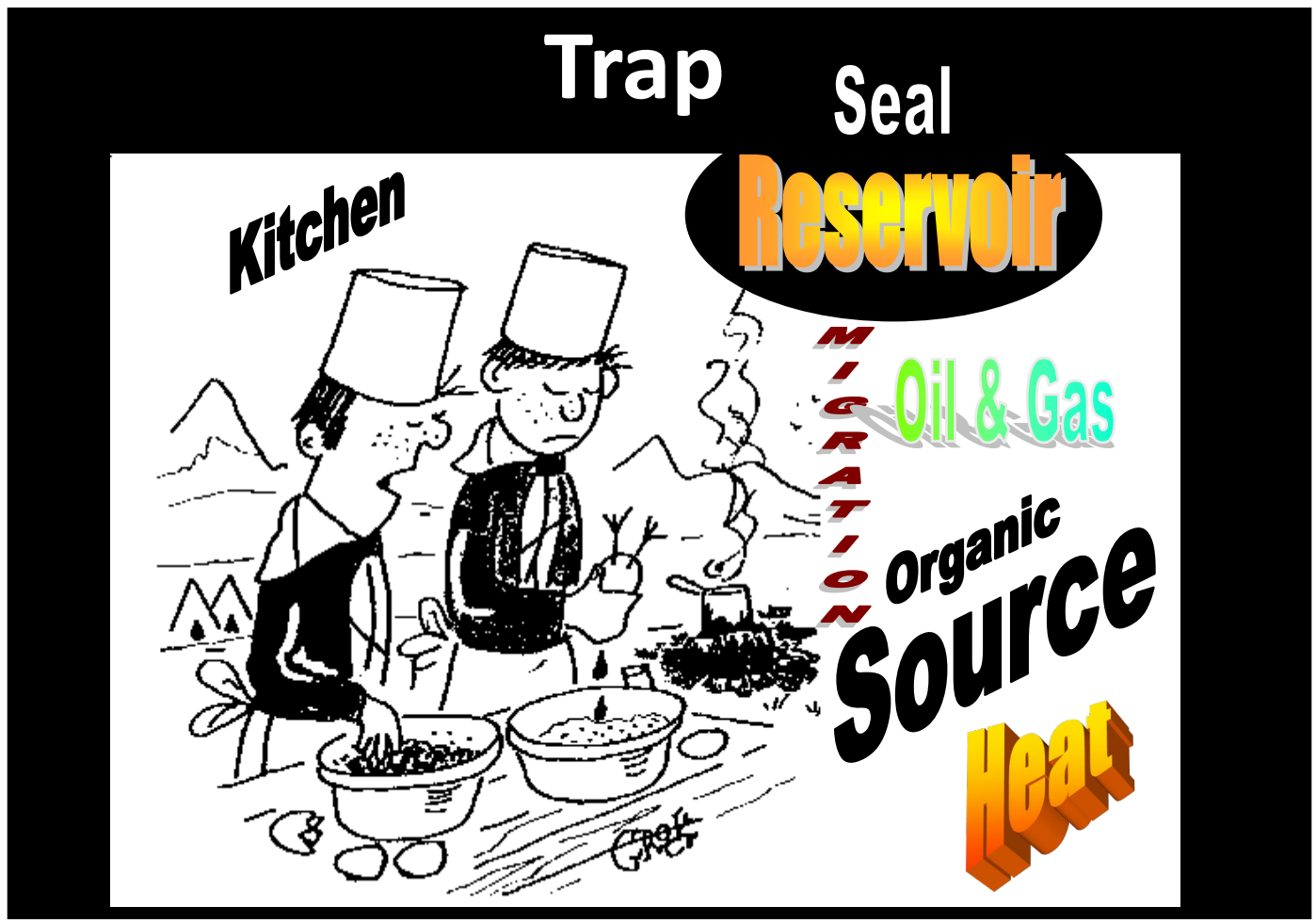
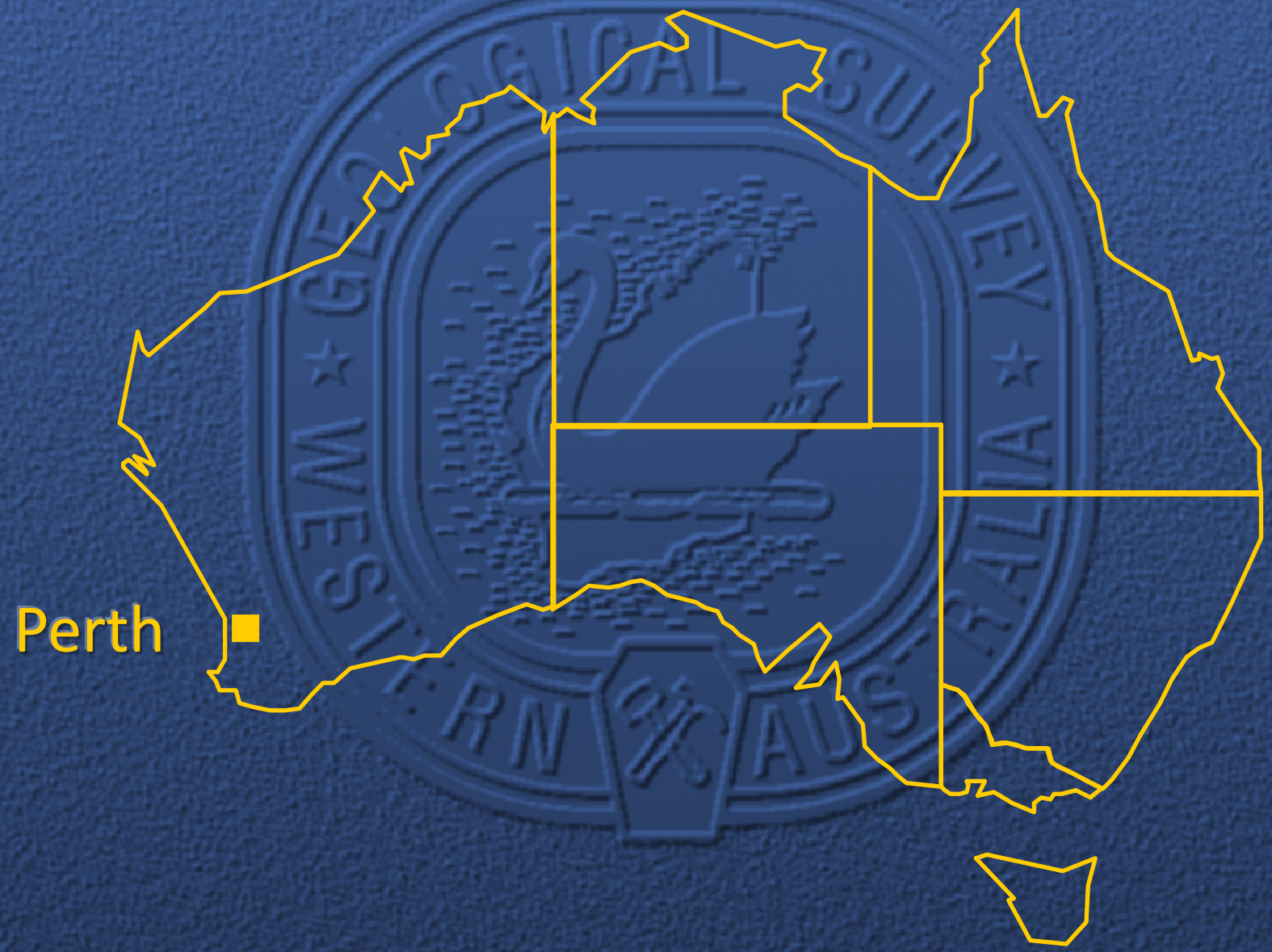
Petroleum System



Petroleum Exploration Initiative



Petroleum System Modelling in Ghadâmis Basin of NW Libya

K. Ameed R. Ghori

Geological Survey of Western Australia

Rajab A. Mohammed

Arabian Gulf Oil Company

Acknowledgements

Management of :

- Arabian Gulf Oil Company for permission to published data
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- Symposium Committee to sponsor my visit
- Ummal-Jawaby Oil Services to facilitate my visit

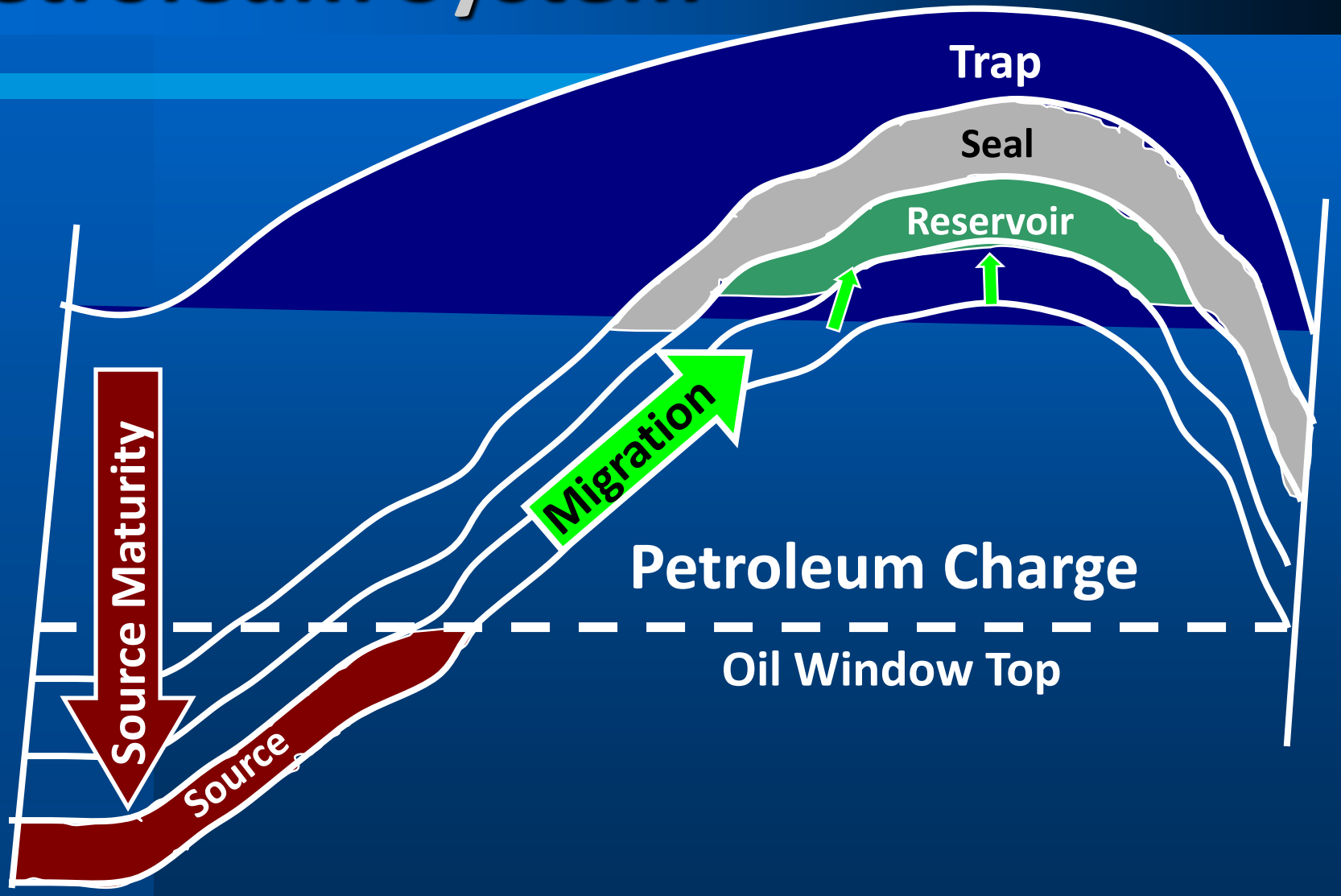
Presentation

- Petroleum prospectivity
  - Principles & Processes
- Ghadâmis Basin
  - Location & Stratigraphy
  - Database & Source potential
  - Source maturity & Modelling
  - Results & Conclusions

Prospectivity—Controlling Factors

- Petroleum charge
  - source type & maturation, hydrocarbon expulsion, migration, & charge timing
- Trap
  - structure, reservoir & seal
- Preservation
  - thermal history & meteoric water invasion

Petroleum System



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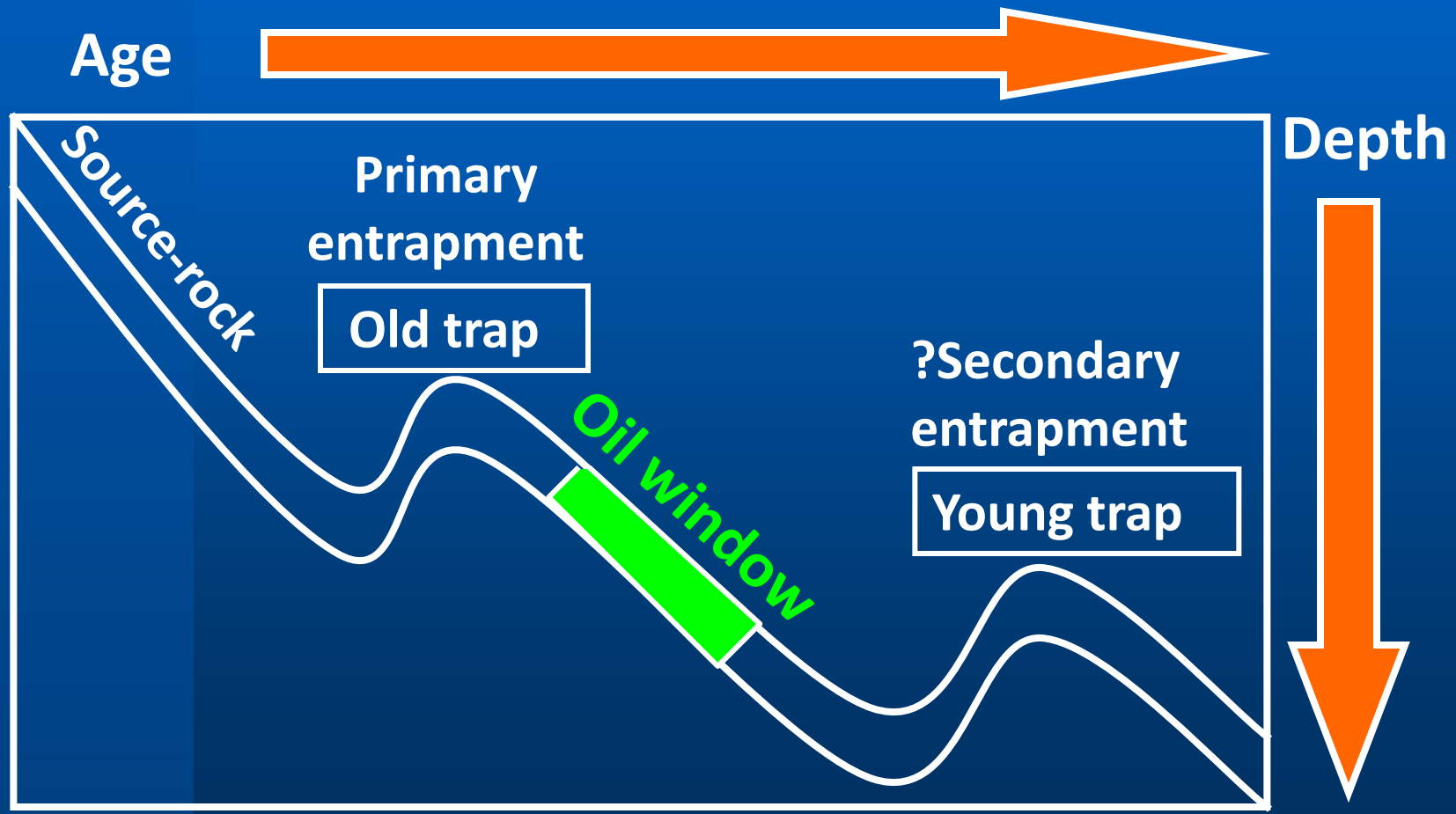
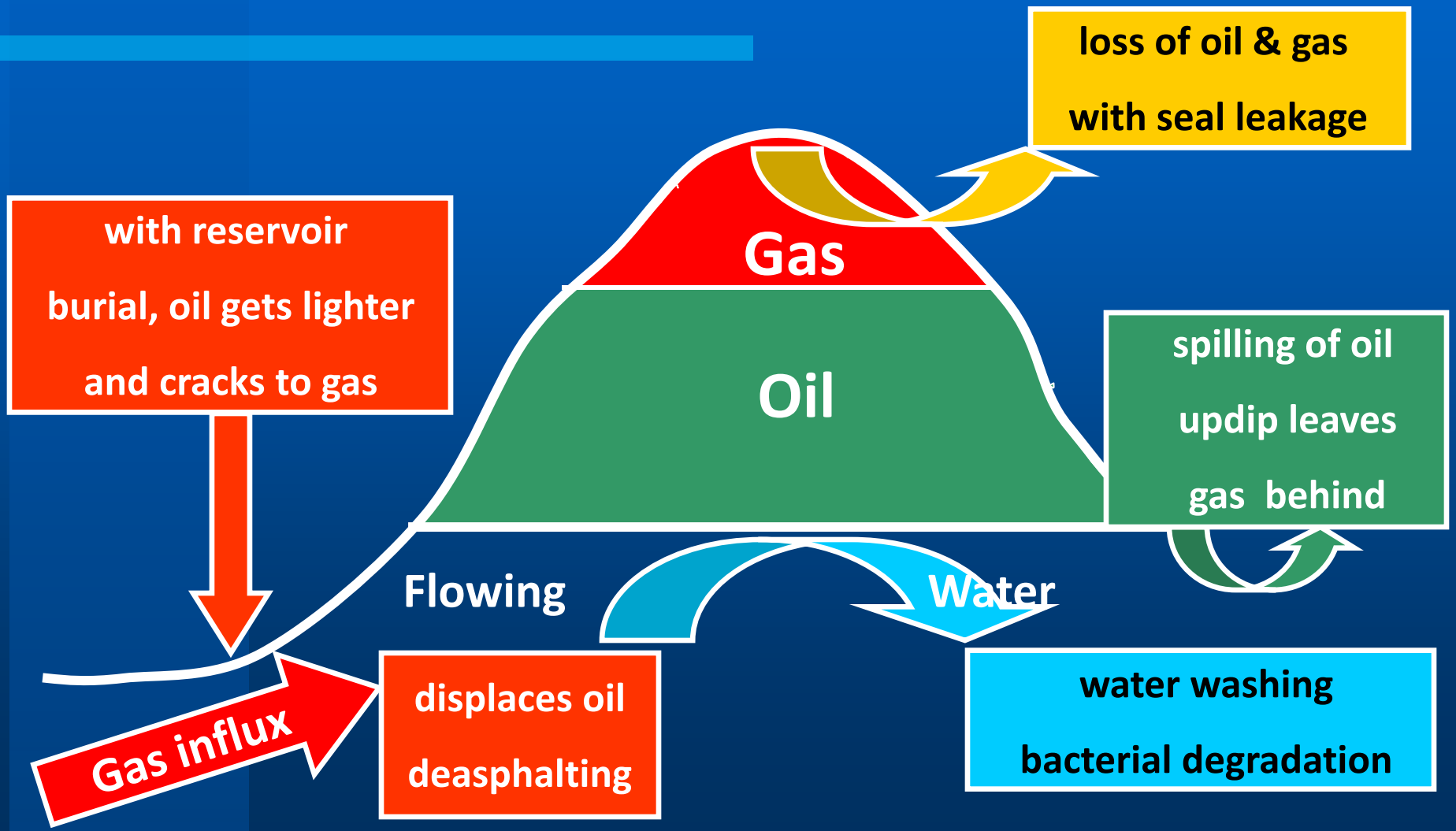
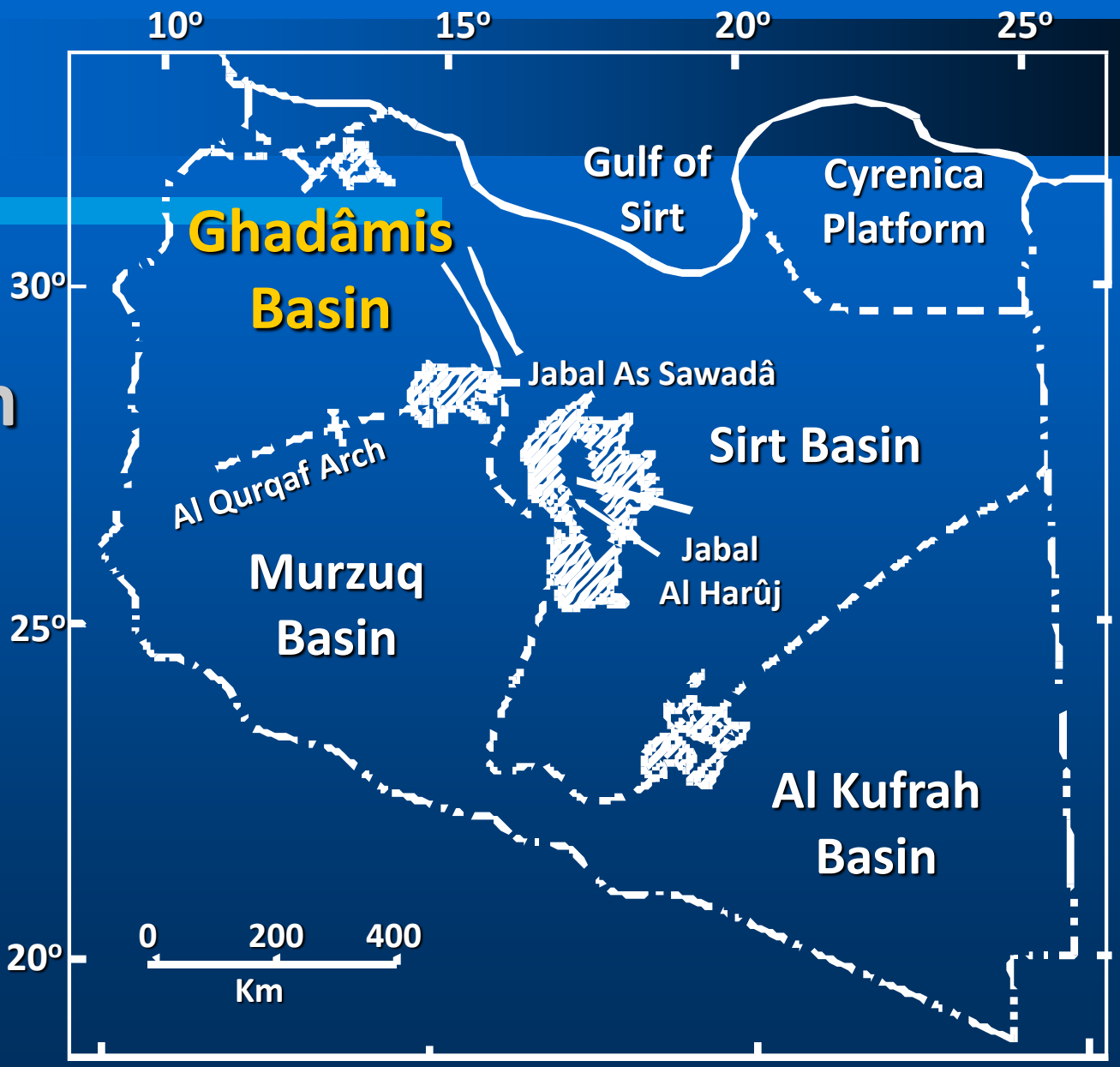
Timing — Generation versus Trap



Petroleum Preservation



Location Map



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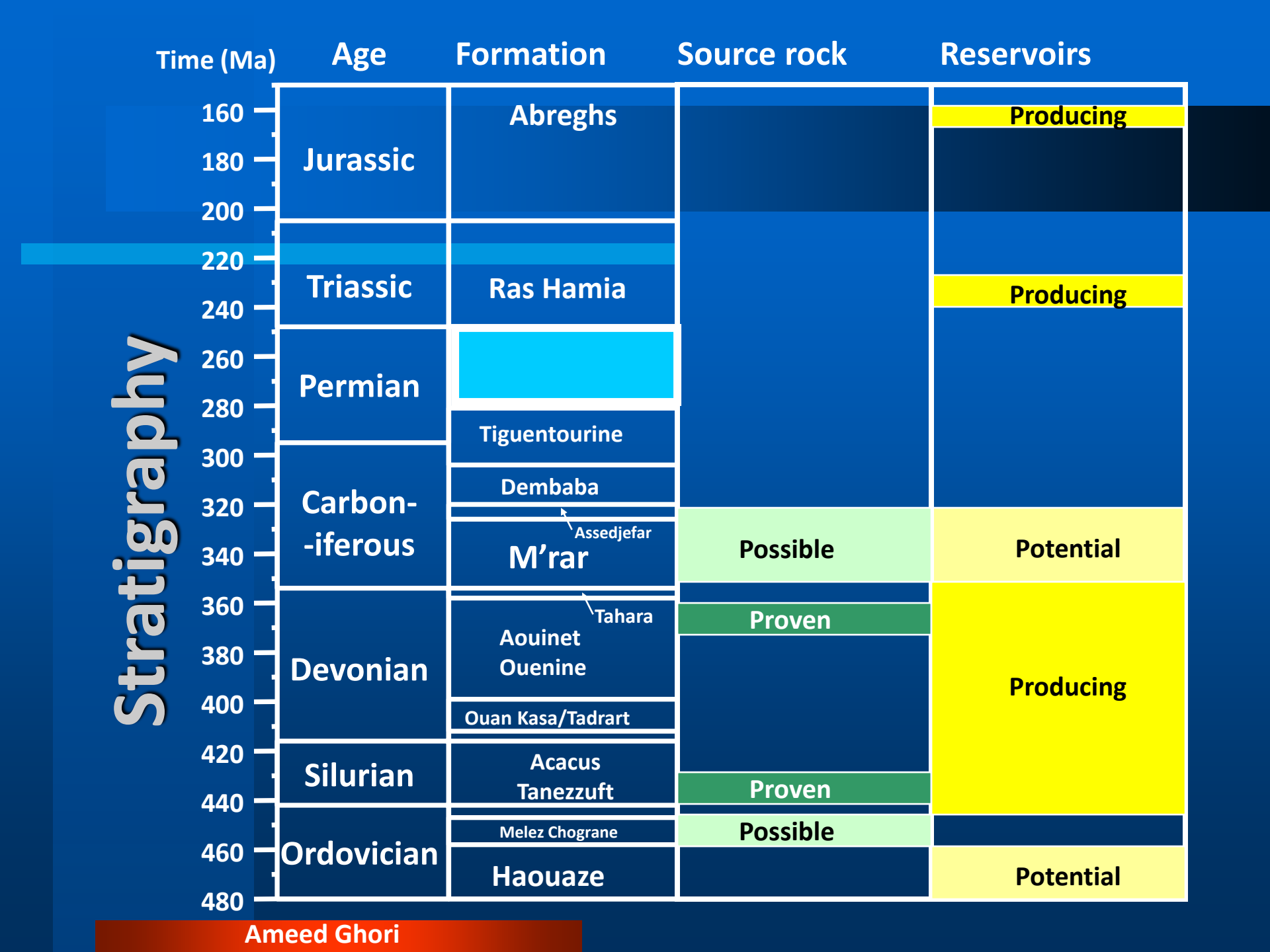
Ghadâmis Basin

- 1956 - Algeria's First Major Discovery
  - Hassi Messaoud Oil Field
  - Hassi R'Mel Gas Field
- 1958 - Libya's First Oil Well
  - Atshan Field Discovery
- 1993 - Algeria's Major Oil Fields
  - 5 year discovery
- 1997 - Libya's Elephant Oil Field
  - Murzuq Basin


Time (Ma)
Age
Formation
Source rock
Reservoirs
Stratigraphy
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
Jurassic
Triassic
Permian
Carbon-
-iferous
Devonian
Silurian
Ordovician
Abreghs
Ras Hamia
Tiguentourine
Dembaba
Assedjefar
M'rar
Tahara
Aouinet
Ouenine
Ouan Kasa/Tadrart
Acacus
Tanezzuft
Melez Chograne
Haouaze
Possible
Proven
Proven
Possible
Producing
Producing
Potential
Producing
Potential
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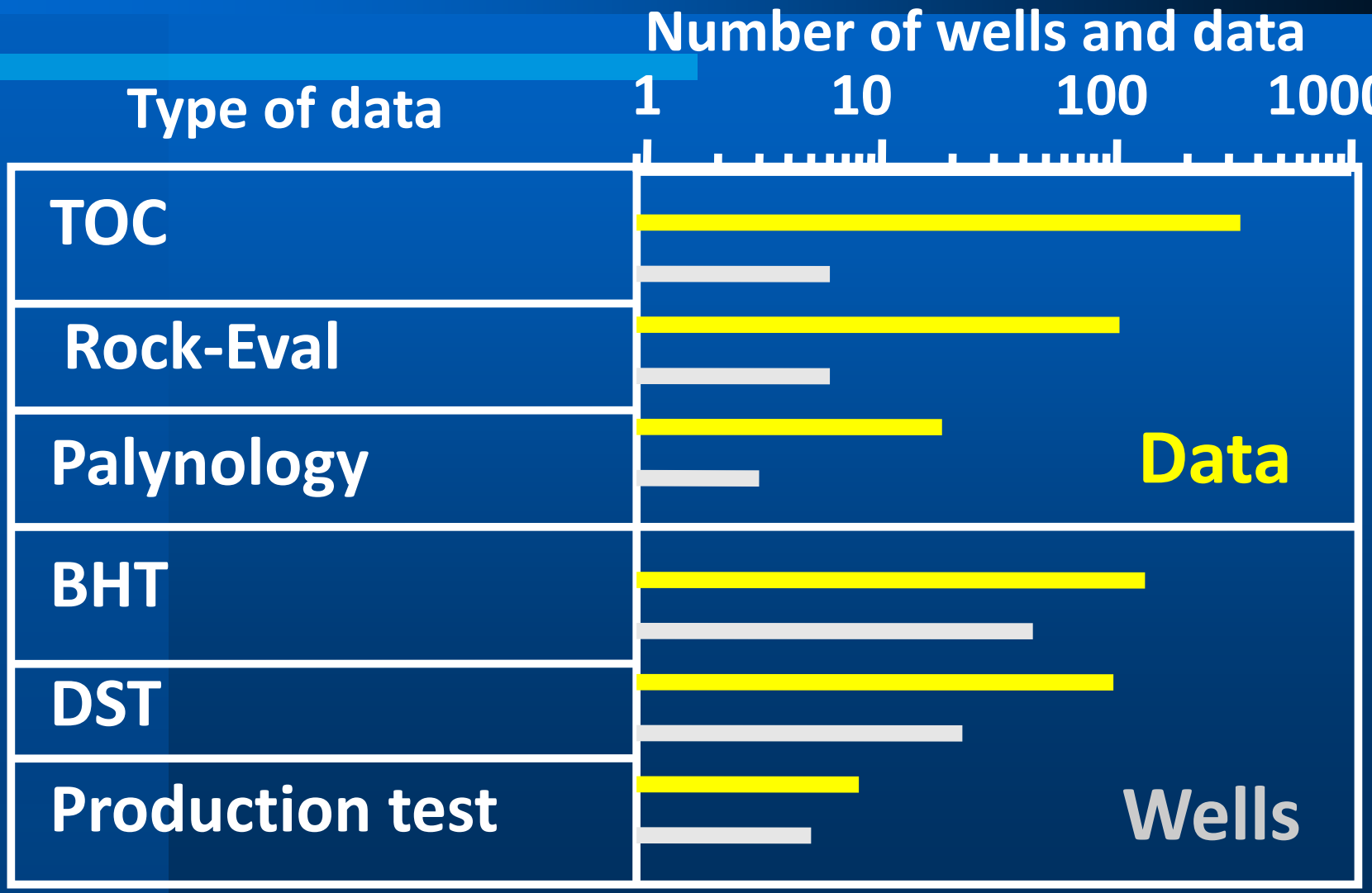
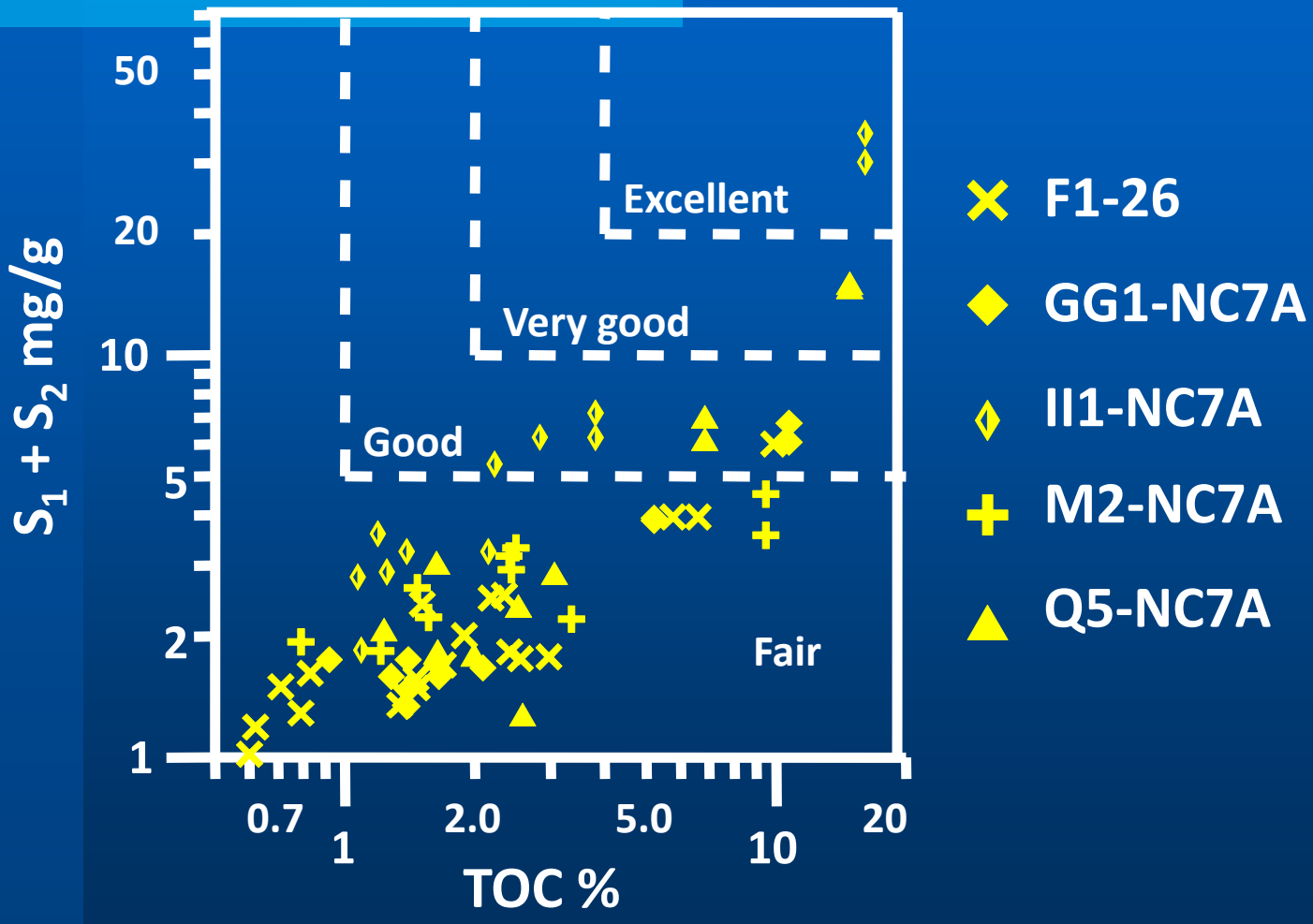
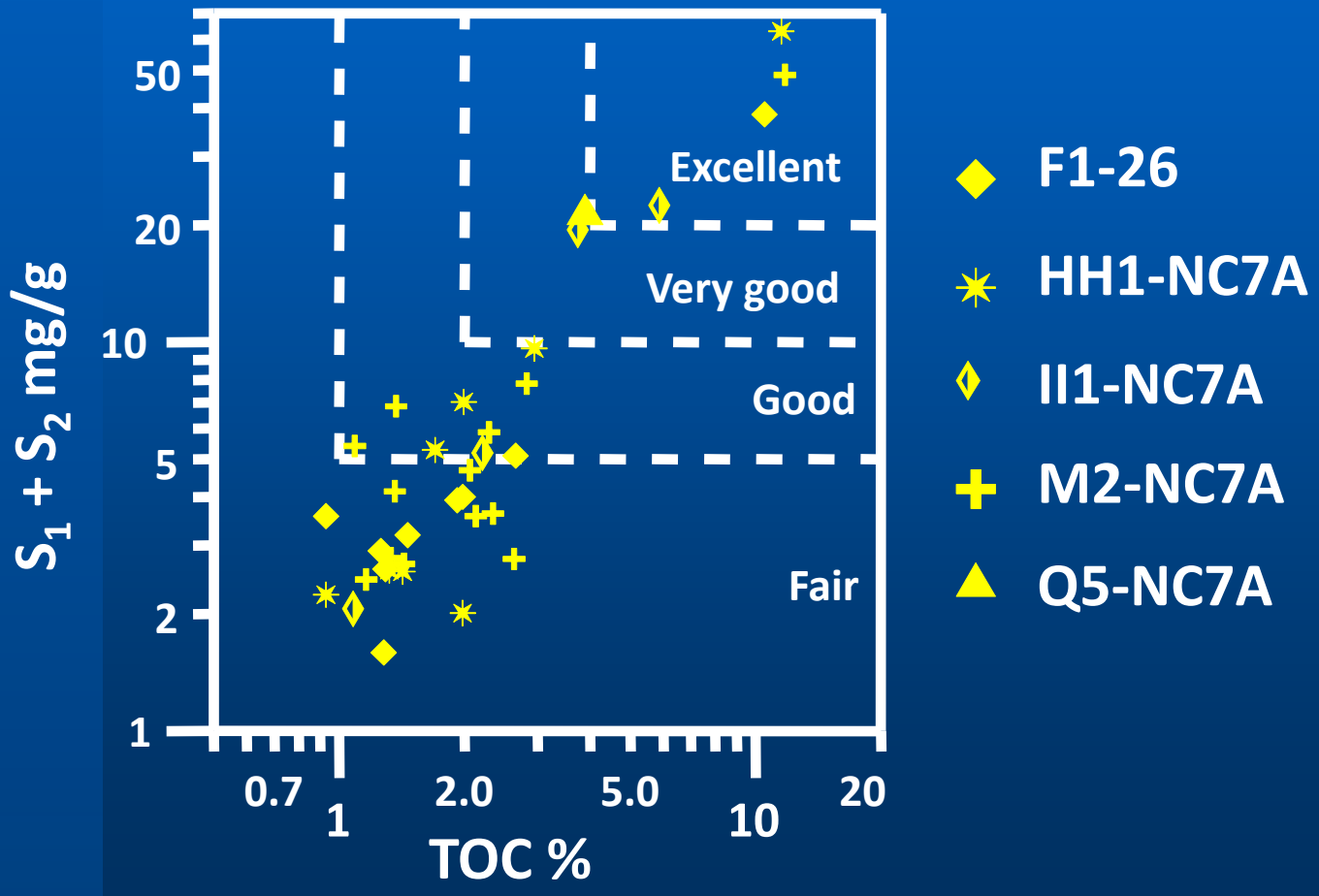
Database


Number of wells and data
1
10
100
1000
Type of data
TOC
Rock-Eval
Palynology
BHT
DST
Production test
Data
Wells

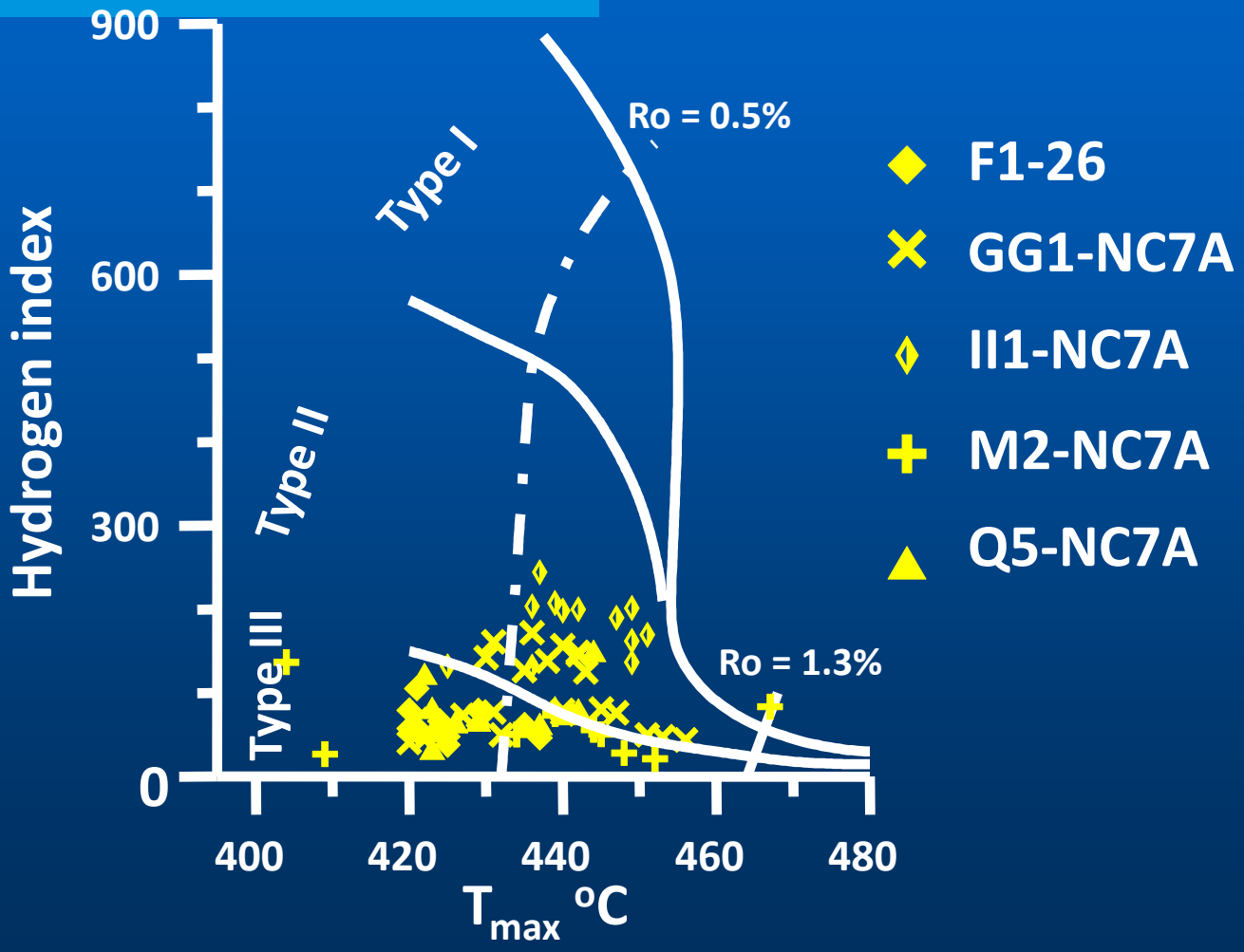
Silurian Generating Potential



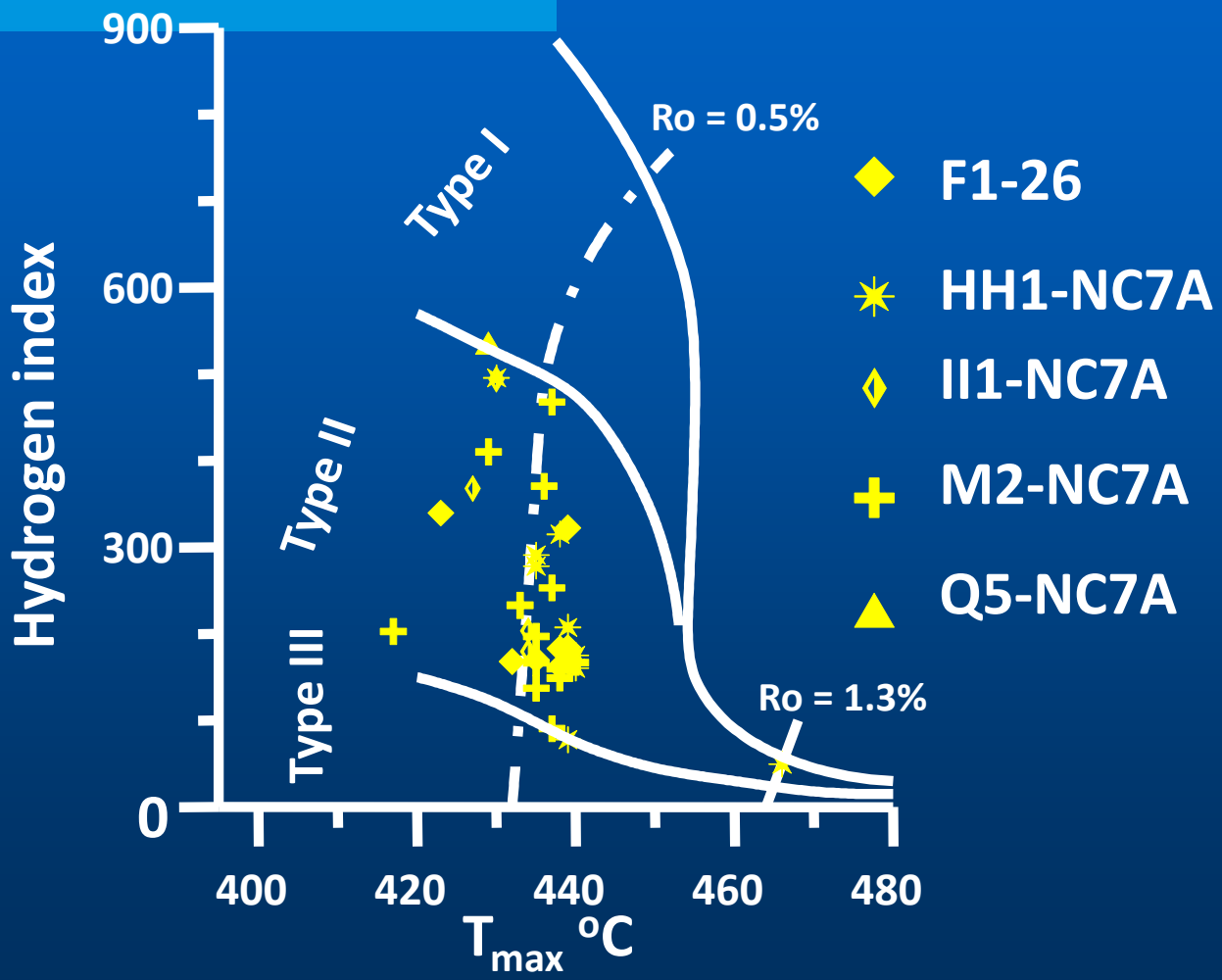
Devonian Generating Potential



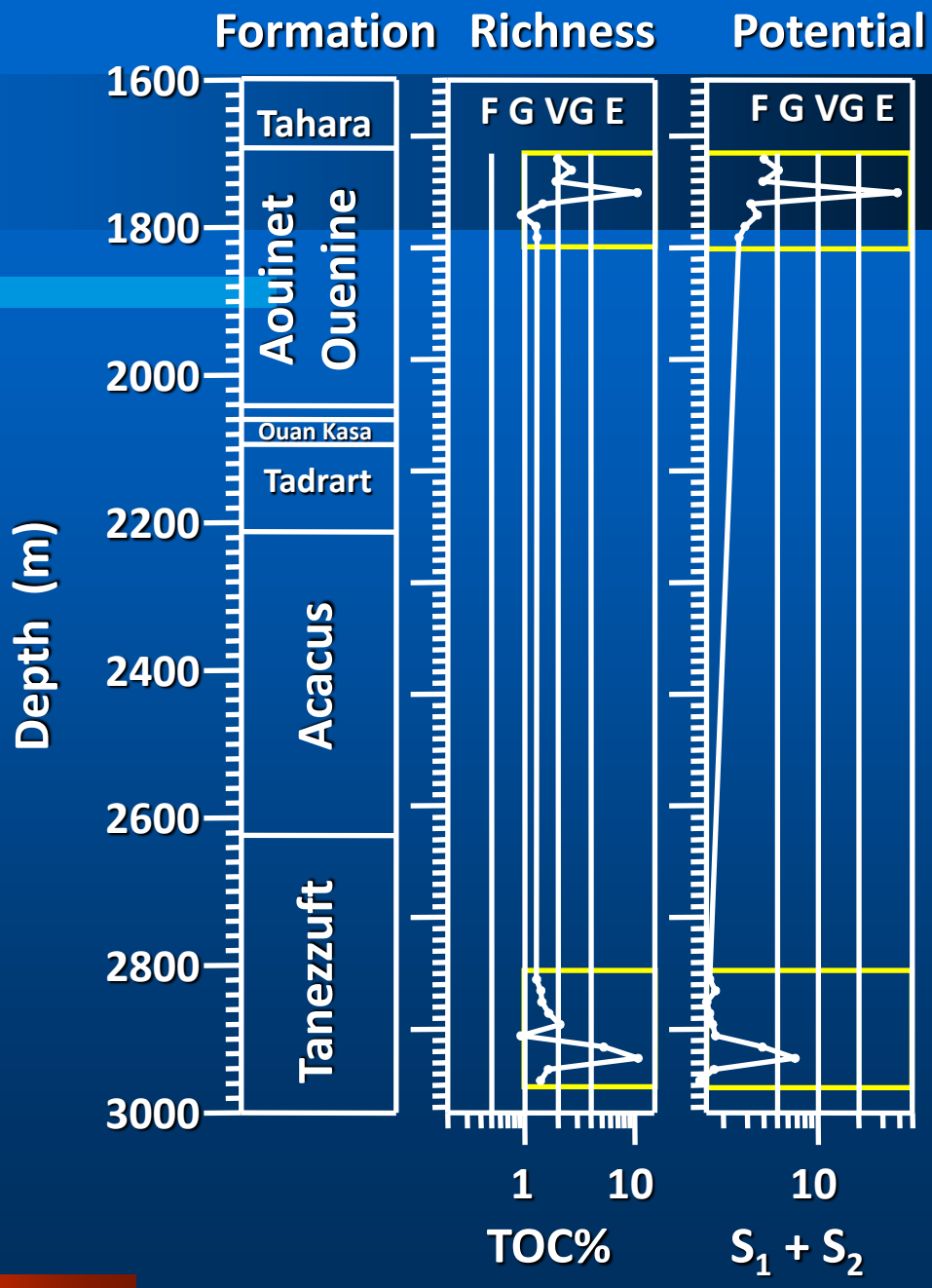
Silurian Kerogen Typing



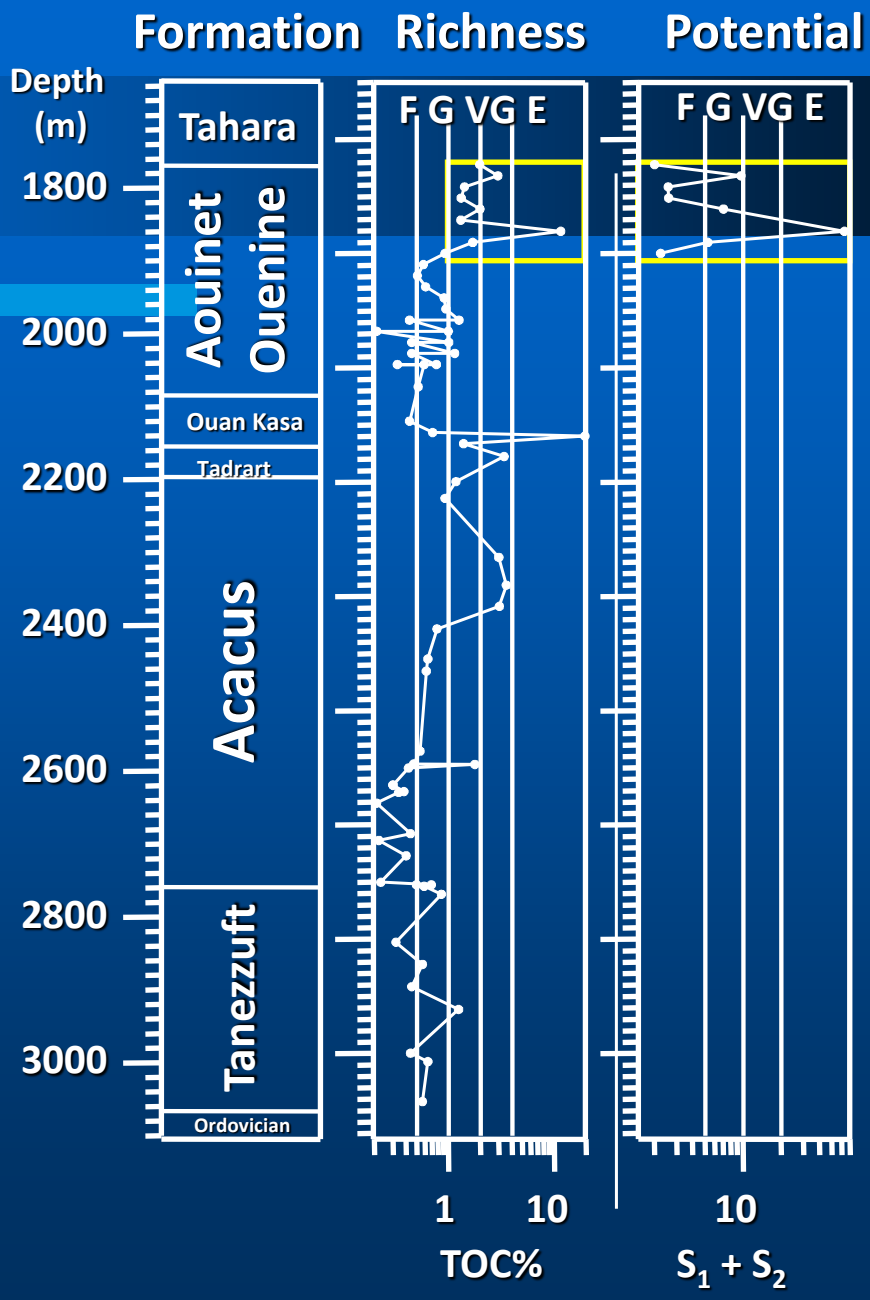
Devonian Kerogen Typing



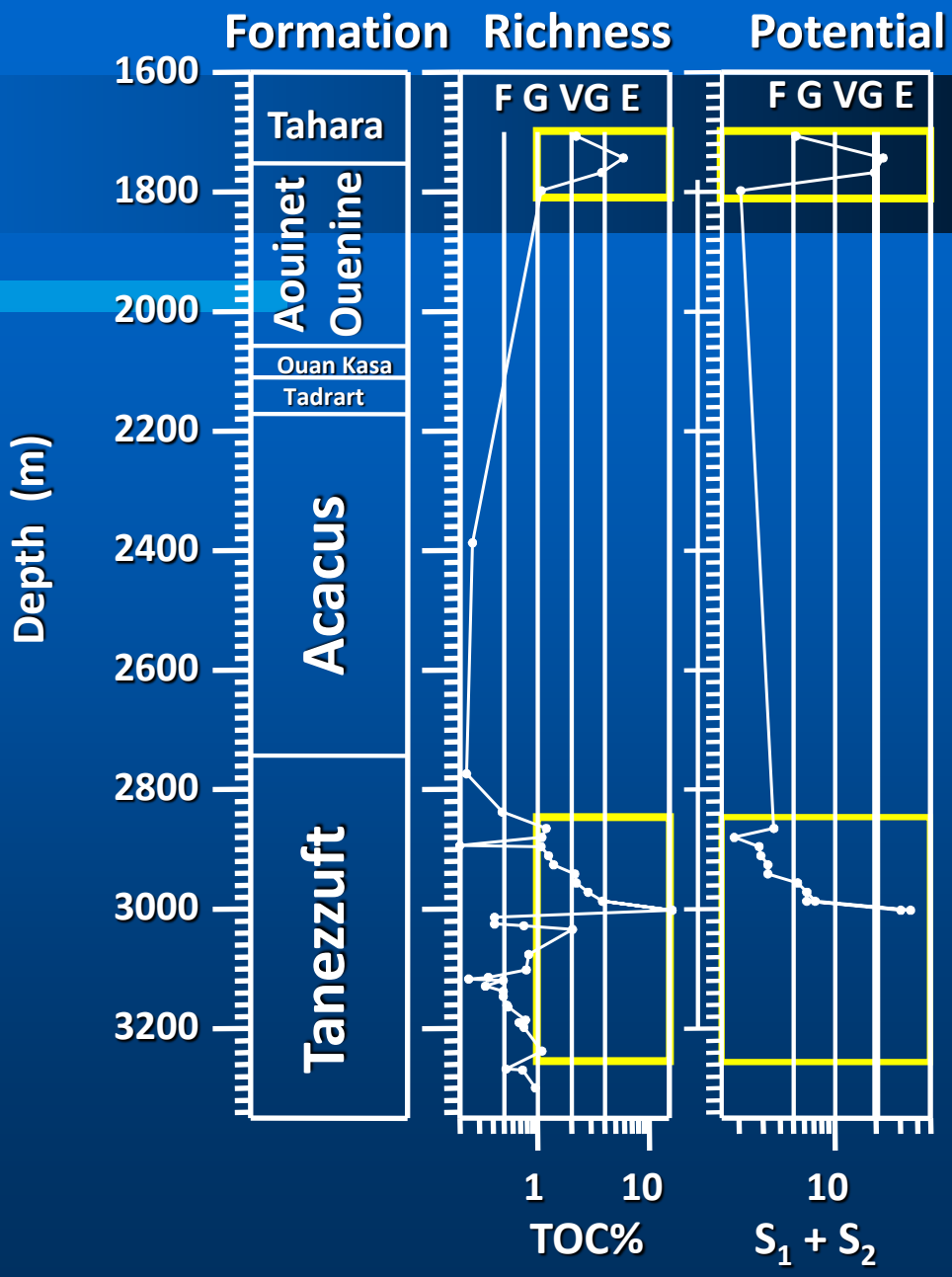
F1-26 Source potential



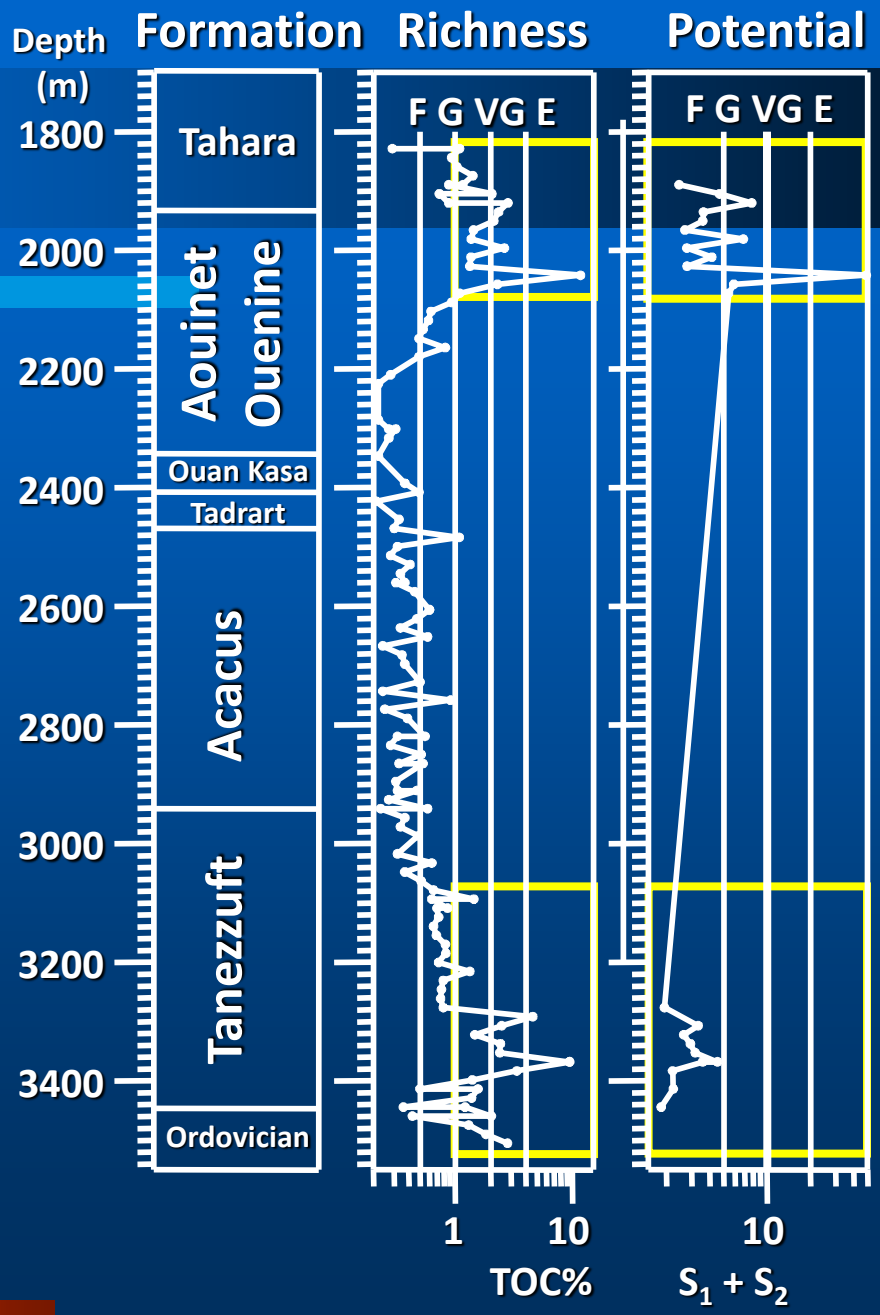
HH1 - NC7A Source potential



II1 - NC7A Source potential



M2 - NC7A Source potential



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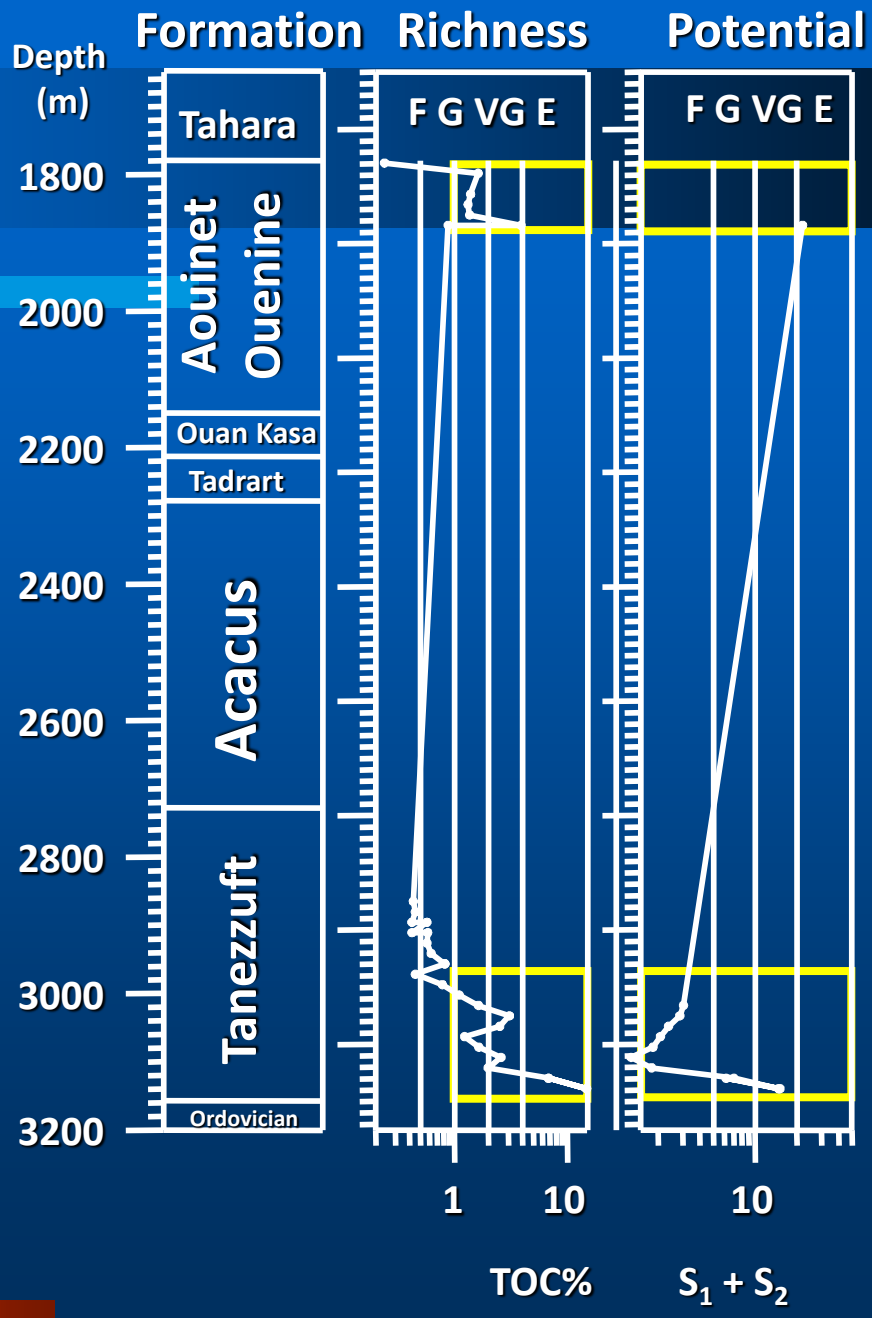
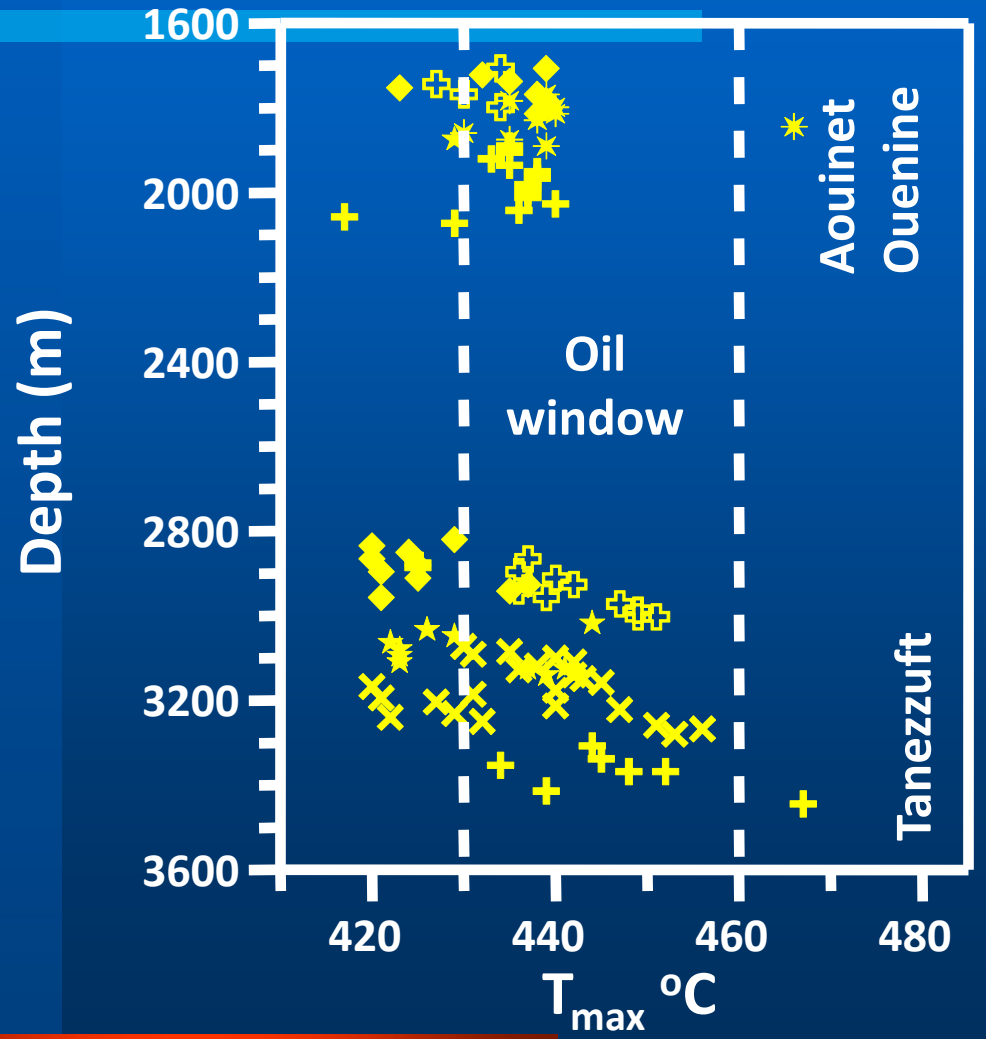
Q5 - NC7A Source potential



Maturity — Rock-Eval Pyrolysis



- F1-26
- GG1-NC7A
- HH1-NC7A
- II1-NC7A
- M2-NC7A
- Q5-NC7A

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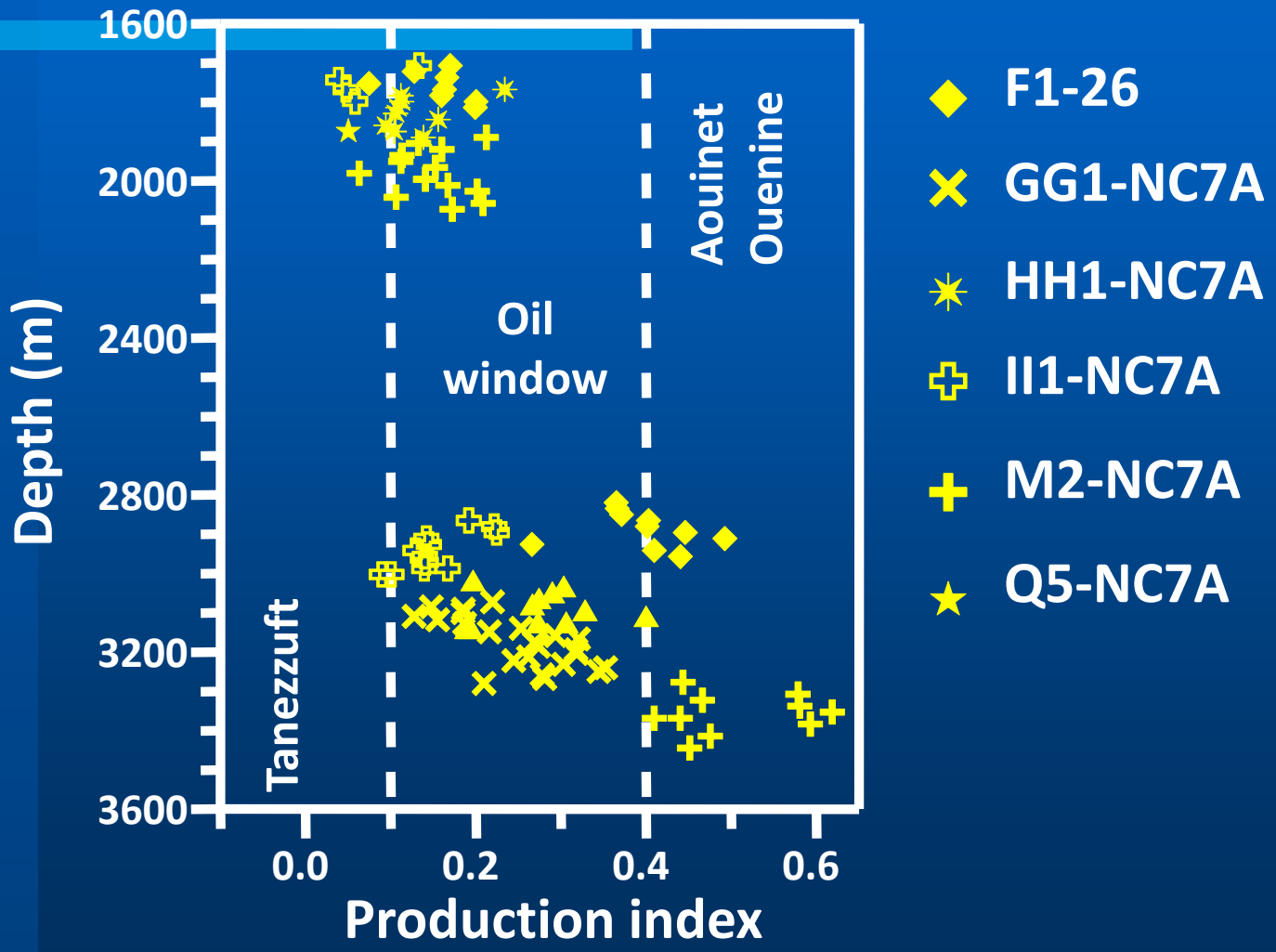
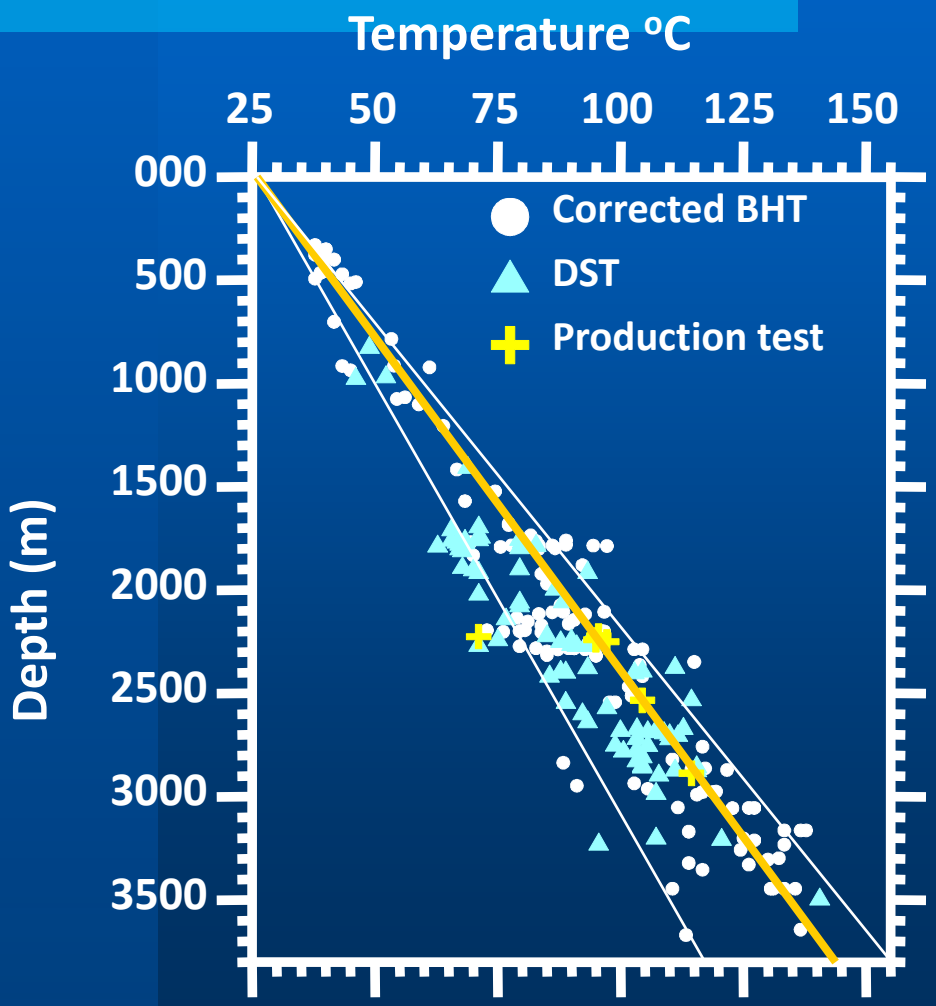
Maturity — Rock-Eval Pyrolysis



Present-day Temperatures



Average Gradient
3.1 °C/100 m

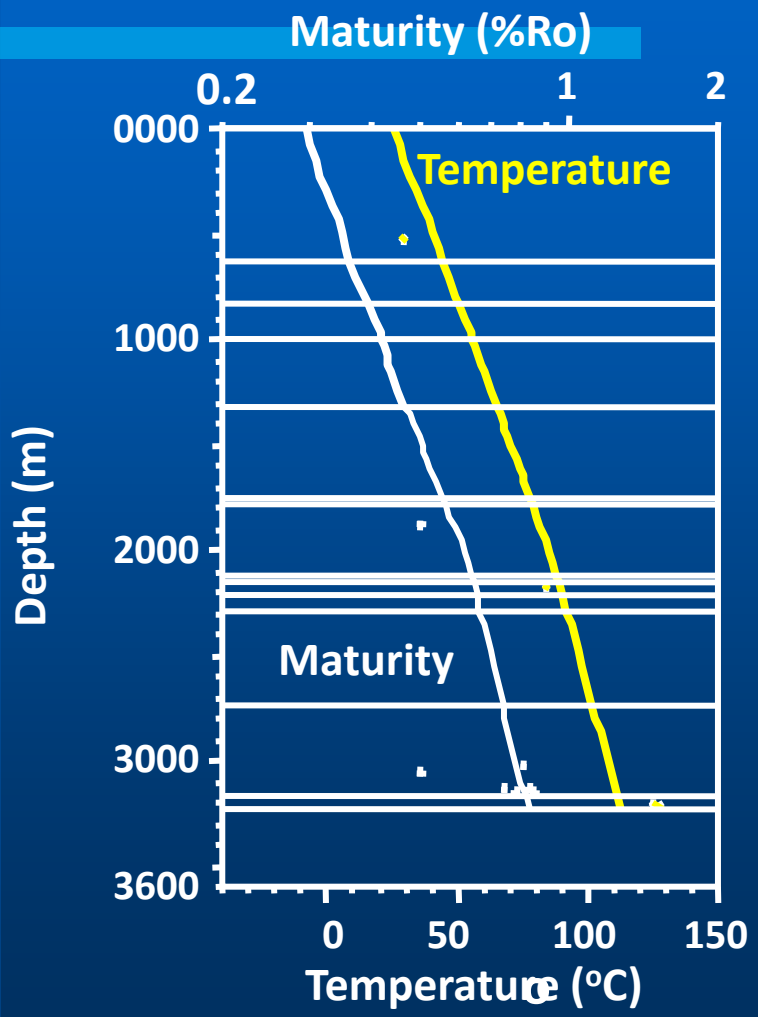
Minimum Gradient
2.4 °C/100 m

Maximum Gradient
3.4 °C/100 m

Modelling of 17 Wells

- Step 1: 1-D modelling of a single well location to Develop and constraint burial and thermal histories
- Step 2: 1-D modelling of multi-well locations to evaluate geographic maturity variation
- Step 3: 2-D modelling of a geological cross section to evaluate maturation timing across the region

Maturity Calibration – Q5-NC7A



Upper Cretaceous

Lower Cretaceous

Jurassic

Triassic

Permian-Carboniferous

Tahara Fm

Aouinet Ouenine

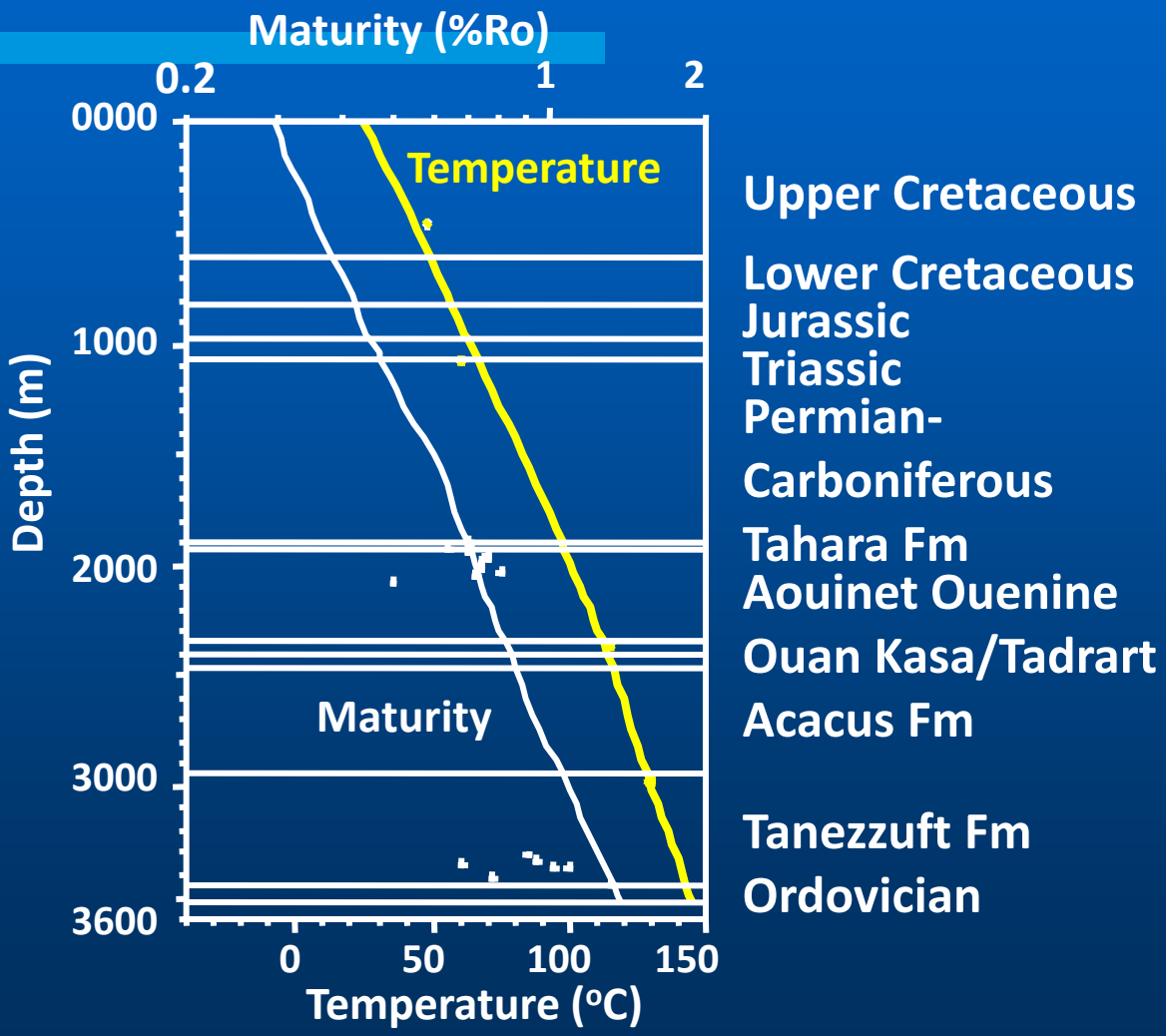
Ouan Kasa/Tadrart

Acacus Fm

Tanezzuft Fm

Ordovician

Maturity Calibration – M2-NC7A



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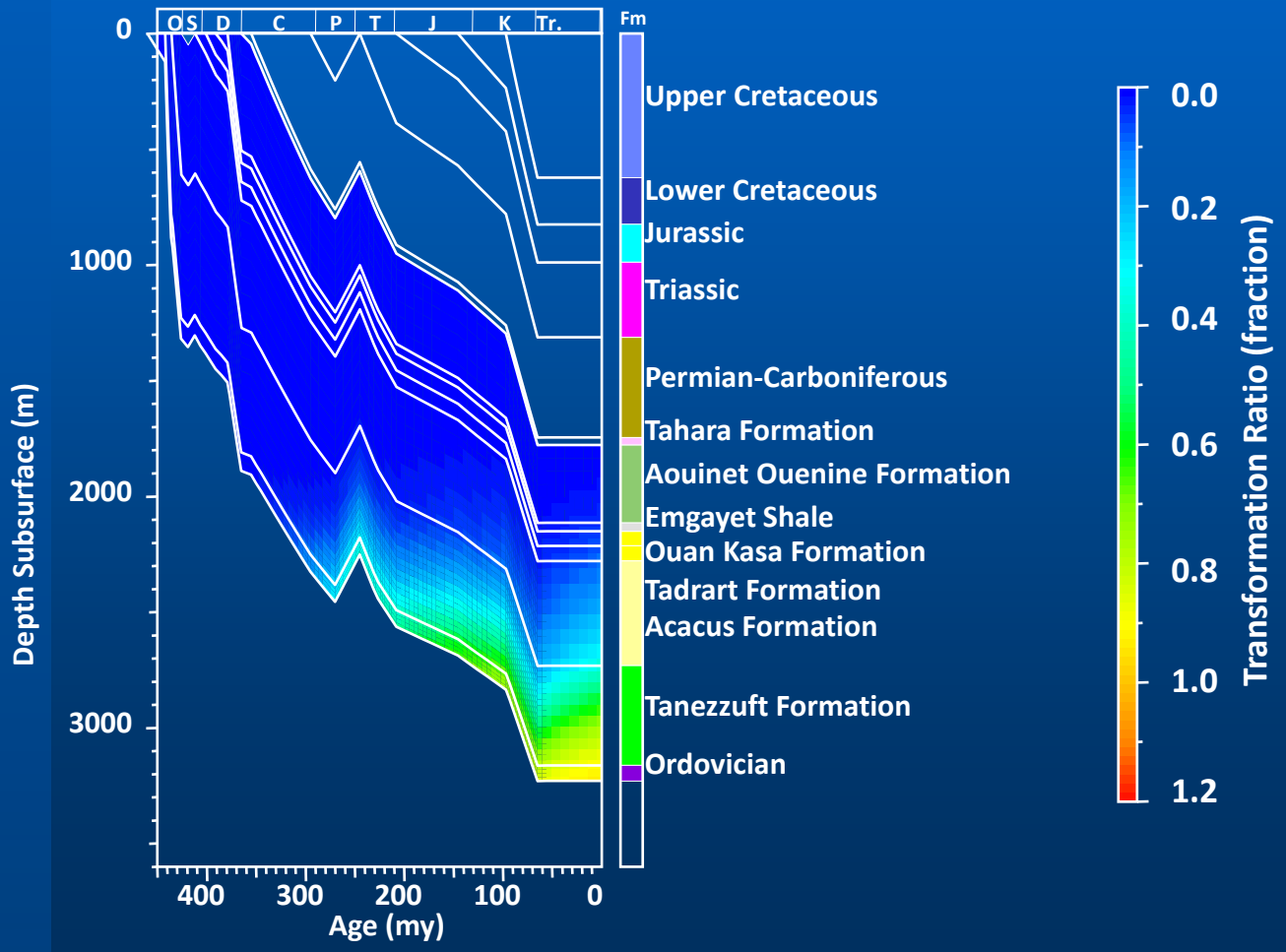
Maturation History — Q5-NC7A



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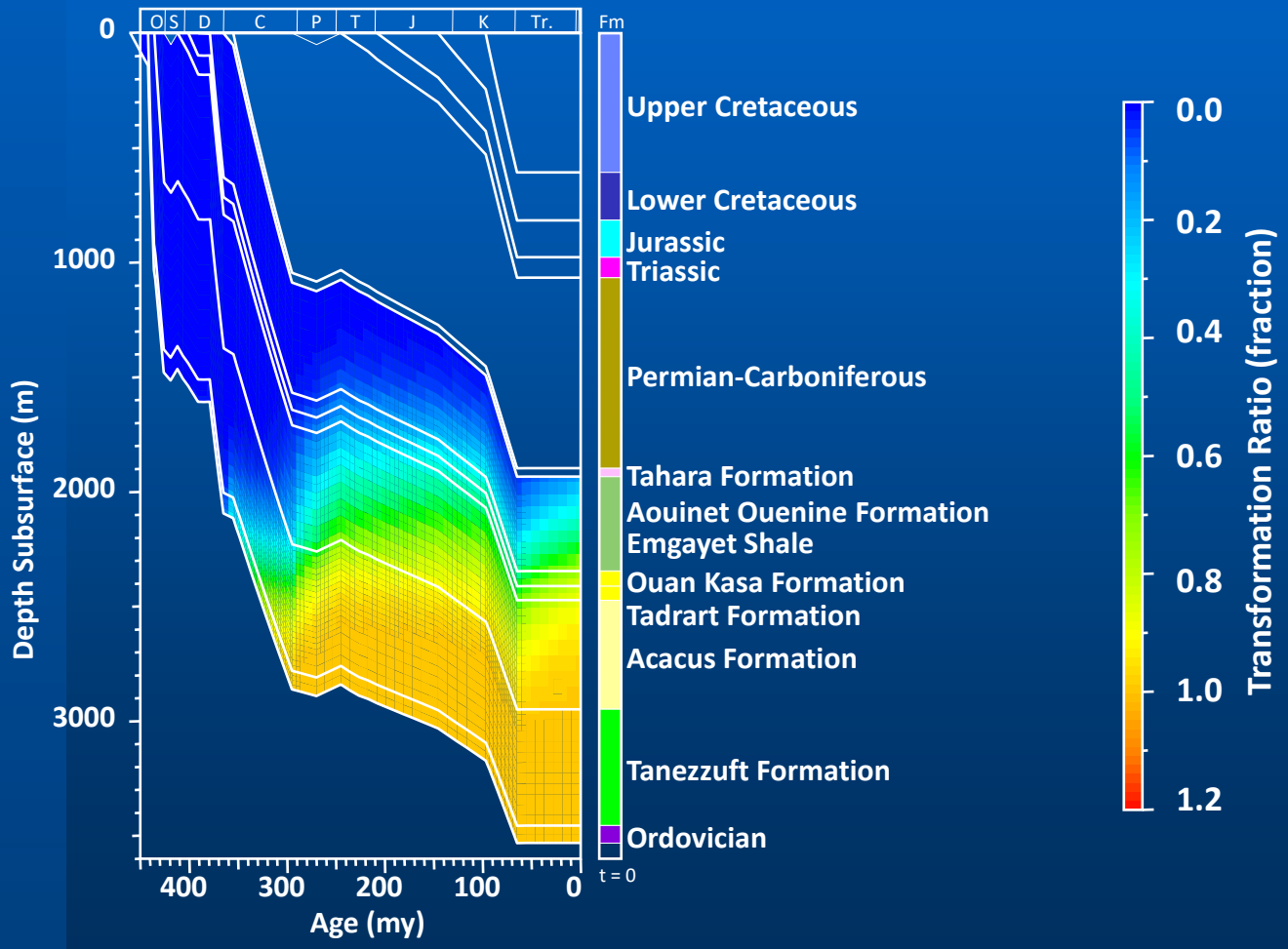
Maturation History — M2-NC7A



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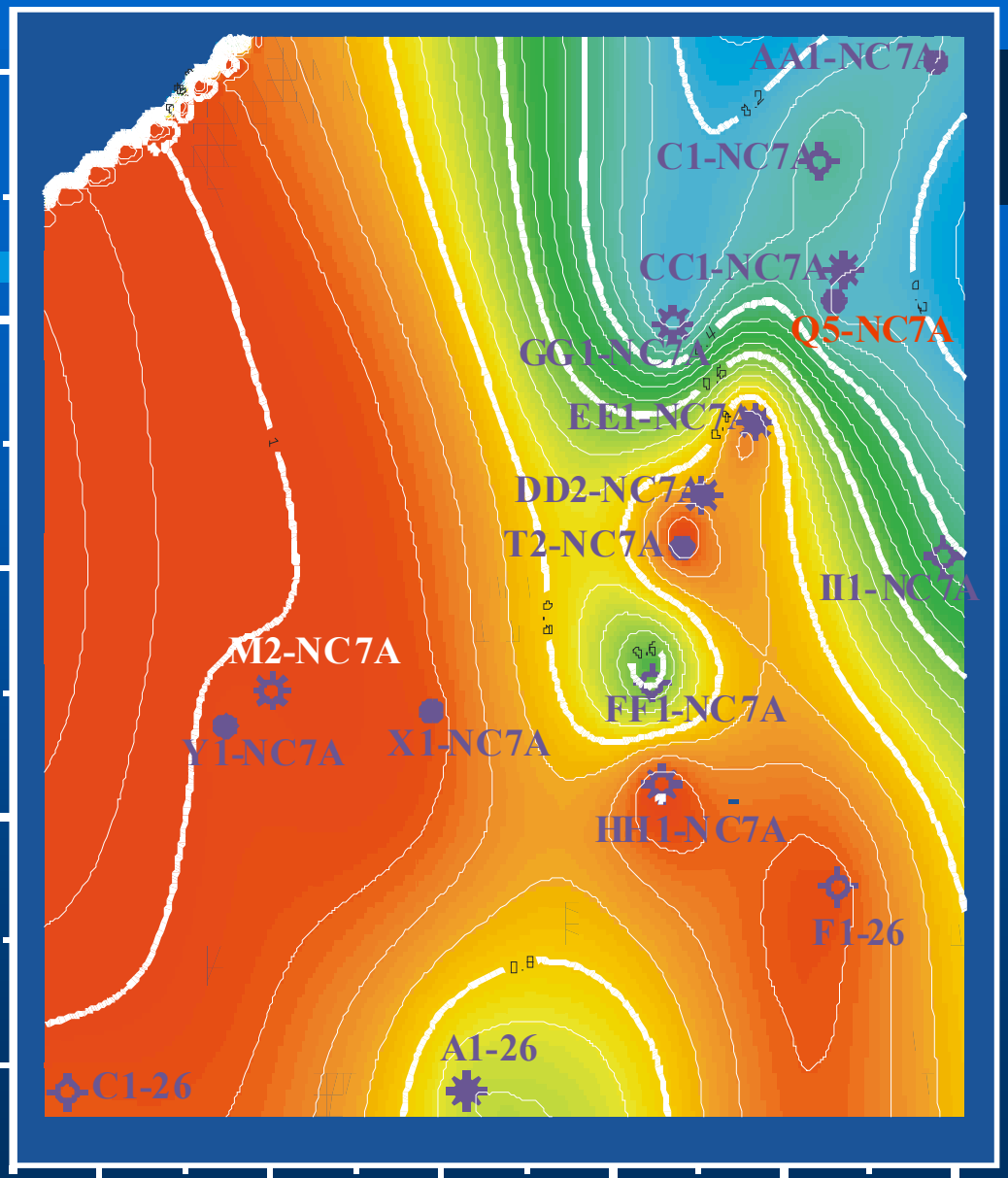
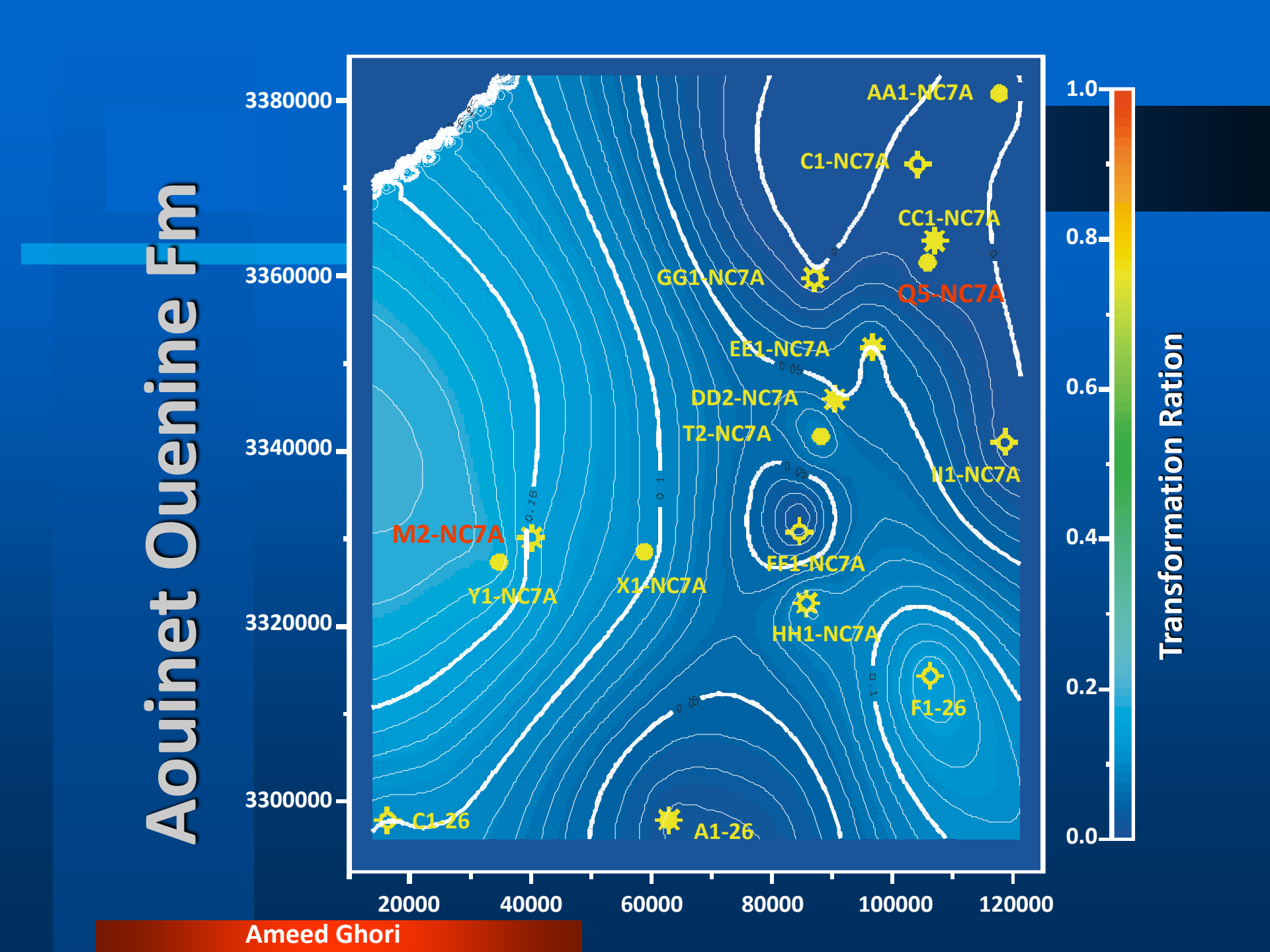
Tanezzuft Formation



Ameed Ghori


Aouinet Ouenine Fm
3380000
3360000
3340000
3320000
3300000
20000
40000
60000
80000
100000
120000
AA1-NC7A
C1-NC7A
CC1-NC7A
GG1-NC7A
Q5-NC7A
EE1-NC7A
DD2-NC7A
T2-NC7A
I1-NC7A
M2-NC7A
Y1-NC7A
X1-NC7A
FF1-NC7A
HH1-NC7A
F1-26
C1-26
A1-26
1.0
0.8
0.6
0.4
0.2
0.0
Transformation Ration
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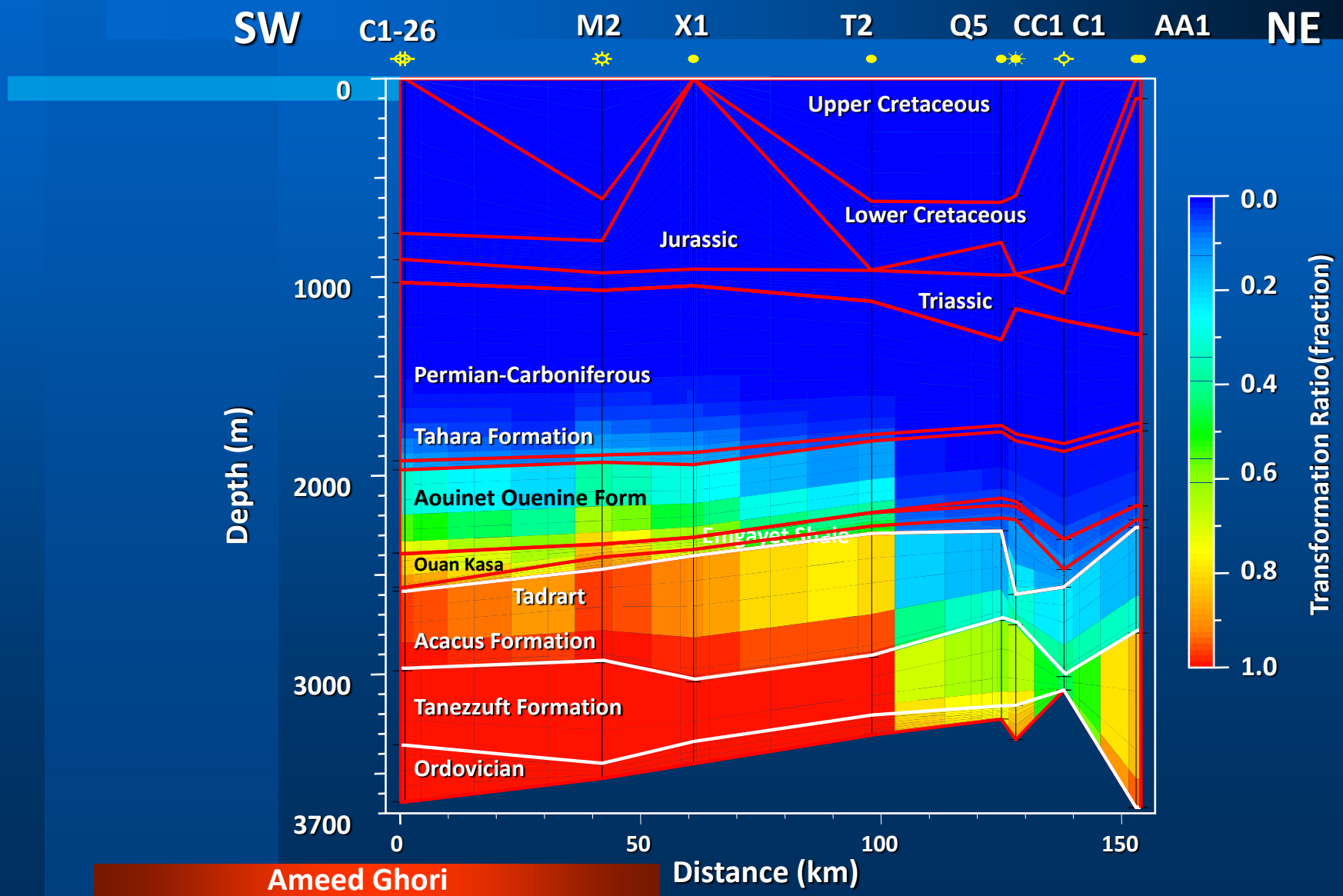
Transformation Ratio Cross Section at Present Day



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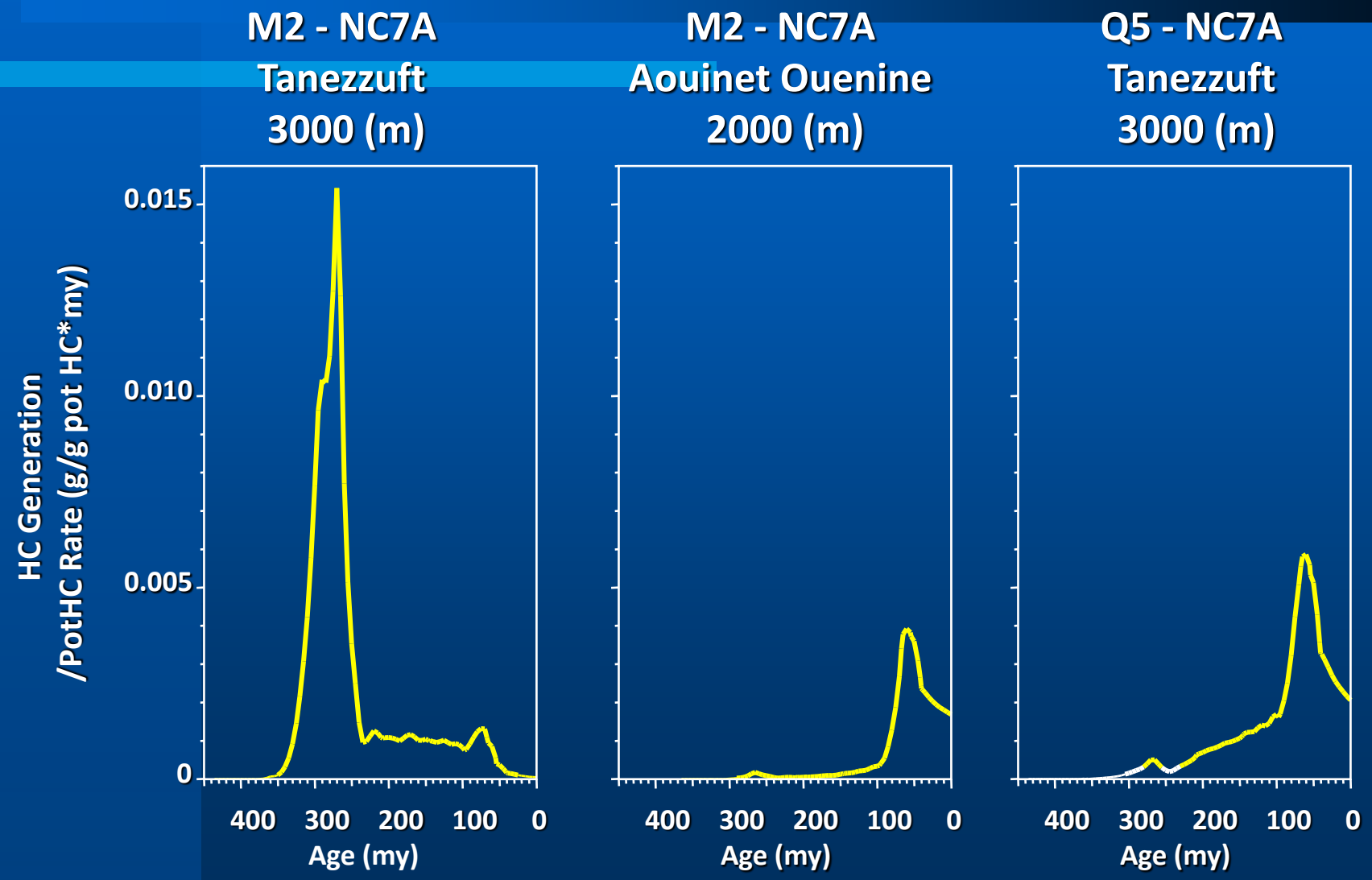
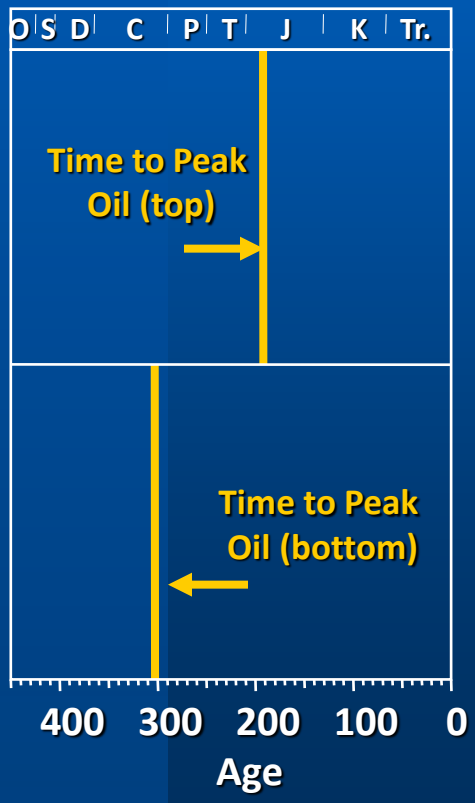
Charge Timing



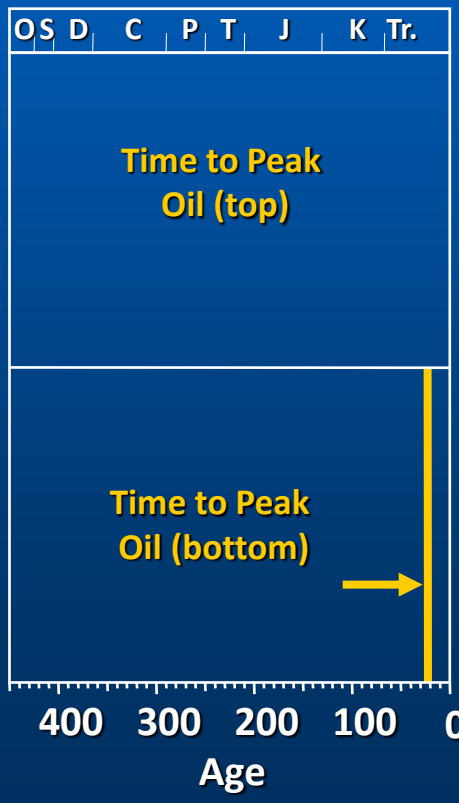
Petroleum Systems

Lower Silurian

M2-NC7A Tanezzuft

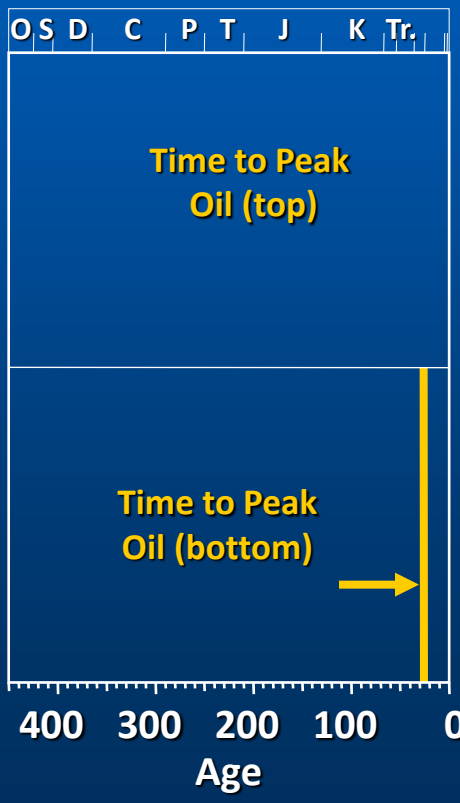


Q5-MC7A Tanezzuft



Upper Devonian

M2-NC7A Aouinet Ouenine



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Conclusions — 1

- **Lower Silurian Petroleum System**
  - Rich Tanezzuft source-beds within the basal 60–140 m thick section
  - First Charge Timing: Carboniferous–Permian
  - Second Charge Timing: Late Tertiary
- **Upper Devonian Petroleum System**
  - Rich Aouinet Ouenine source-beds within the upper 60–140 m thick section
  - Charge Timing: Late Tertiary

Conclusions — 2

- **Present-day Geothermal Gradient**
  - Average gradient: 3.1°C/100 m
  - Minimum gradient: 2.4°C/100 m
  - Maximum gradient: 3.4°C/100 m
- **Reservoirs** (Preservation Temperature Limit ~150°C)
  - Ordovician: Memouniat Formation
  - Silurian: Tanezzuft and Acacus Formations
  - Devonian: Tadrart, Ouan Kasa, Aouinet Ouenine, and Tahara Formations
  - Triassic: Ras Hamia Formation
  - Jurassic: Abreghs Formation

Thanks