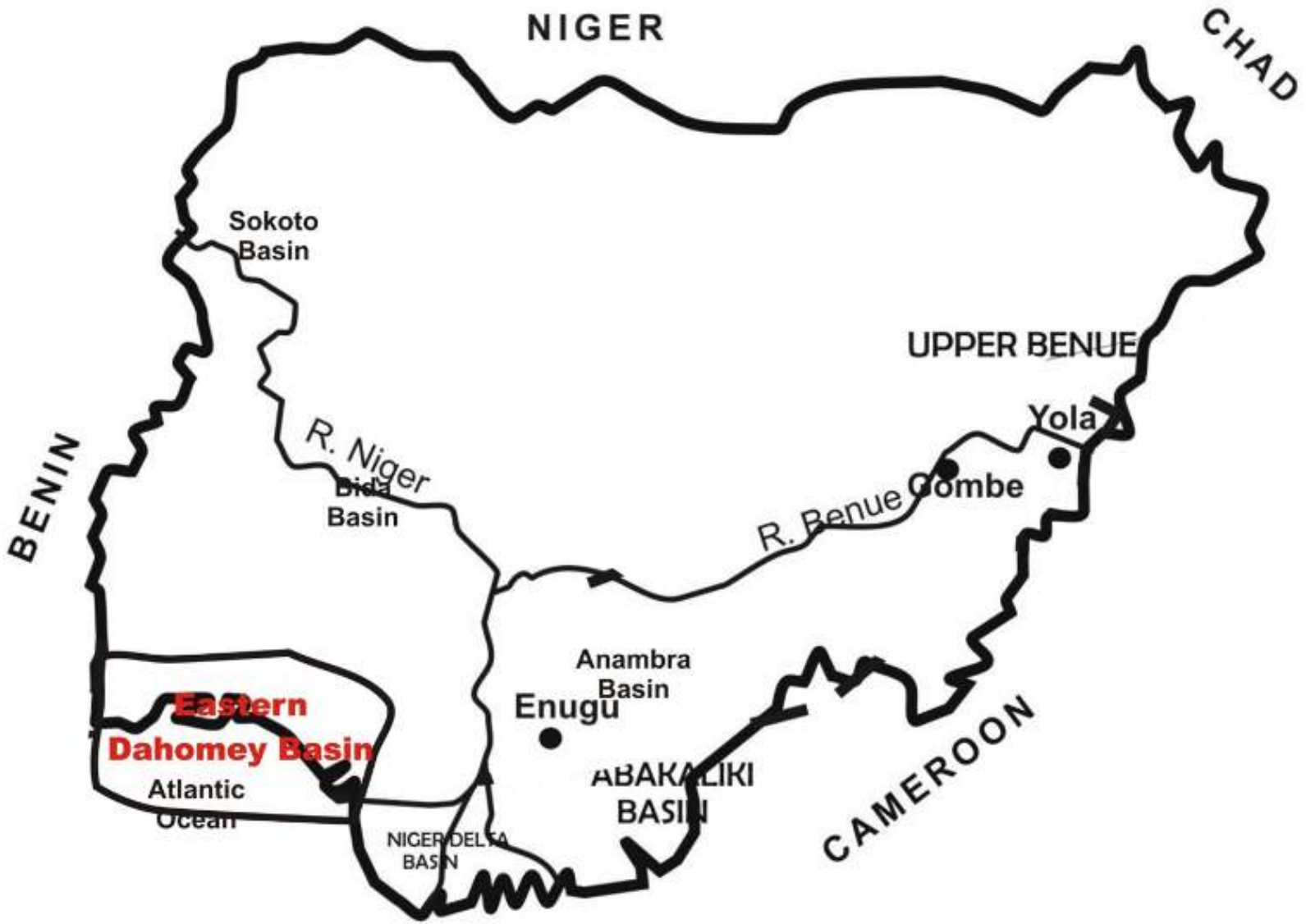


Map of Nigeria

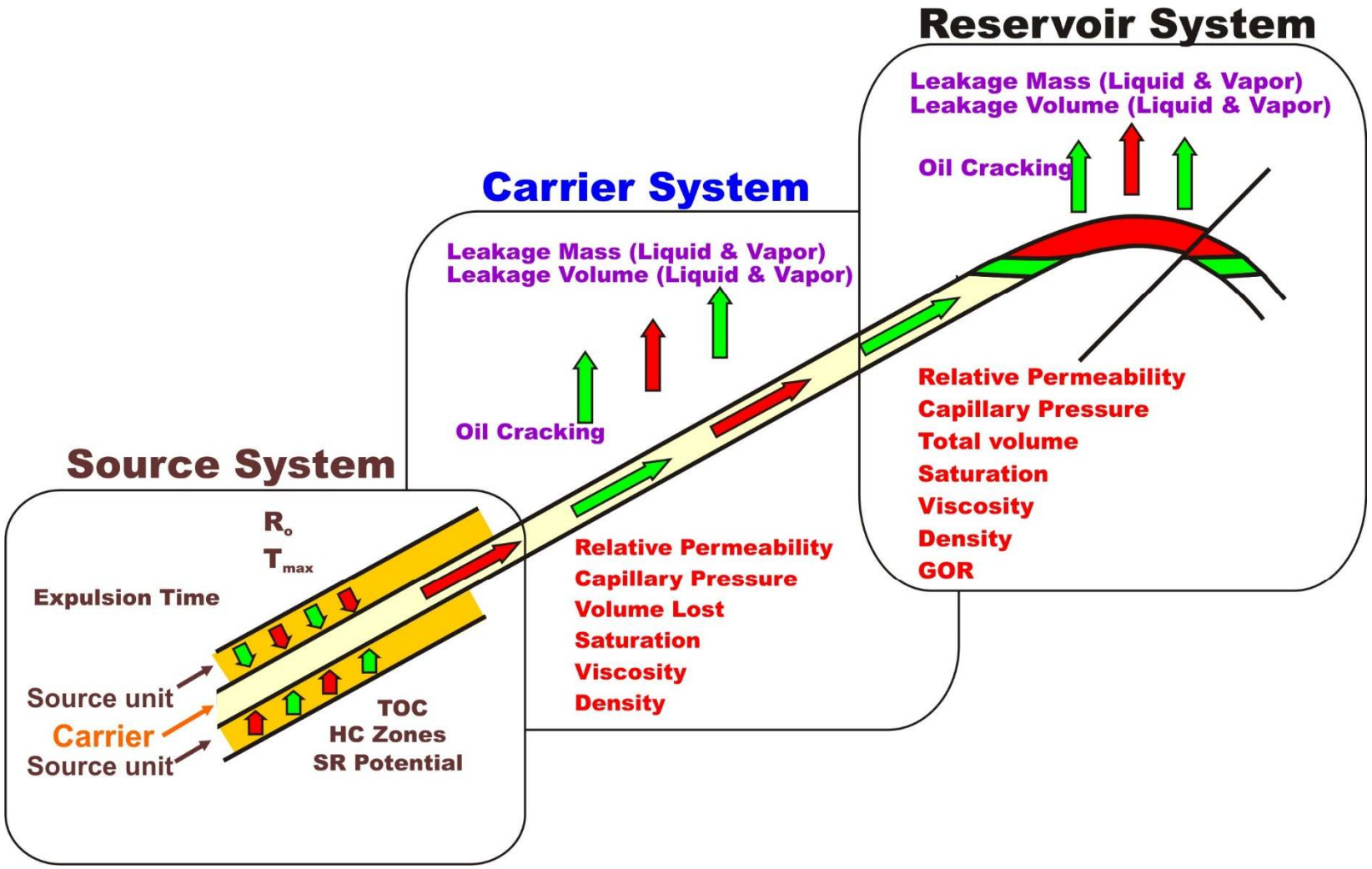
Goal and Objectives of the Study

Goal: To identify potential Cretaceous petroleum system source rock within the Dahomey Basin

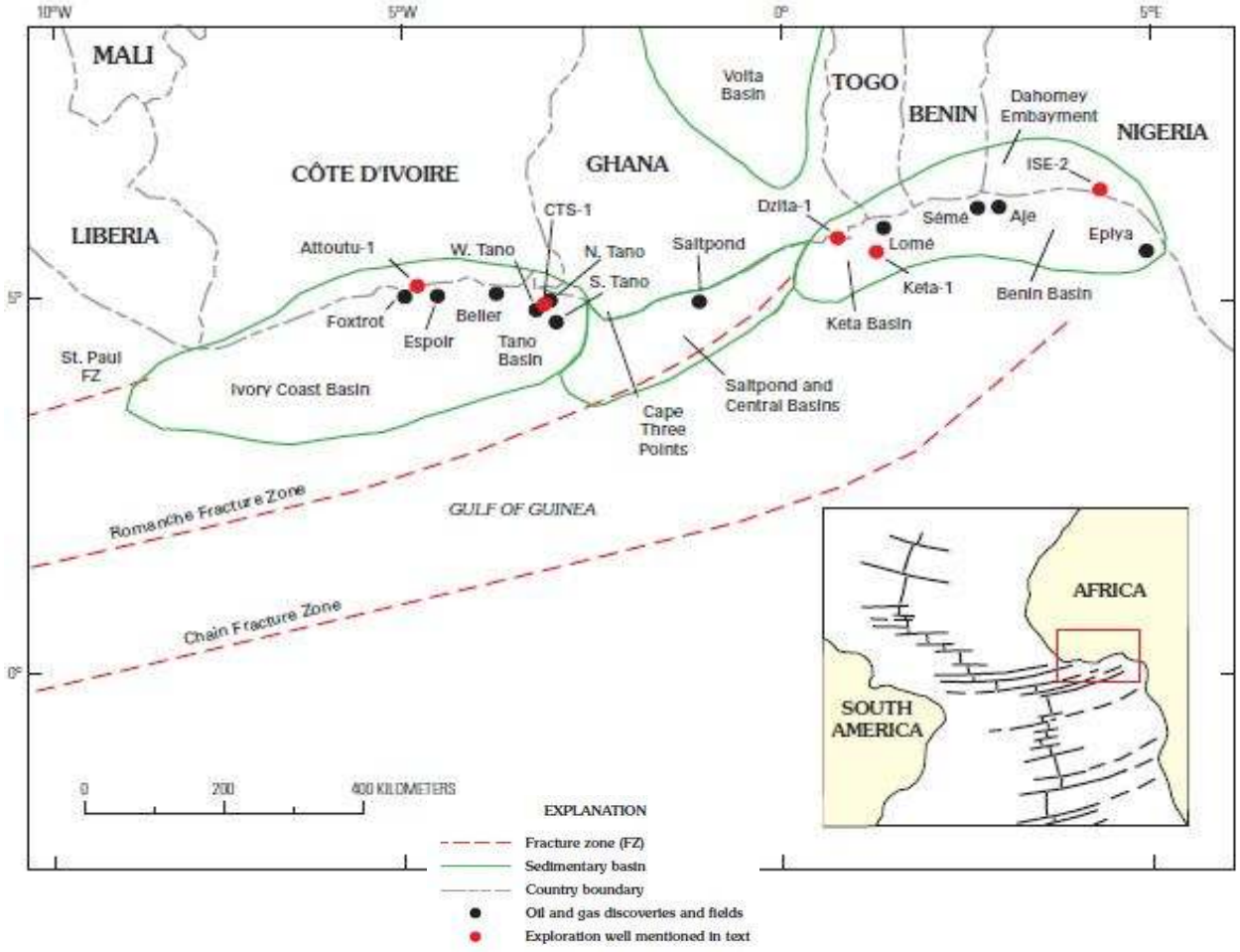
Objectives:

- **Evaluate the thickness and distribution of potential source rock using lithostratigraphy and sedimentological data.**
- **Characterize the potential source rock through geochemical study**
- **Establish the stratigraphic position and depositional environments of the source rocks through sedimentological, and foraminifera studies.**
- **Construct a thermal history model of the basin to assess source rock(s) maturity using Petromod software**

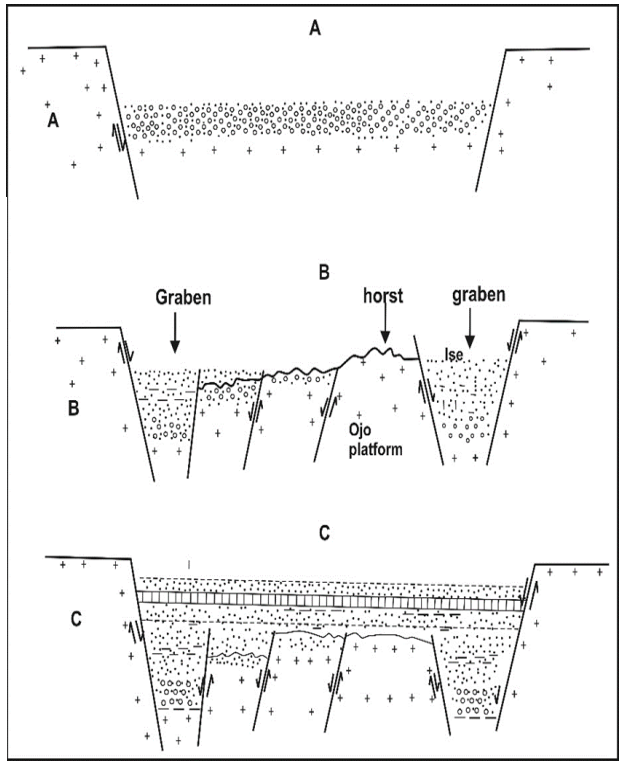
Petroleum System Evaluation- Elements and Processes



Tectonic Settings and Evolution History of Dahomey Basin



Brownfield and Charpentier ,2006



(Modified after Omatsola and Adegoke, 1981)

Stratigraphic Setting of Dahomey Basin

AGE		FORMATION	
QUART.	PLEISTOCENE	BENIN Fm	
TERTIARY	EOCENE	ILARO Fm	
		OSHOSUN Fm	
	PALEOCENE	EWEKORO Fm	
CRETACEOUS	CAMPANIAN - MAASTRICHTIAN	ABEOKUTA GROUP	ARAROMI Fm
	TURONIAN - CONIANCIAN		AFOWO Fm
	BARREMIAN - CENOMANIAN		ISE Fm

After Omatsola and Adegoke, 1981

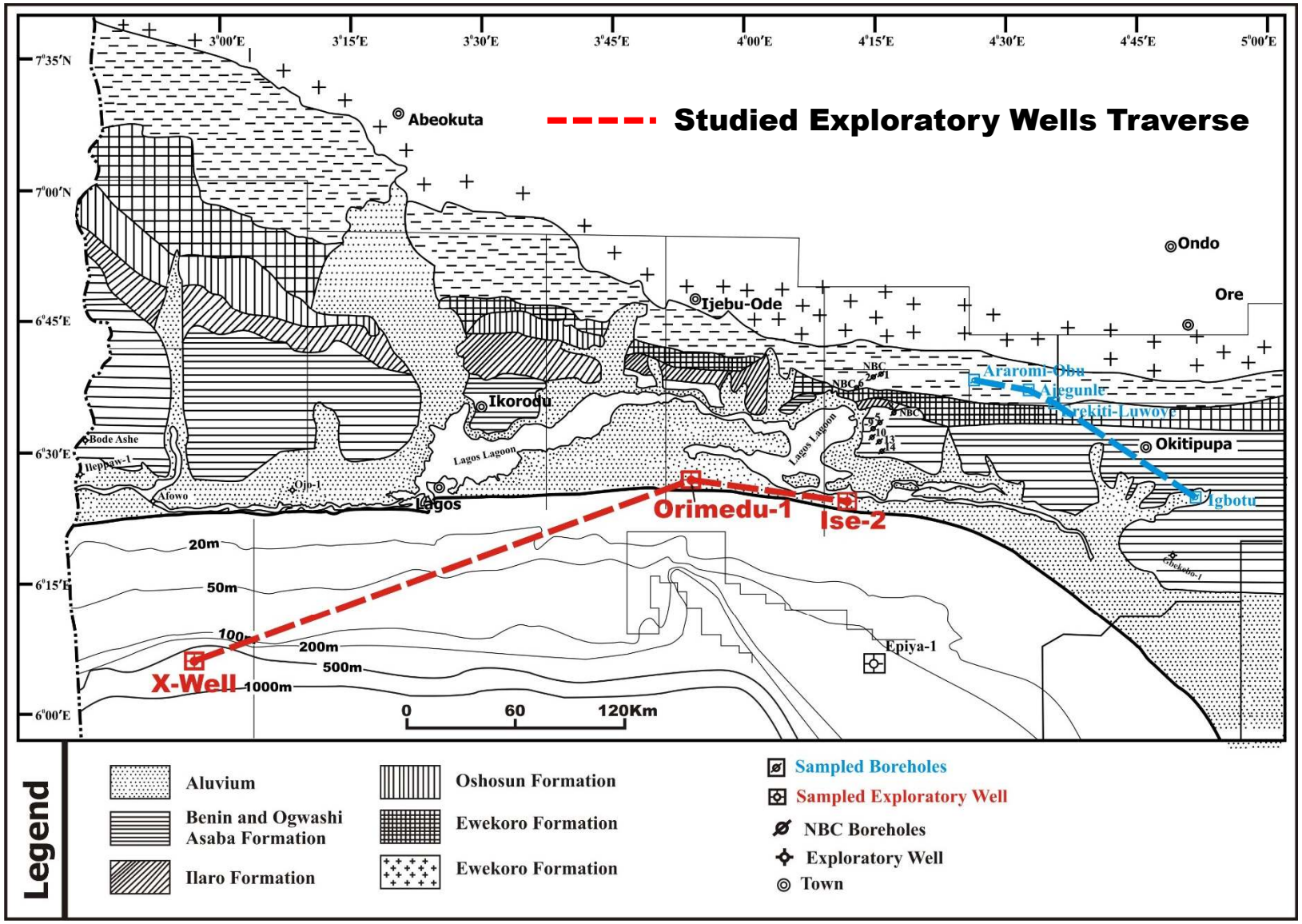
Previous Studies

- **Evolutionary history** (Adegoke et al., 1972, Billman, 1976, Omatsola and Adegoke, 1981, Adediran, , Ako et al., 1980 and Adegoke, 1987)
- **Sedimentology** (Allix, 1983, Adekeye, 2005)
- **Geochemistry** (Russ, 1924, Adekeye, et al., 2005, 2007)
- **Paleontological** (Reyments, 1966, Adegoke 1972, 1977, Nwachukwu et al., 1992, Okosun 1990, 1996, 2000, Bankole et al., 2007, Gebhardt, 2010).
- **Petroleum potential** (Ekweozor and Nwachukwu, 1989, Adekeye et al., 2004, 2006, Nton et al., 2005, Akande et al., 2010, 2012, Haack et al., 2000, Kaki et al., 2013).

Methodology

- Field Data gathering
- Laboratory Studies
  - ✓ Foraminifera Biostratigraphic Study
  - ✓ Geochemistry
- Thermal history Modeling

Methodology- Field Work

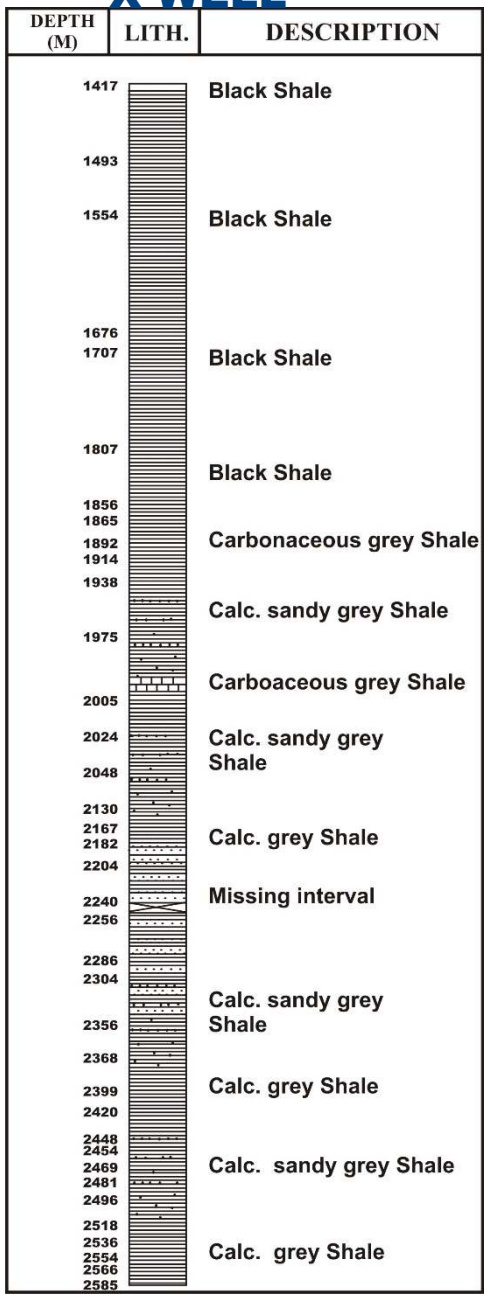


Geological Map of Dahomey Basin, SW Nigeria

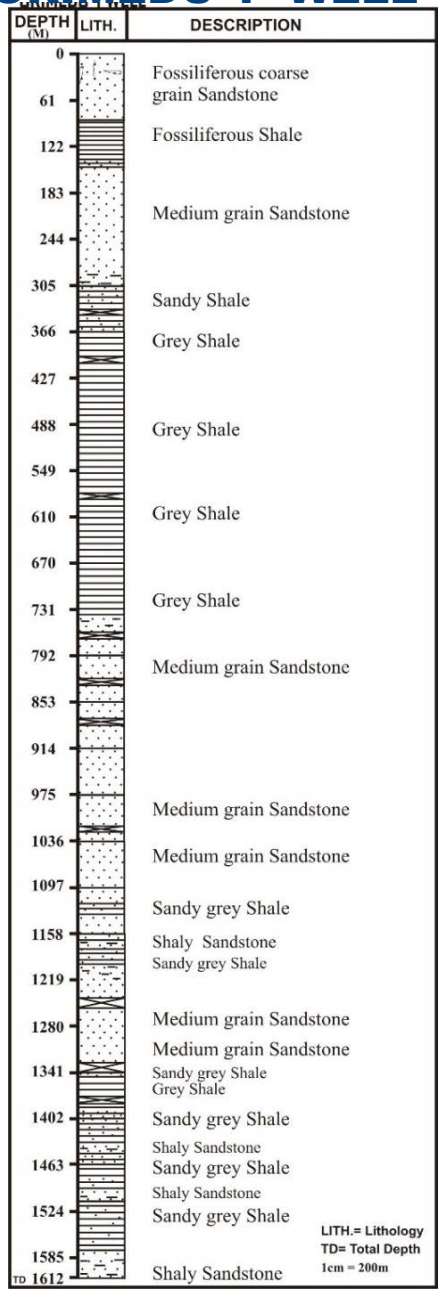
(Modified after Adekeye, 2005)

Lithostratigraphy

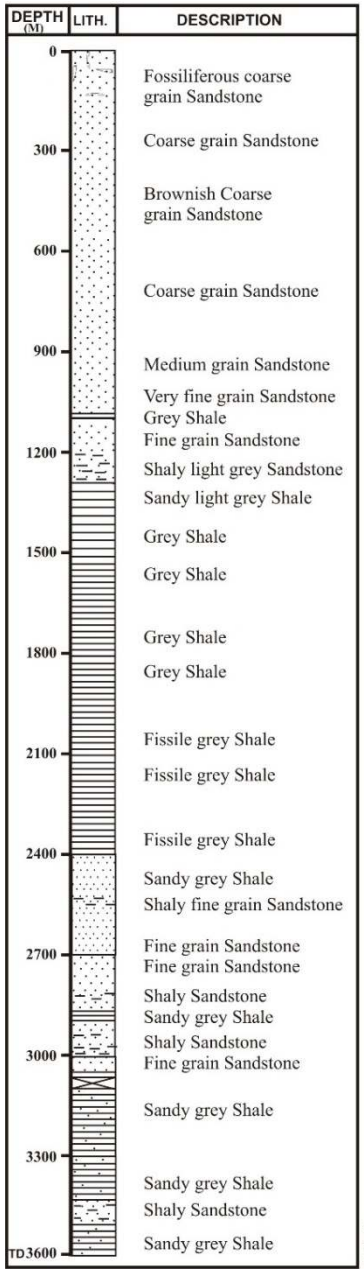
X WELL



ORIMEDU-1 WELL

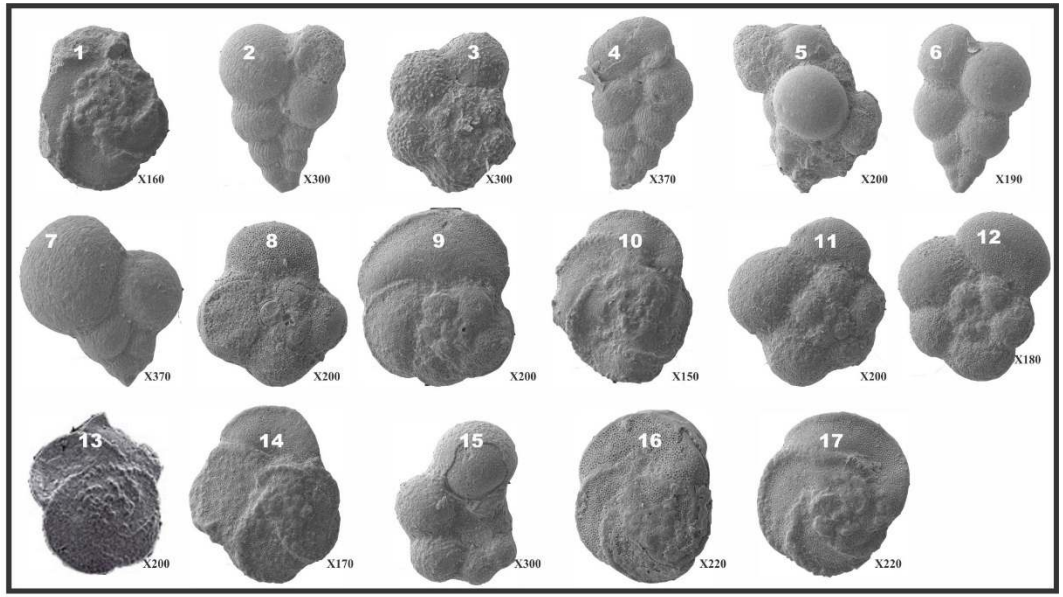


ISE-2 WELL



Biostratigraphy

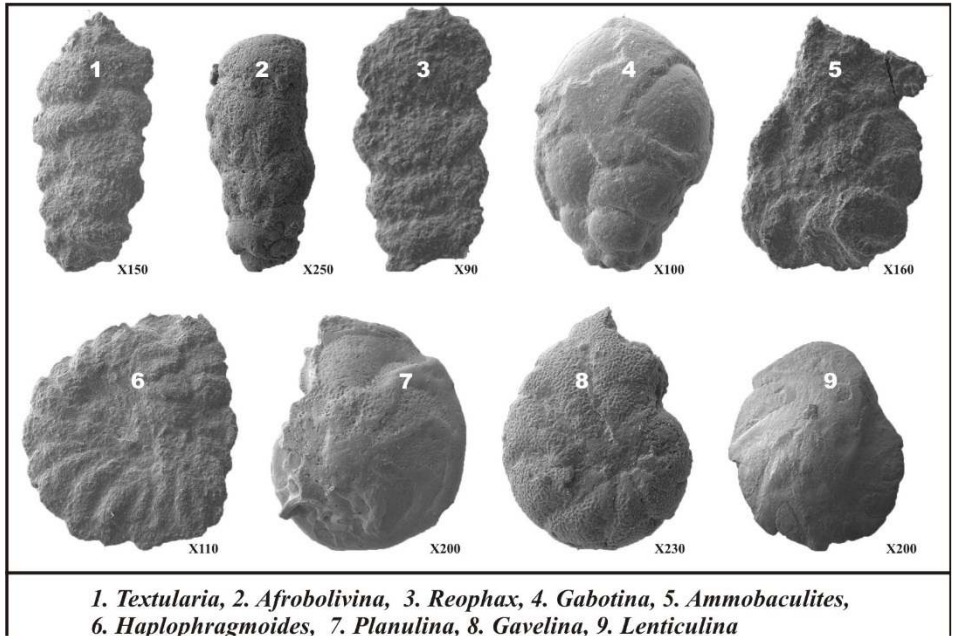
Recovered Planktonic and Benthic foraminifera



1. Rotaliporal greenhenoensis, 2. Heterohelix moremani, 3. Globotruncana sp., 4. Heterohelix pulchra, 5. Gumbelitarian sp. 6. Heterohelix globulosa, 7. Heterohelix reussi, 8. Praeglobotruncana stephani, 9. Whiteinella inornata, 10. Marginotruncana cf. Renzi 11. Whiteinella archaeocretacea, 12. Whiteinella baltica, 13. Globotruncana aegyptica, 14. Dicarinella primitive, 15. Hedbergella simplex 16. Marginotruncana cf. pseudolinneiana

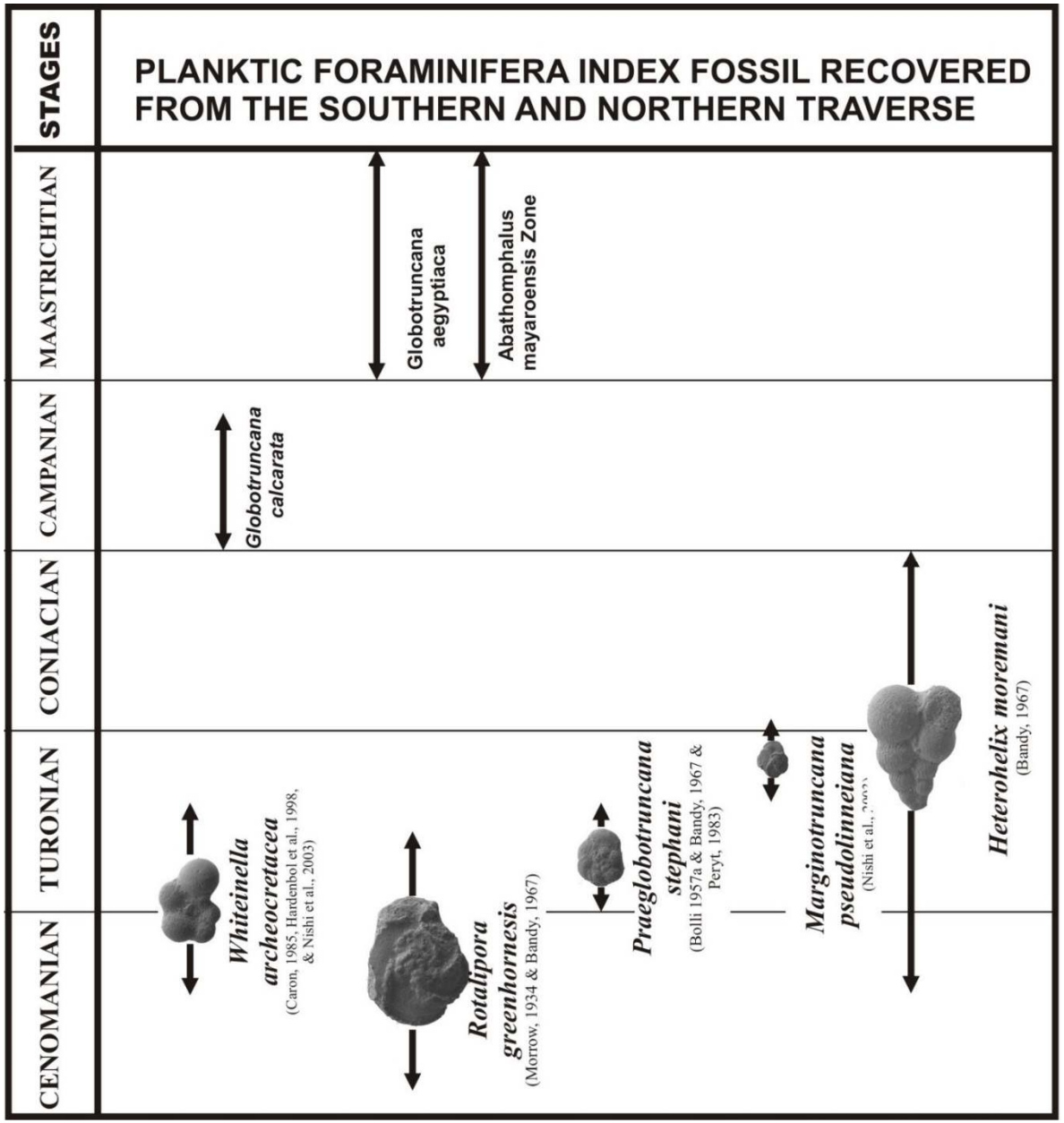
Planktonic species

Benthic species



1. Textularia, 2. Afrobolivina, 3. Reophax, 4. Gabotina, 5. Ammobaculites, 6. Haplophragmoides, 7. Planulina, 8. Gavelina, 9. Lenticulina

Index Fossil for Biostratigraphy Zonation



Morrow, 1934,

Bolli, 1957a

Bandy, 1967

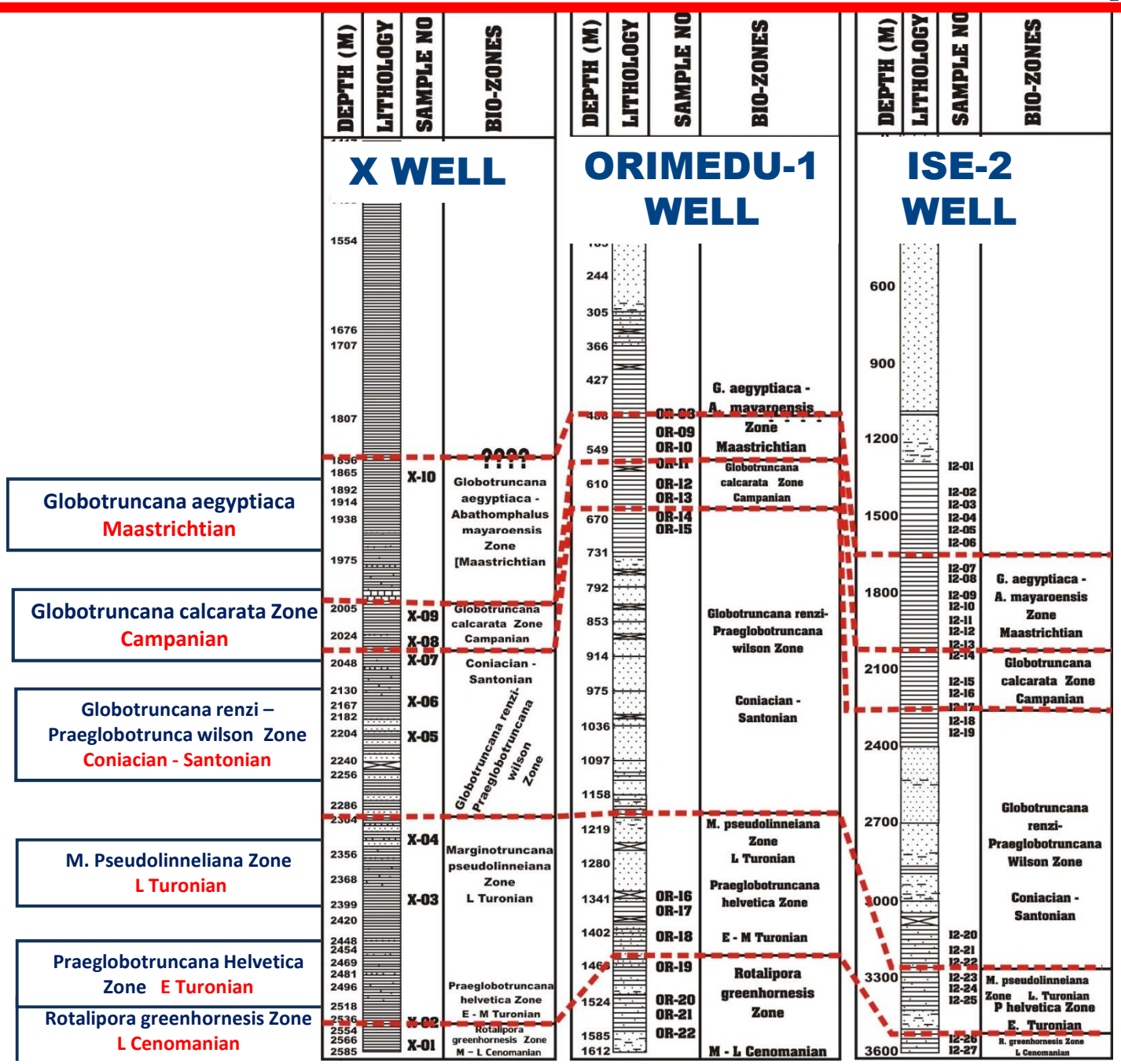
Peryt, 1983

Caron, 1985

Hardenbol et al 1998 and

Nishi et al., 2003,

Biostratigraphic Zonation



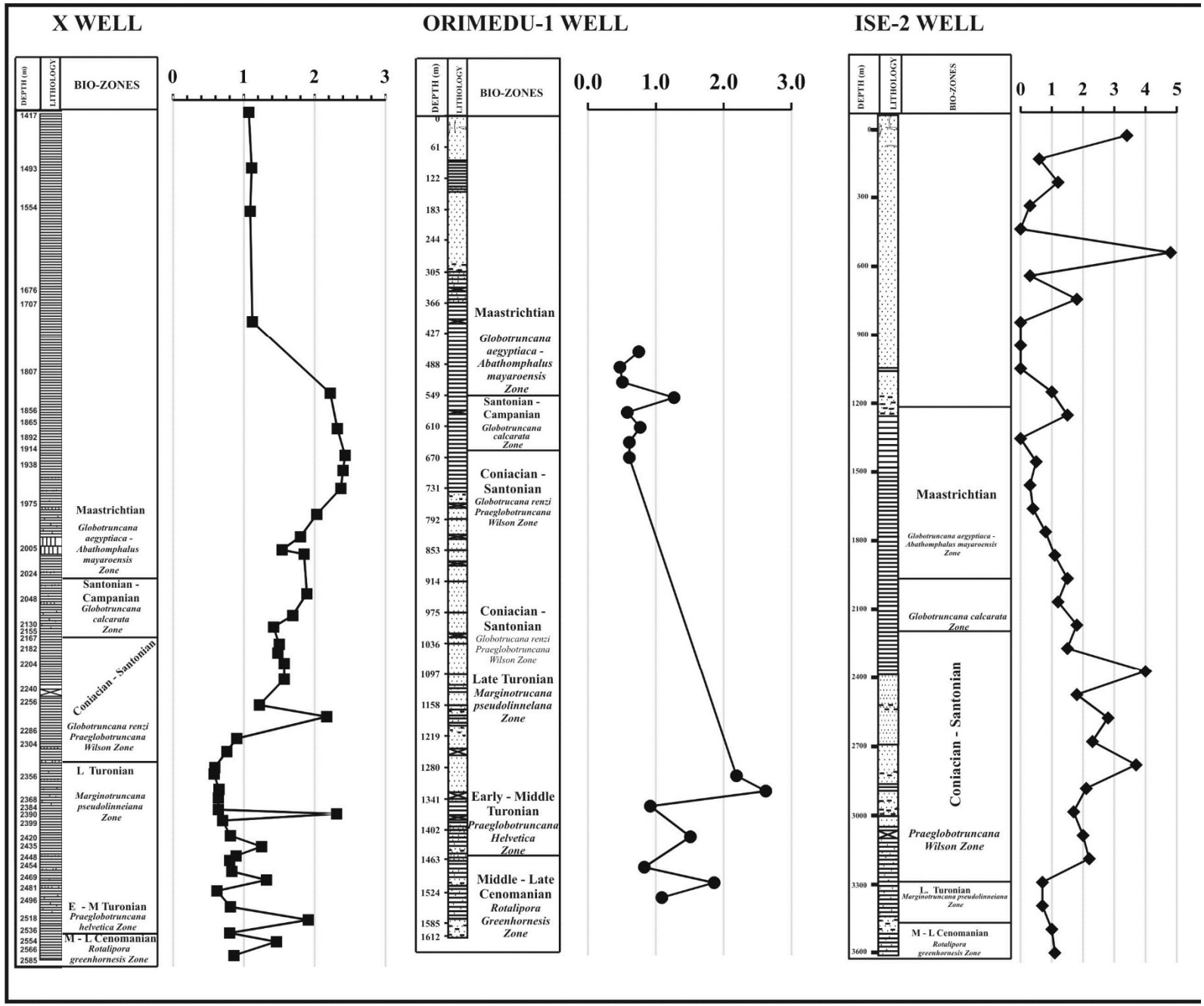
Present Study

Cenomanian – Turonian Shale	V/Ni	V/(V + Ni)	Ni/Co	Interpretations
X-Well	3.3	0.8	2.7	Marine organic matter Oxic – dysoxic
Orimedu-1	1.2	0.5	3.7	Terrigenous organic matter More Oxic
Ise-2 Well	2.2	0.7	2.7	Mixed terrigenous and marine More Oxic

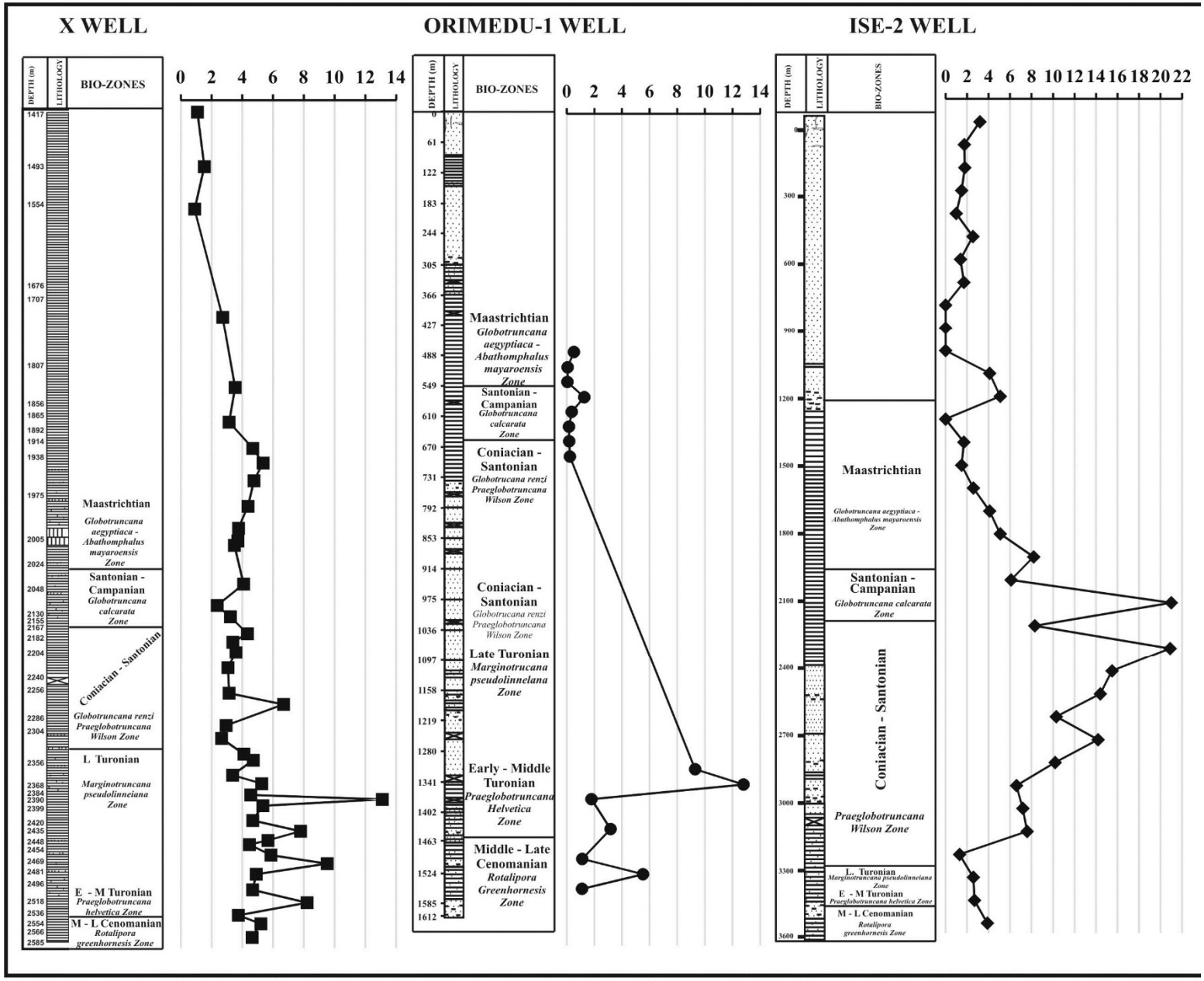
References

S/N	Trace Elements Ratios	Values and Interpretation	Authors
1.	V/Ni	> 3 Reducing Environment, Marine organic material 1.9 – 3 Mixed terrigenous and marine	Barwise (1990), Galarraga et al. (2008)
2.	V/(V + Ni)	0.69 – 0.76 Dysoxic	Adegoke et al., 2014
3.	Ni/Co	> 5 Dysoxic – Anoxic < 5 Oxic	Jones and Manning, 1994

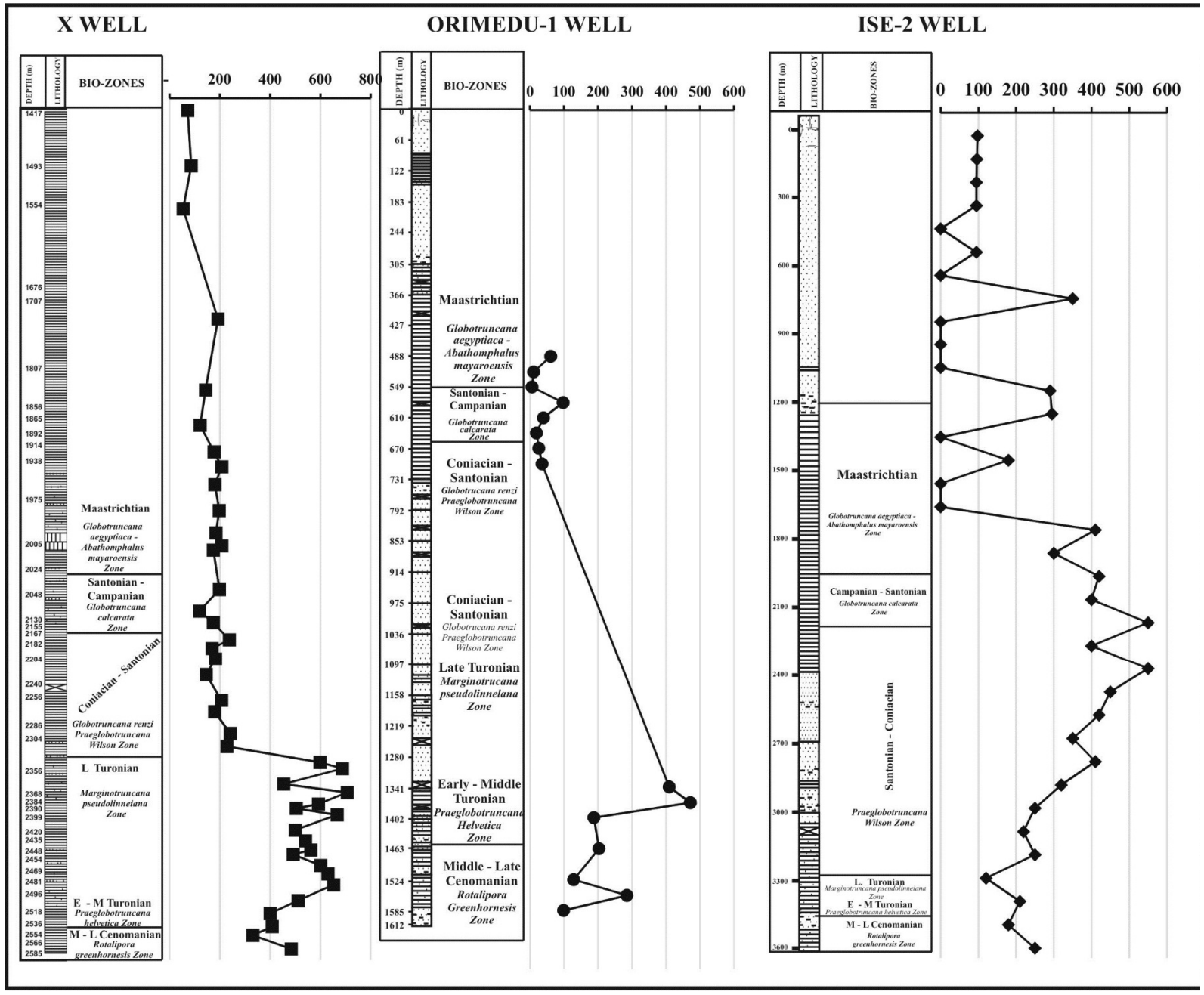
Total Organic Contents TOC (wt%)



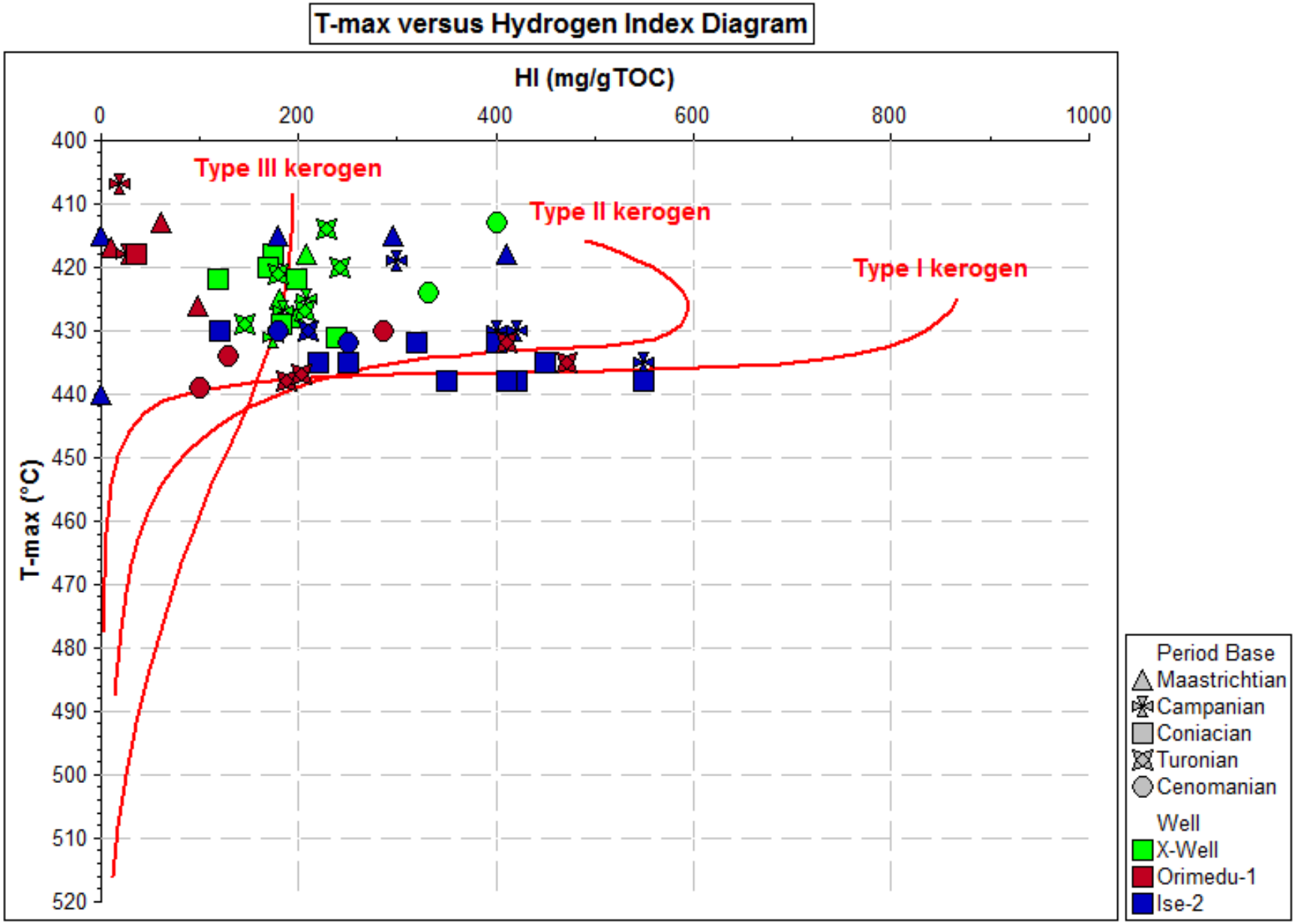
Source Potential (S_1 + S_2)



Hydrogen Index (HI) mgHC/gTOC



Organic Geochemistry- Kerogen Type

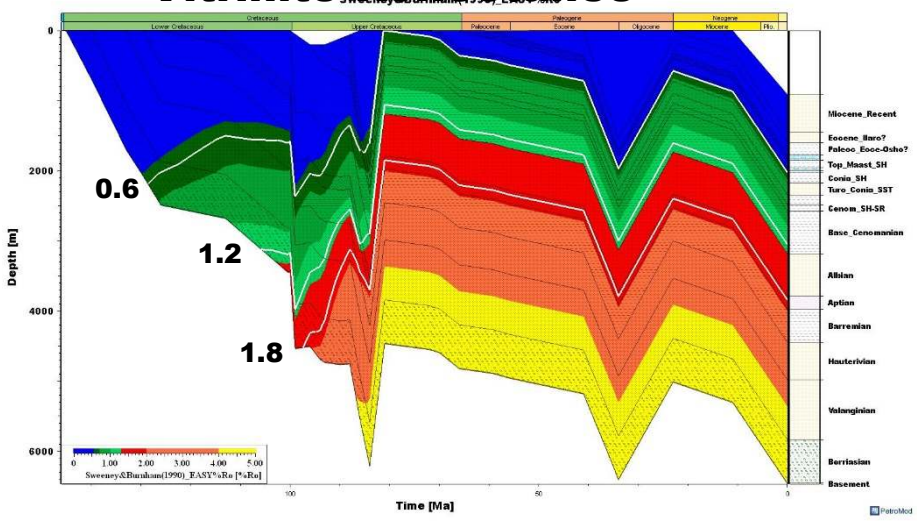


HI/Tmax plots of shales in the exploratory wells (IGI Software)

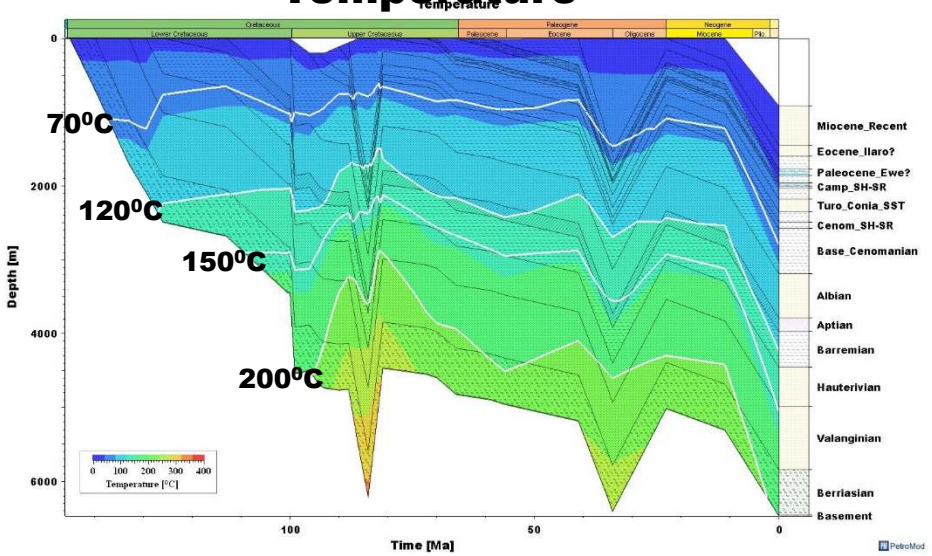
Thermal History

PetroMod 1D Output- X Well

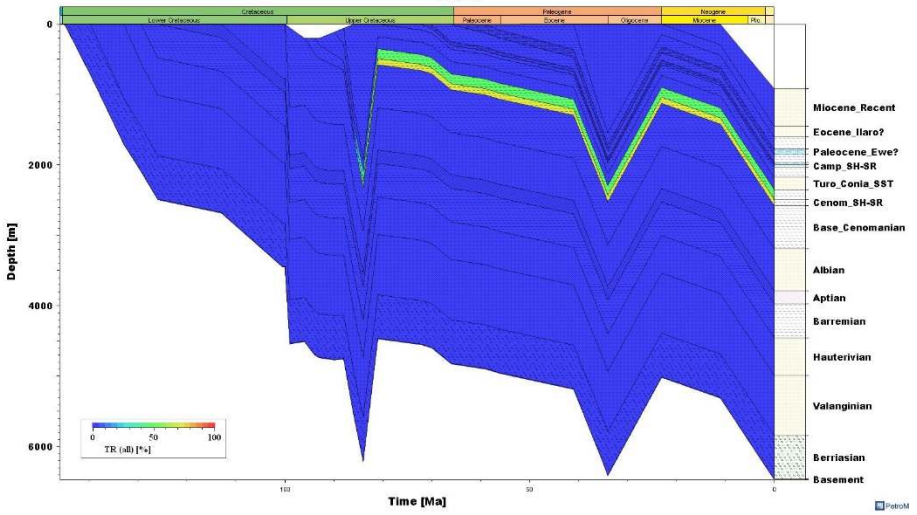
Vitrinite Reflectance



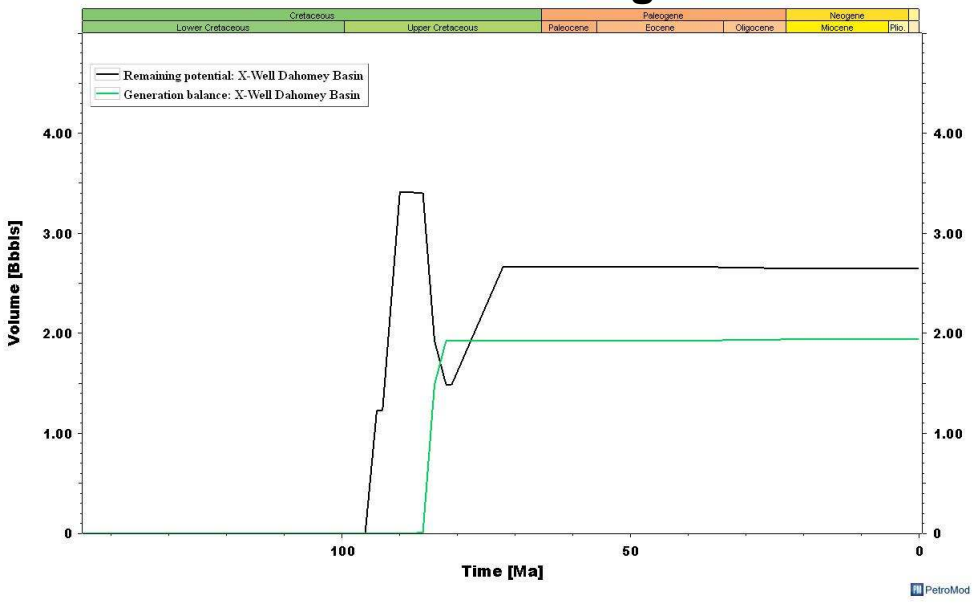
Temperature



Transformation Ratio



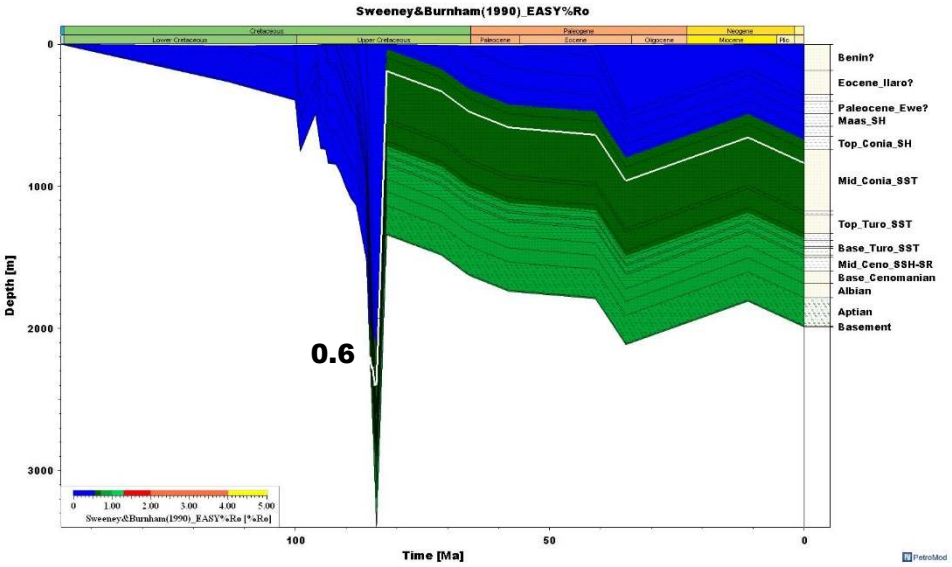
Generated & Remaining Potential



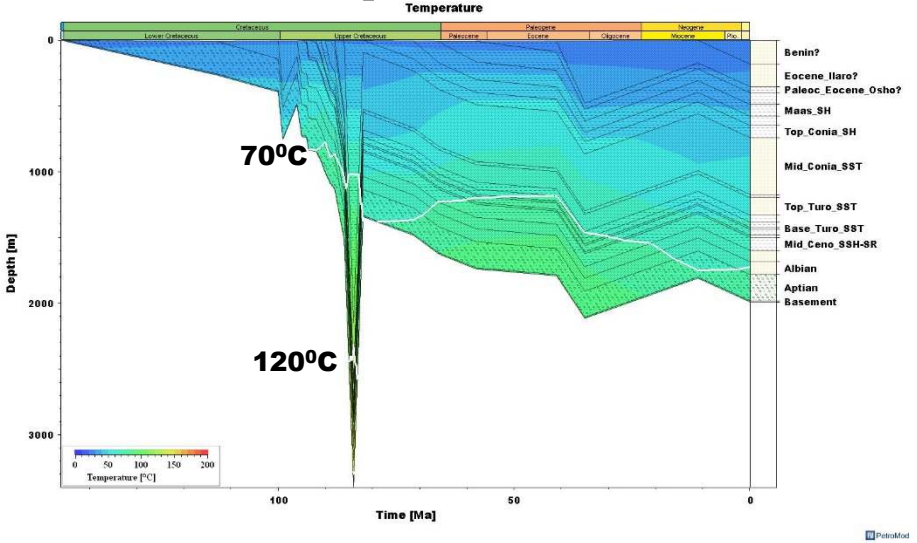
PetroMod1D Output Data – Orimedu-1Well

NMGS Ilorin 2016

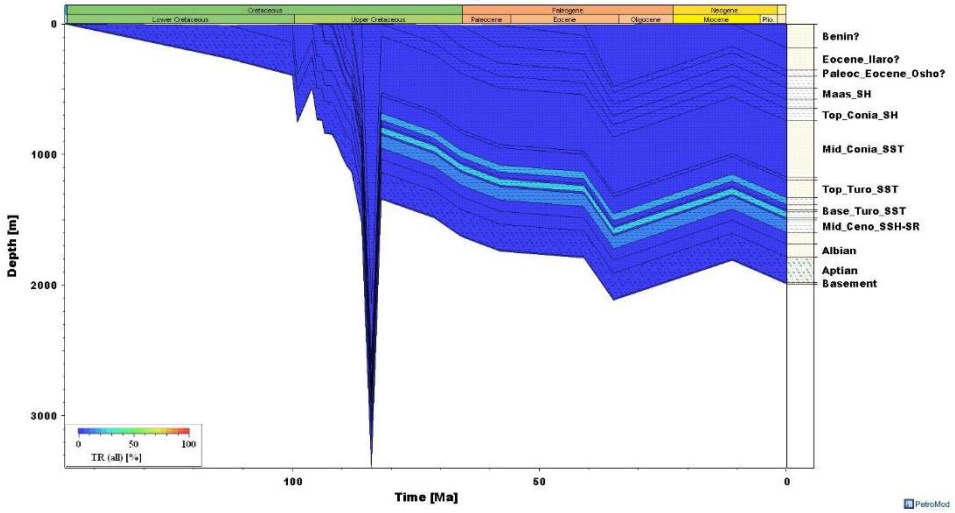
Vitrinite Reflectance



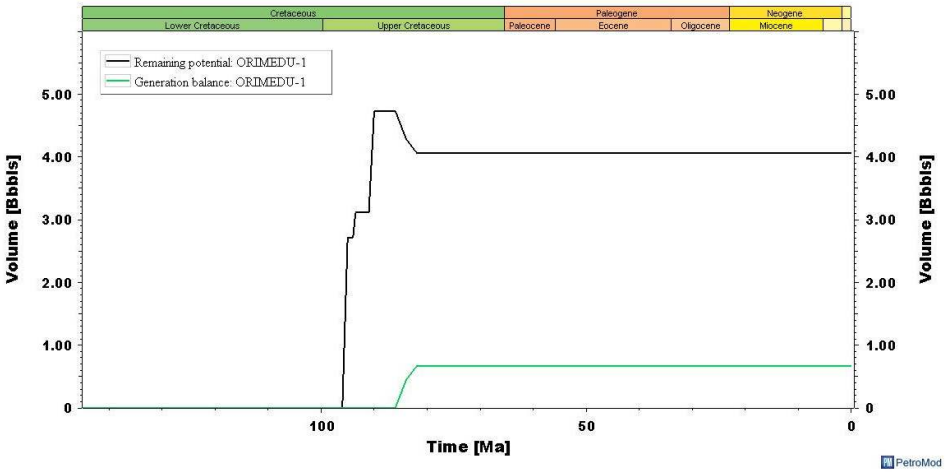
Temperature



Transformation Ratio

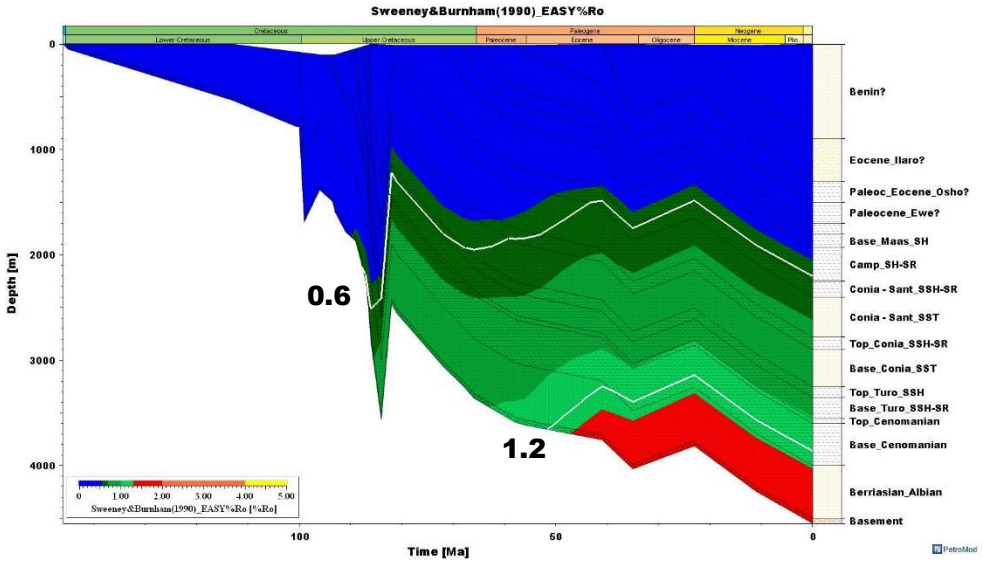


Generated Volume with time

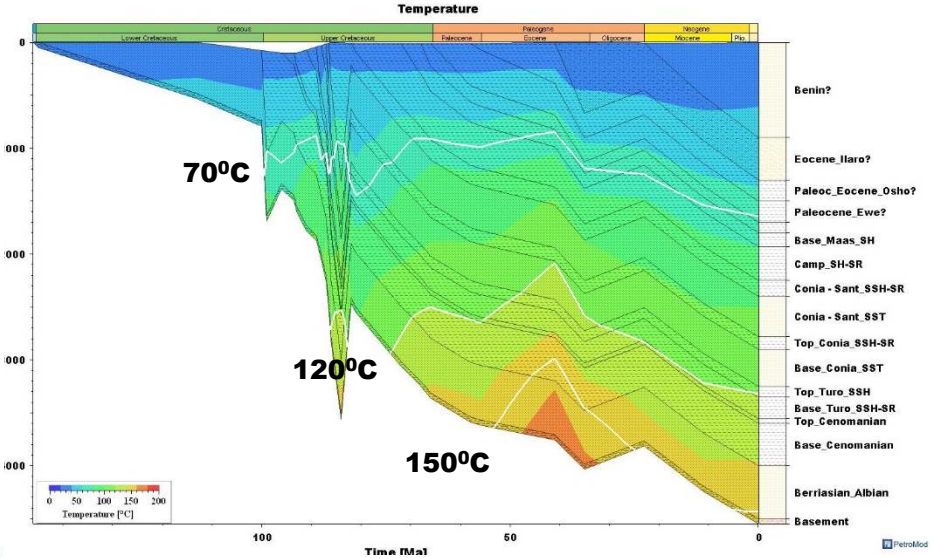


PetroMod1D Output Data – Ise-2 Well

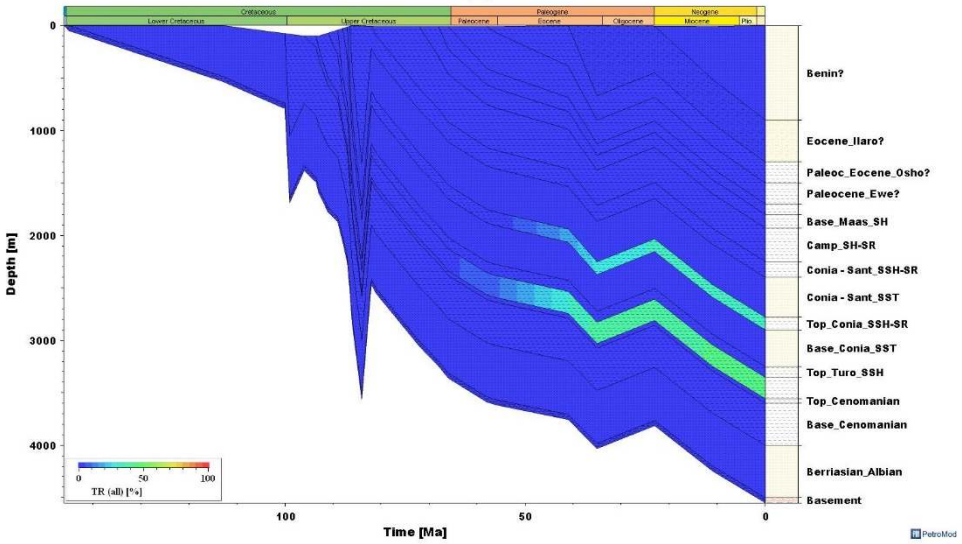
Vitrinite Reflectance



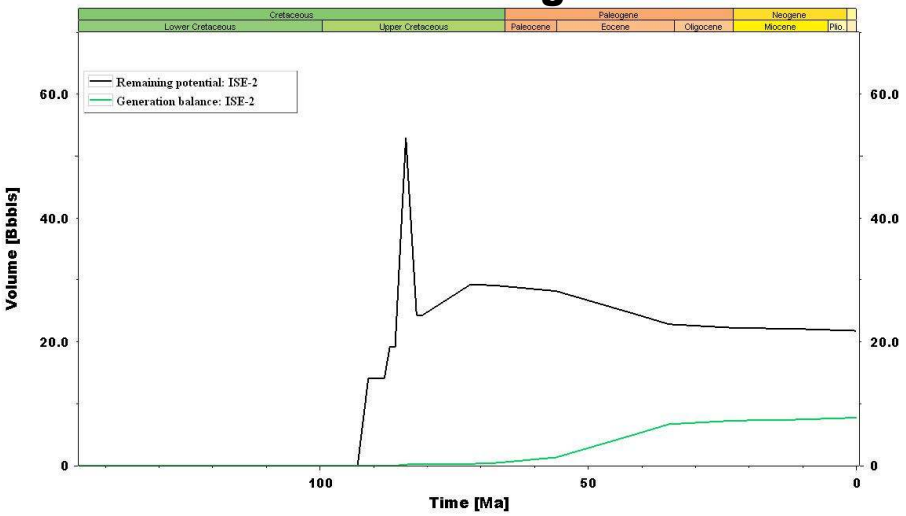
Temperature



Transformation Ratio



Generated & Remaining Potential



Conclusions

Conclusions

S/NO	PARAMETERS	CHARATERISTICS
i.	Source Rock Facies	Shale
ii.	Age	Cenomanian – Turonian
iii.	Paleowater Depth	< 250m (upper Bathyal) to < 100m (middle - outer Neritic e.g Open shelf)
iv.	Depositional Environments	Marine
v.	Organic Matter Type	I, II, II/III
vi.	TOC	Good to Excellent
vii.	Maturity	Mature
viii.	Transformation	Begins in Upper Cretaceous in X and Orimedu -1 Well and Paleocene in Ise-2

Tano and Ivory Coast basins have Albian to Coniacian petroleum system while Dahomey basin have Cenomanian to Turonian Petroleum Source rock.

Acknowledgements

- Petroleum Technology Development Fund (PTDF)
- Weatherford Laboratories, Houston Texas, USA
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- Technical University Berlin, Germany, ZELMI
- Schlumberger - SIS NGA

Thanks for Listening