Hydrous pyrolysis of Tertiary coals from central and southern Alaska: source rocks for oil?

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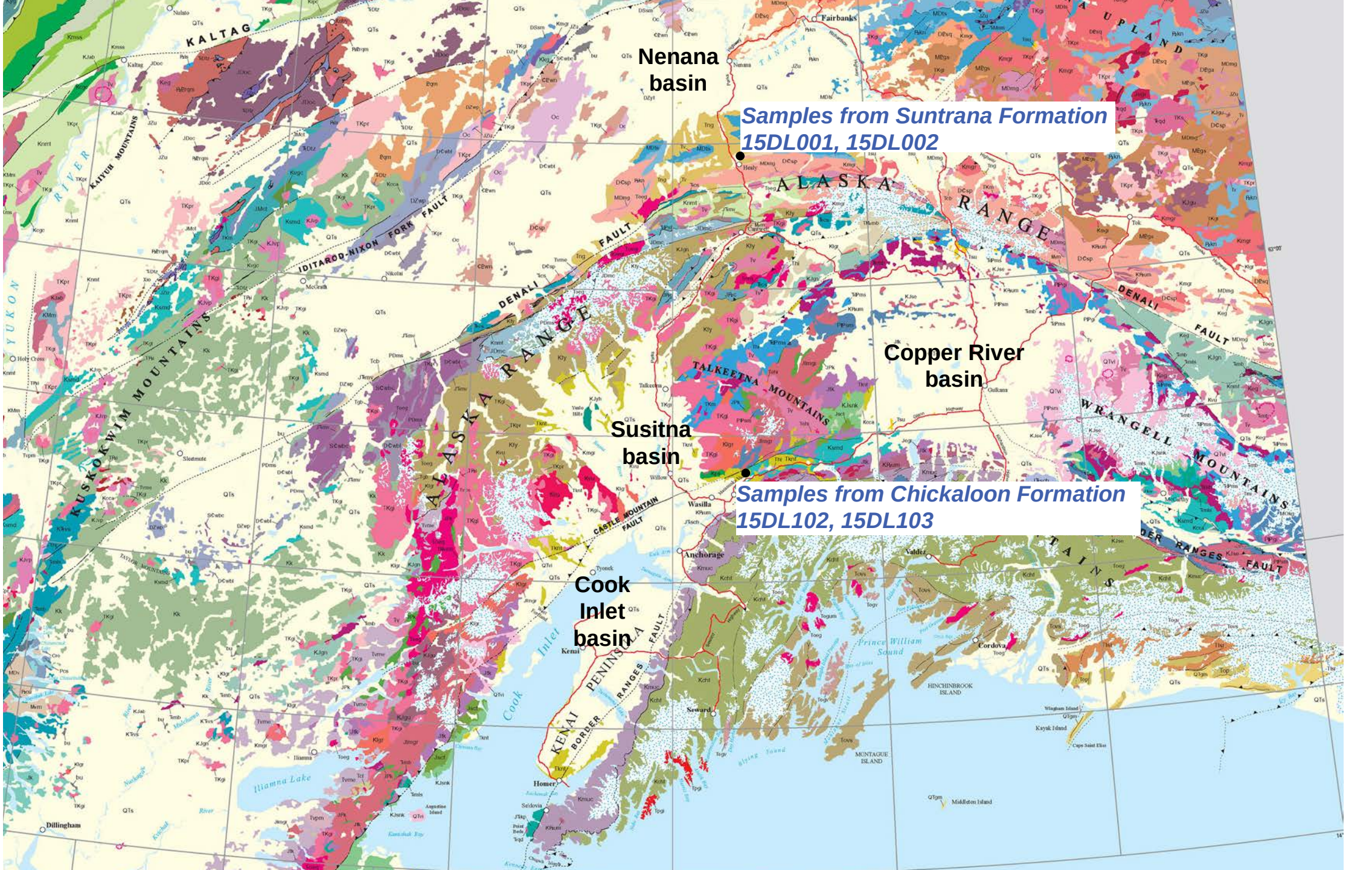
Summary

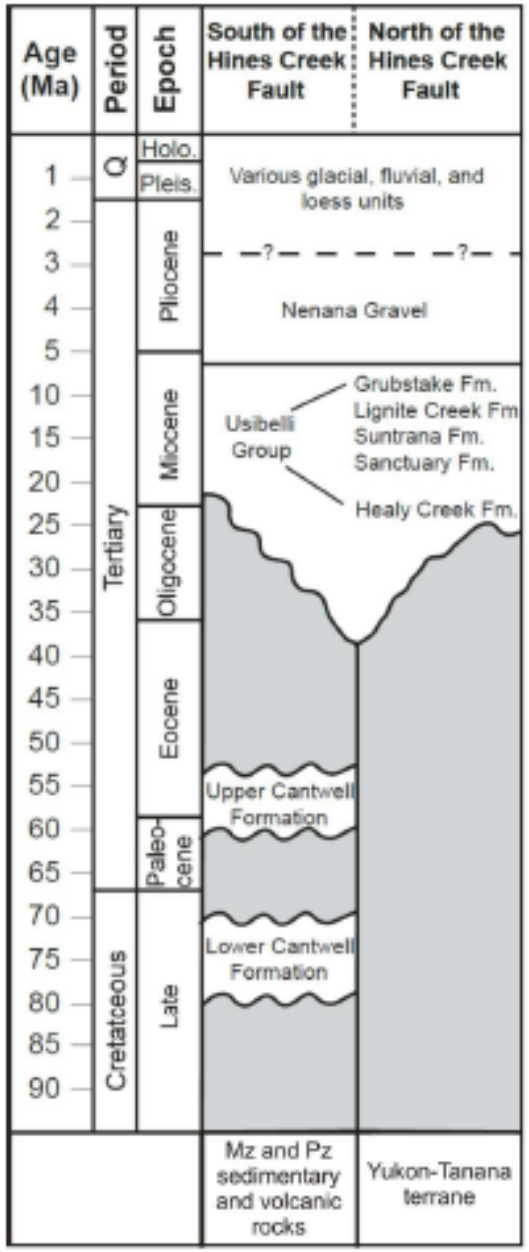
- Four Tertiary coals from Nenana/Susitna area of Alaska -
- Hydrous pyrolysis at 360°C/72 hours
- All four coals generated oil – 60 to 101 mg oil/gram TOC
- Oil characteristics – waxy (land plant), high pristane/phytane (>4)

Samples and Methods

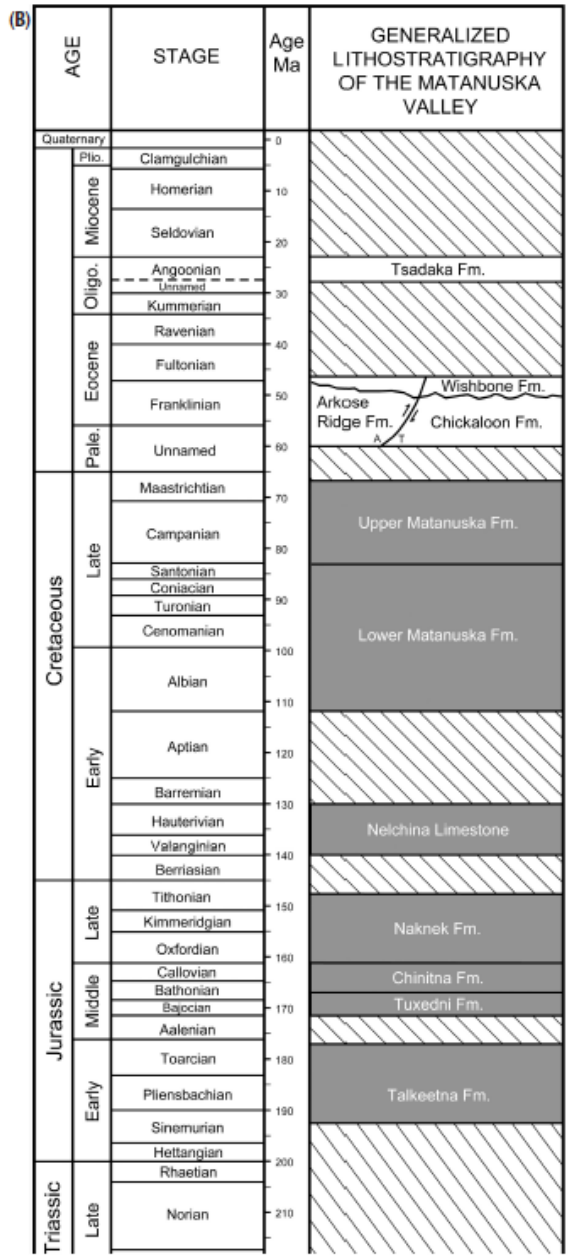
- Samples
  - Miocene Suntrana Fm. - Nenana Basin, Usibelli Mine, (2 smpls)
  - Paleogene Chickaloon Fm. - Matanuska Valley (SE of Susitna Basin), (2 smpls)
- Methods
  - Hydrous pyrolysis 360°C/72 hours of 250 grams coal
  - Collected free oil, gas, and spent rock
  - Gas chromatography – whole oil completed
  - Rock-Eval and vitrinite reflectance of original and spent coals after HP
- Planned analyses
  - bulk and molecular characterization of oils
  - H/C of original coals and spent coals after HP experiments


Nenana basin
Samples from Suntrana Formation
15DL001, 15DL002
Copper River basin
Susitna basin
Samples from Chickaloon Formation
15DL102, 15DL103
Cook Inlet basin
KALTAG
KAIYUH MOUNTAINS
IDITAROD-NIXON FORK FAULT
DENALI FAULT
ALASKA RANGE
KUSKOKWIM MOUNTAINS
TALKEETNA MOUNTAINS
WRANGELL MOUNTAINS
CASTLE MOUNTAIN FAULT
KENAI PENINSULA BORDER RANGES FAULT
Fairbanks
Nenana
Healy
Tok
McGrath
Talkeetna
Willow
Wasilla
Anchorage
Valdez
Cordova
Seward
Kenai
Homer
Dillingham
Sleetmute
Holy Cross
Nikolai
Gulkana
Cook Inlet
Prince William Sound
Iliamna Lake
HINCHINBROOK ISLAND
MONTAGUE ISLAND
Middleton Island

Nenana Basin

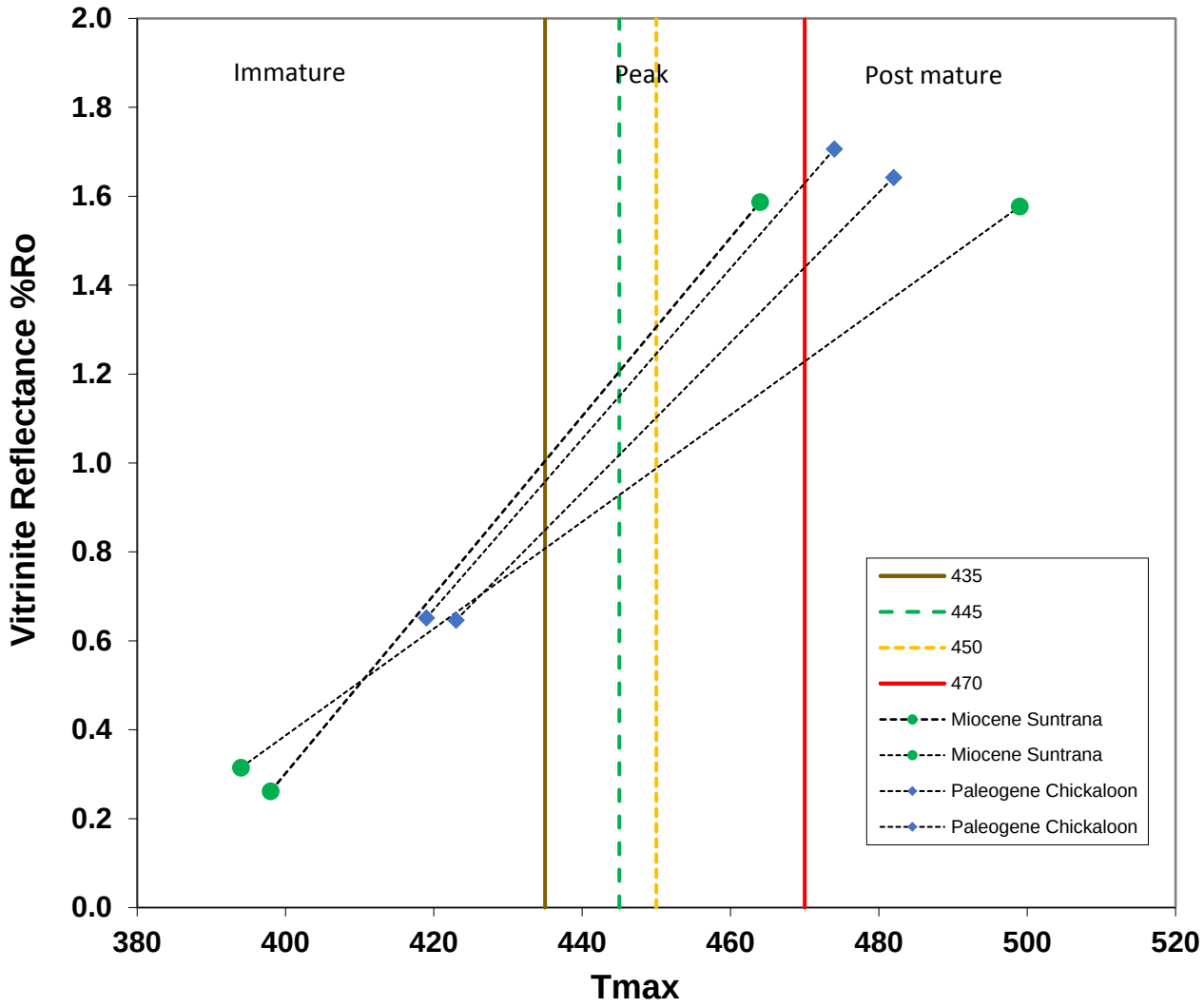


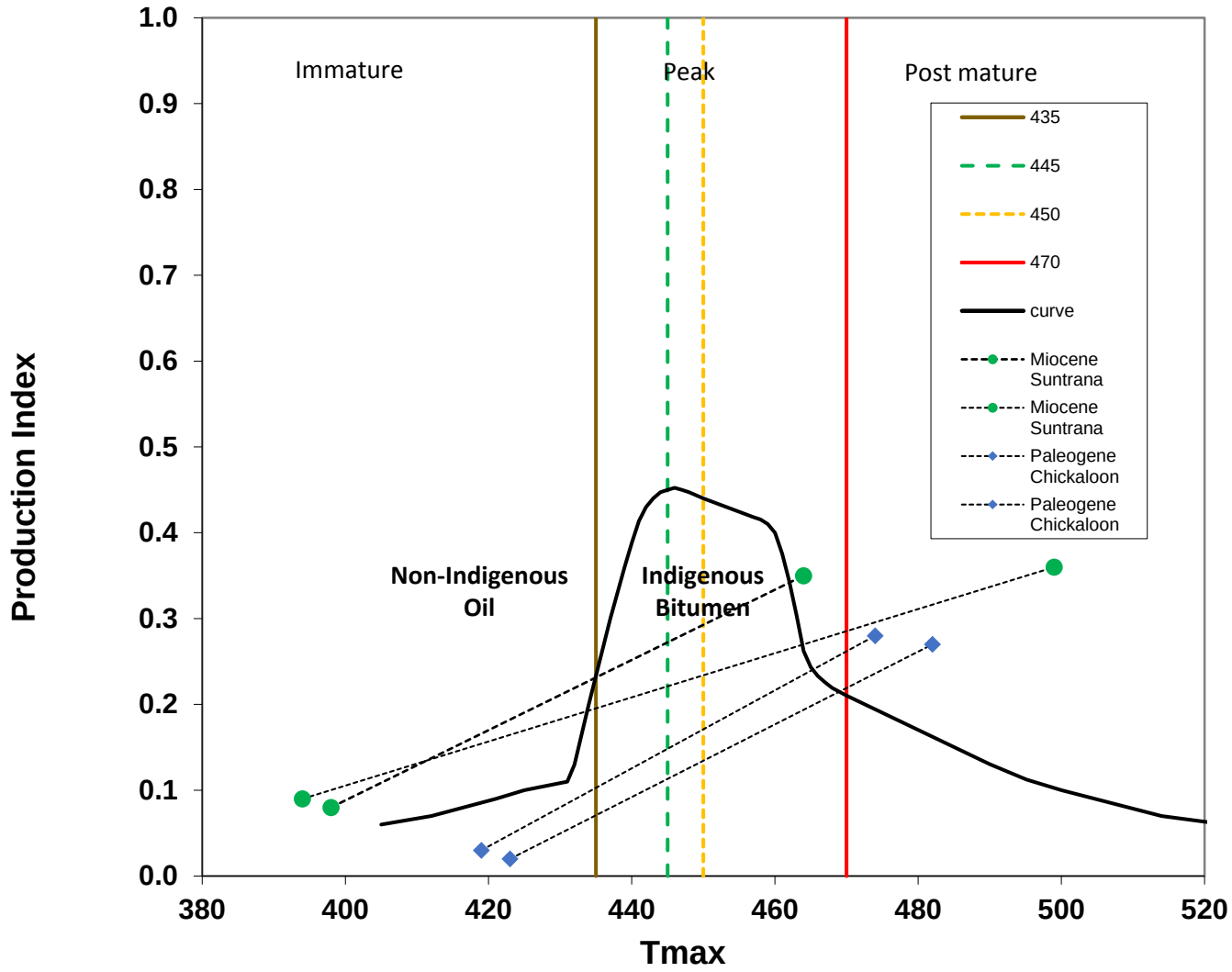
Matanuska Valley

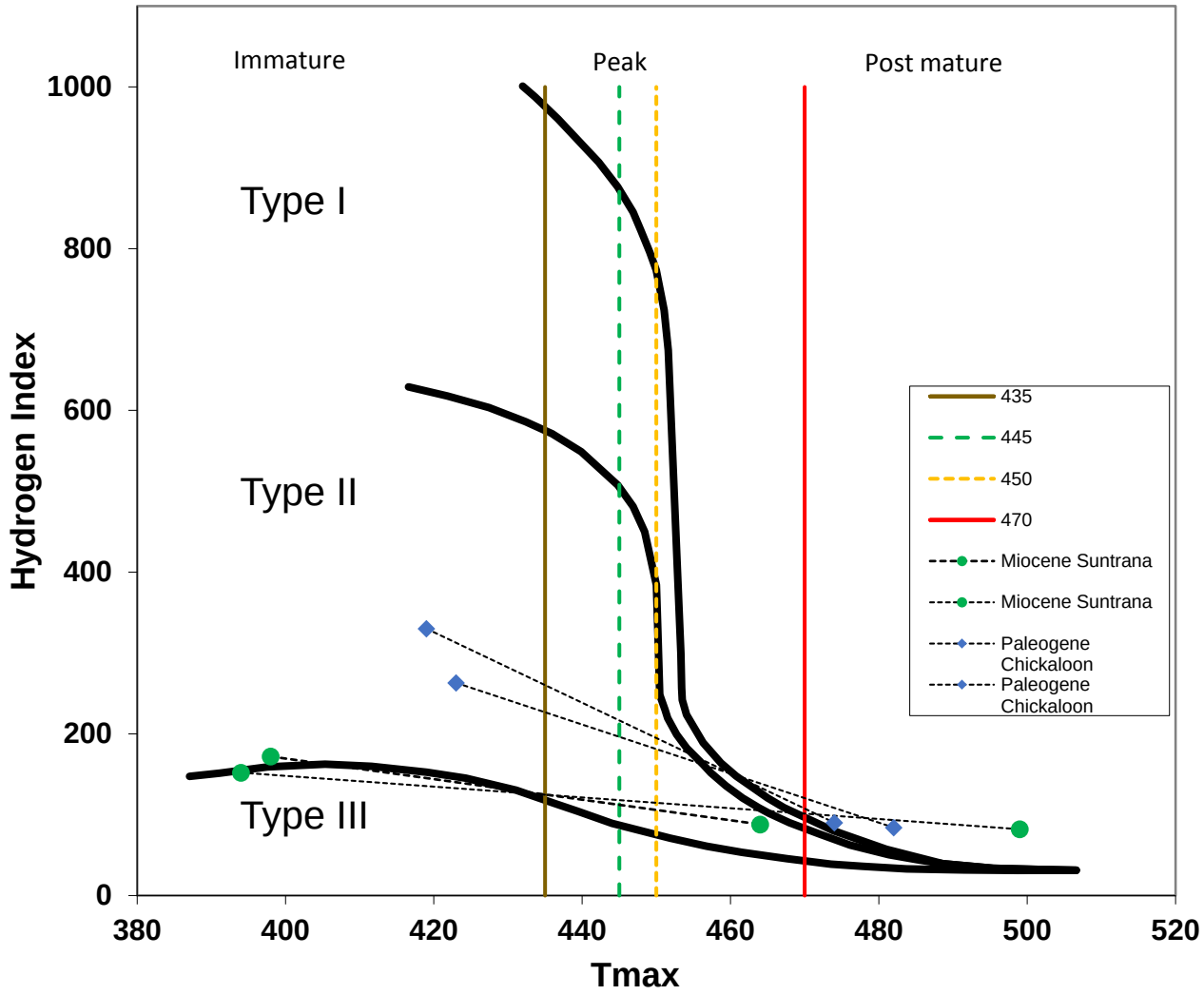


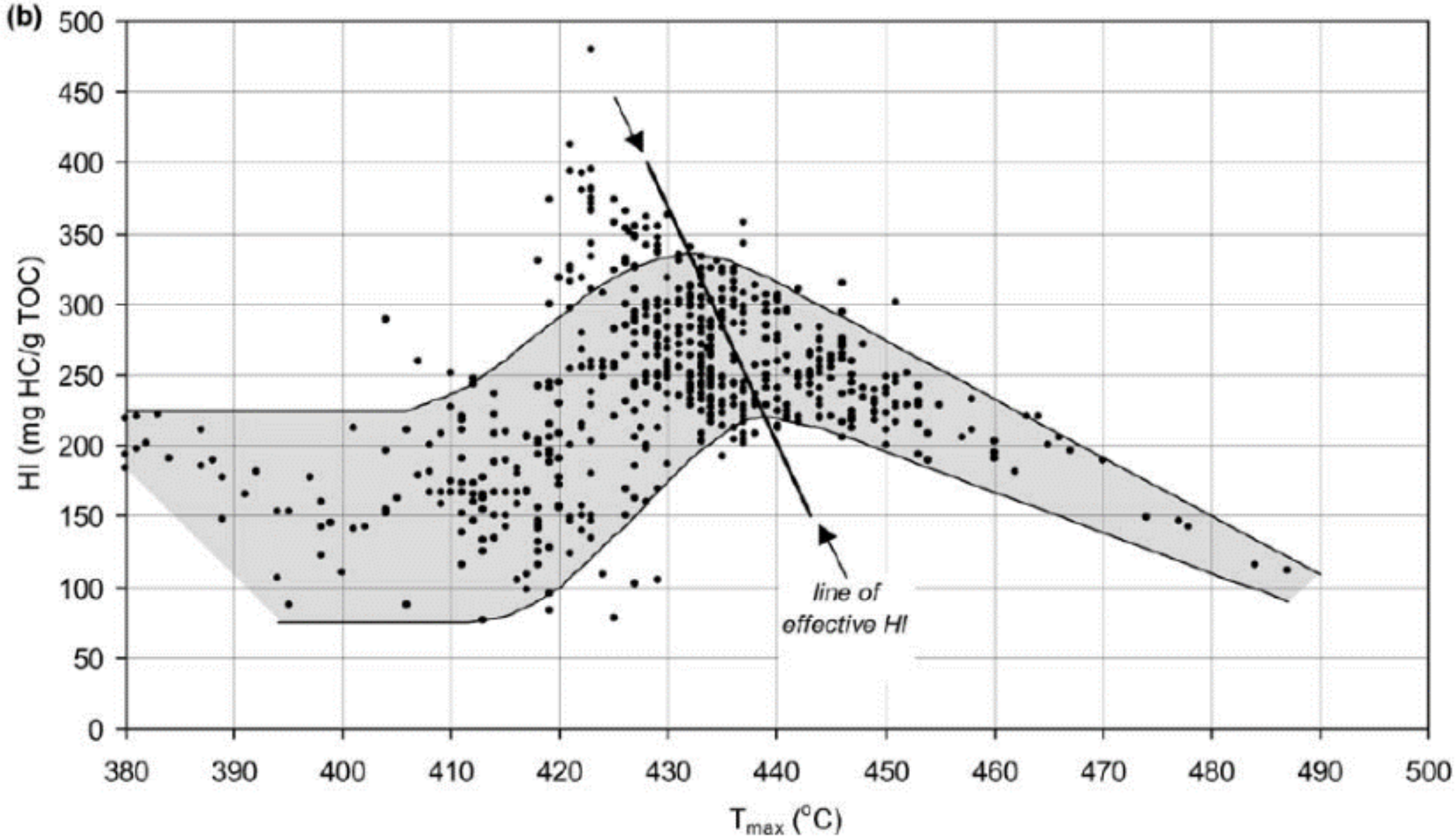
Results

- Good oil generation yields – 65 to 107 mg oil / gram TOC
  - Similar to other oil generative coals worldwide
- Gas yields – no compositions as yet
- Oil composition consistent with natural oils from coal sources
  - Waxy – high concentration of n-C_{22} +
  - Odd-carbon # predominance – n-C_{23} C_{25} C_{27} C_{29} etc (land plants)
  - High pristane/phytane ratio > 4

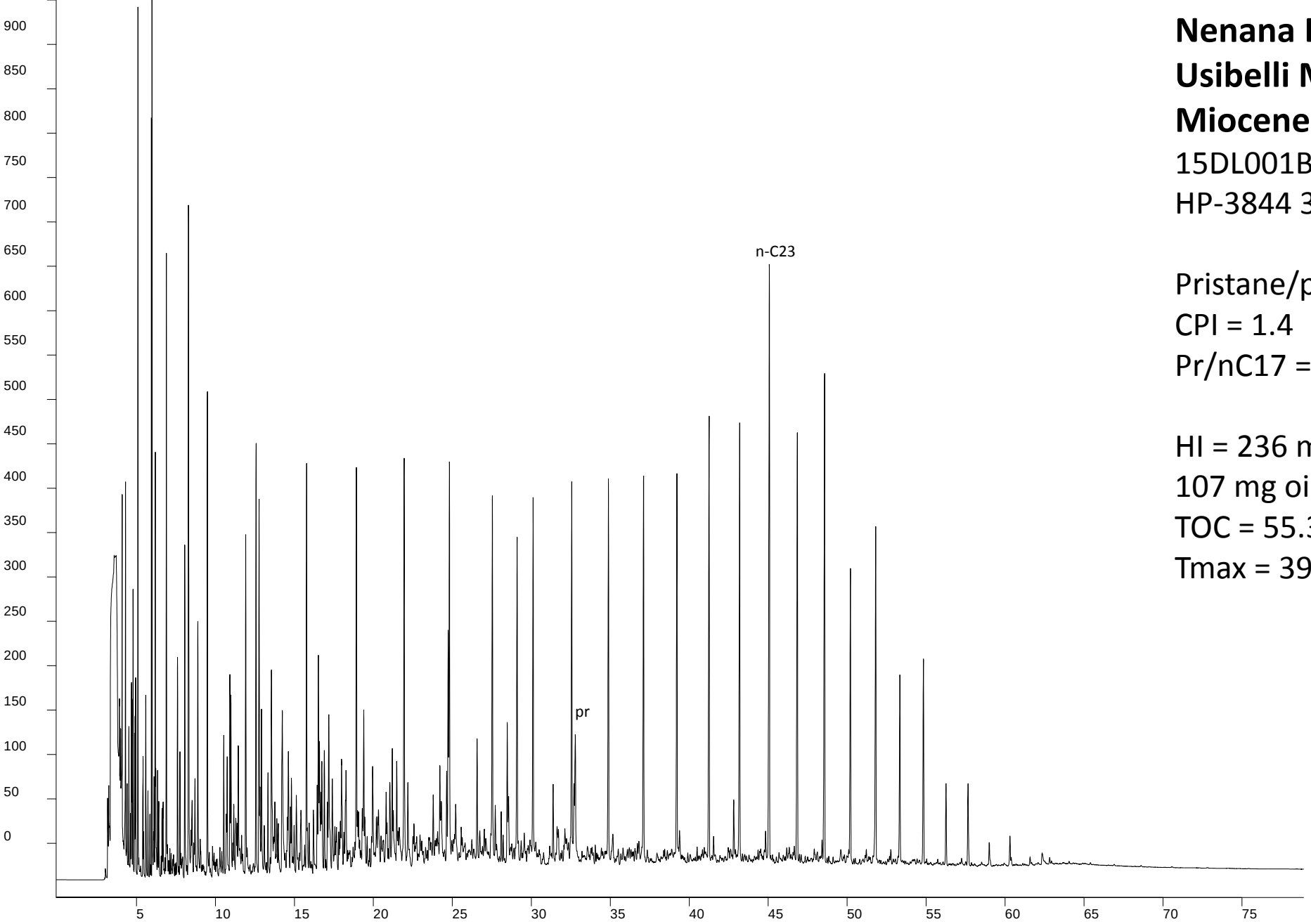

Immature
Peak
Post mature
Vitrinite Reflectance %Ro
Tmax
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
380
400
420
440
460
480
500
520
435
445
450
470
Miocene Suntrana
Miocene Suntrana
Paleogene Chickaloon
Paleogene Chickaloon


Production Index
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
380
400
420
440
460
480
500
520
Tmax
Immature
Peak
Post mature
Non-Indigenous Oil
Indigenous Bitumen
435
445
450
470
curve
Miocene Suntrana
Miocene Suntrana
Paleogene Chickaloon
Paleogene Chickaloon


Immature
Peak
Post mature
Type I
Type II
Type III
Hydrogen Index
Tmax
1000
800
600
400
200
0
380
400
420
440
460
480
500
520
435
445
450
470
Miocene Suntrana
Miocene Suntrana
Paleogene Chickaloon
Paleogene Chickaloon



Sykes and Snowdon 2002



Nenana Basin
Usibelli Mine
Miocene Suntrana Fm.
15DL001B
HP-3844 360°C/72hr

Pristane/phytane = 4.2
CPI = 1.4
Pr/nC17 = 0.34

HI = 236 mg HC/g TOC
107 mg oil/g TOC
TOC = 55.3 wt%
Tmax = 397 °C

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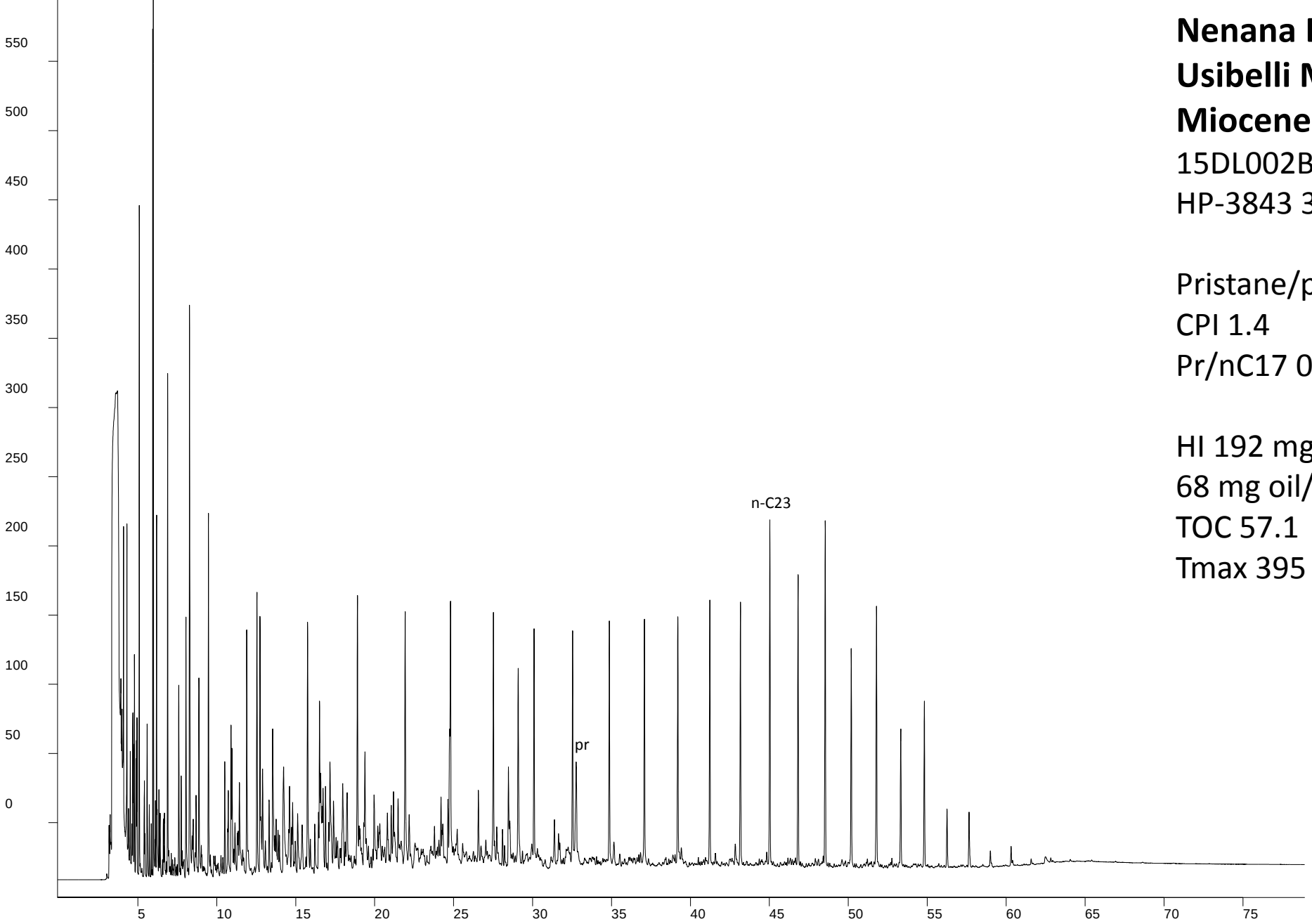

Nenana Basin
Usibelli Mine
Miocene Suntrana Fm.
15DL002B
HP-3843 360°C/72hr

Pristane/phytane 4.5
CPI 1.4
Pr/nC17 0.44

HI 192 mg HC/g TOC
68 mg oil/g TOC
TOC 57.1
Tmax 395 °C

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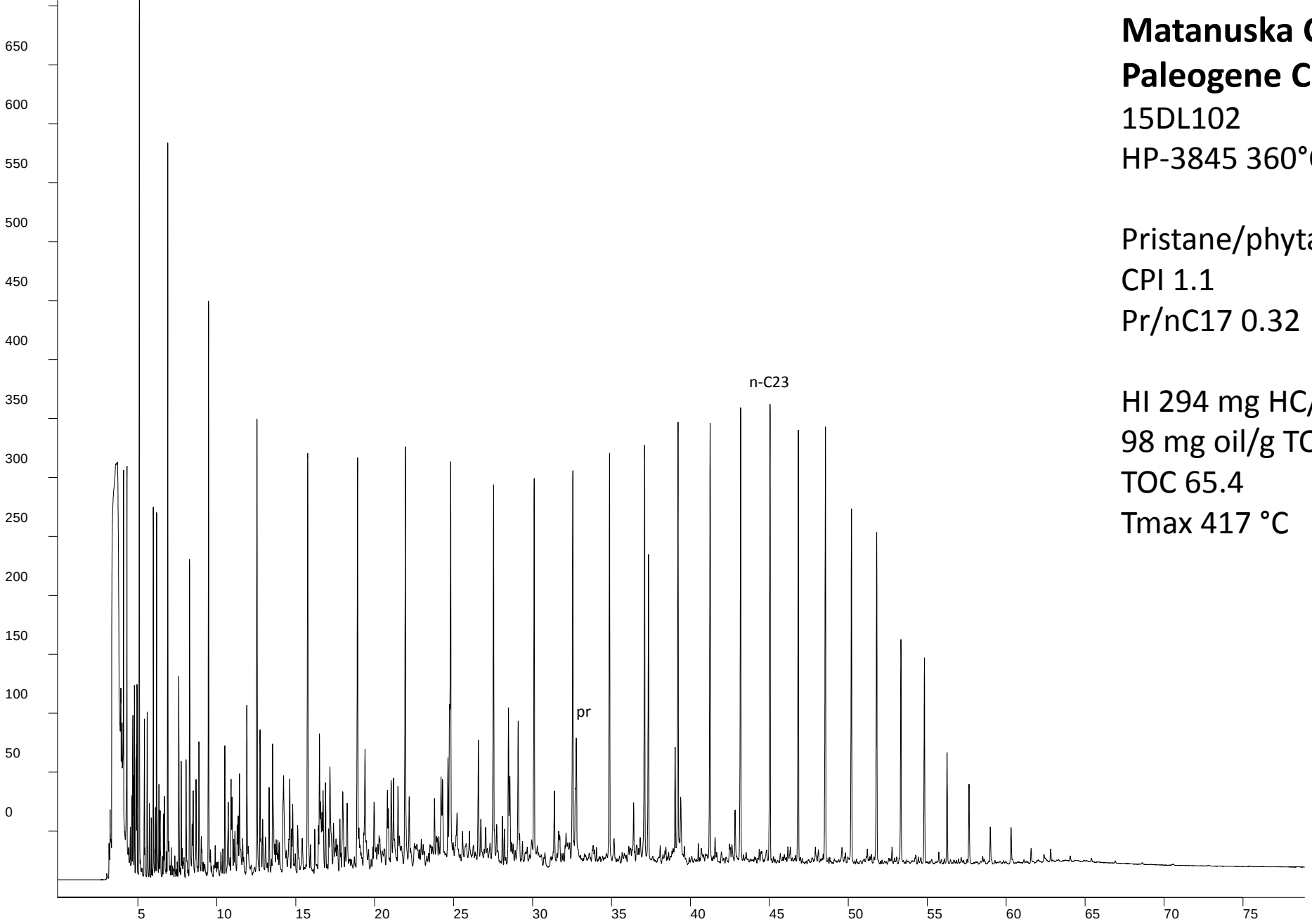

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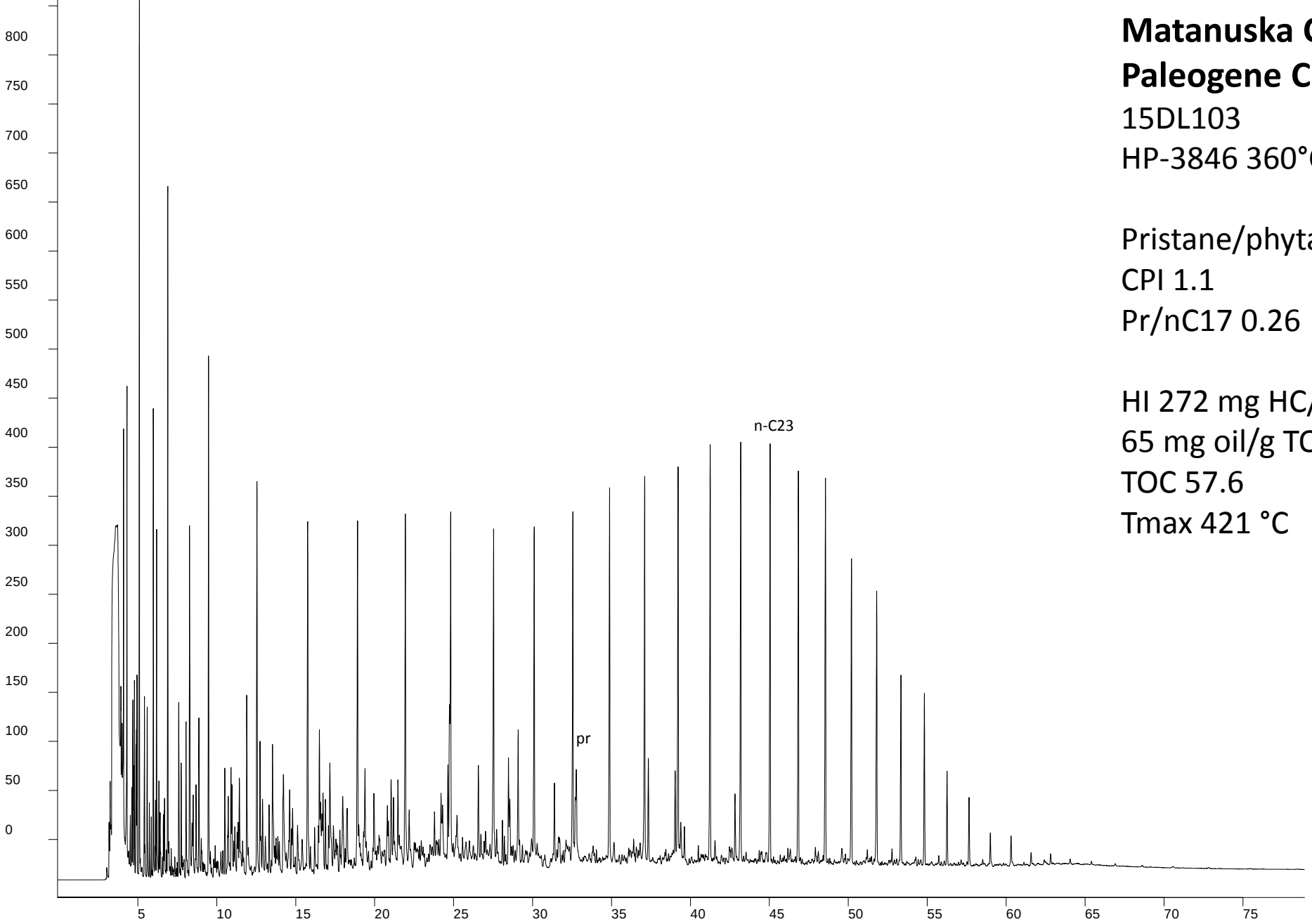
Matanuska Coal Field
Paleogene Chickaloon Fm.
15DL102
HP-3845 360°C/72hr

Pristane/phytane 4.7
CPI 1.1
Pr/nC17 0.32

HI 294 mg HC/g TOC
98 mg oil/g TOC
TOC 65.4
Tmax 417 °C



Matanuska Coal Field
Paleogene Chickaloon Fm.
15DL103
HP-3846 360°C/72hr

Pristane/phytane 4.1
CPI 1.1
Pr/nC17 0.26

HI 272 mg HC/g TOC
65 mg oil/g TOC
TOC 57.6
Tmax 421 °C

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Oil Yield Considerations

- Yield is a function of thermal maturity/experiment conditions
  - Hydrous pyrolysis 360°C/72 hours is equivalent to %Ro between 1.30 to 1.51 in other coals (no data yet here)
  - Maximum yield may be at a lower temperature/time (e.g. 340°C/72hrs)
- Yield is a function of H/C (hydrogen index as a fair proxy)
- Yield is a function of expulsion efficiency
  - Generated oil adsorbed by gas-prone kerogen
- Hydrous pyrolysis exaggerates oil expulsion by a factor of 50%

Other coals worldwide – Oil yield

Paleocene Calvert Bluff Fm. (Wilcox Gp)

- 61.5% TOC
- 261 HI
- 125.2 mg/g coal at 350°C/96hrs

Paleogene Imo Shale (Nigeria)

- 63.46% TOC
- 481 HI
- 259 mg/g TOC fr. Sequential 330°C/72 + 355°C/72hrs

Cretaceous Almond Fm. (Wyoming)

- 69% TOC
- 150 HI
- 21 mg/g coal at 360°C/ 72hrs

Paleocene Sentinel Butte Fm. (N. Dakota)

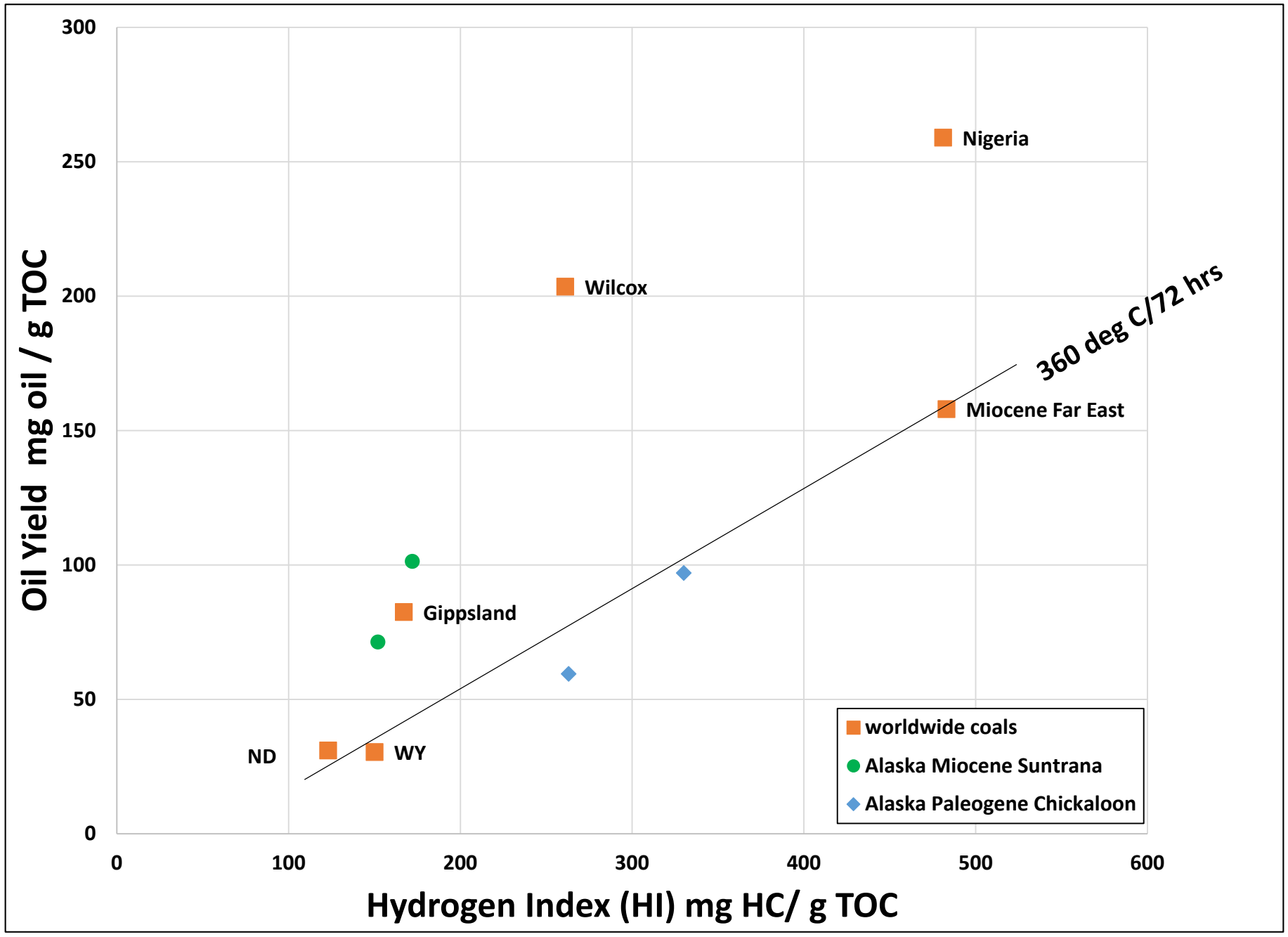
- 55.3% TOC
- 123 HI
- 31 mg/g TOC at 360°C/72hrs

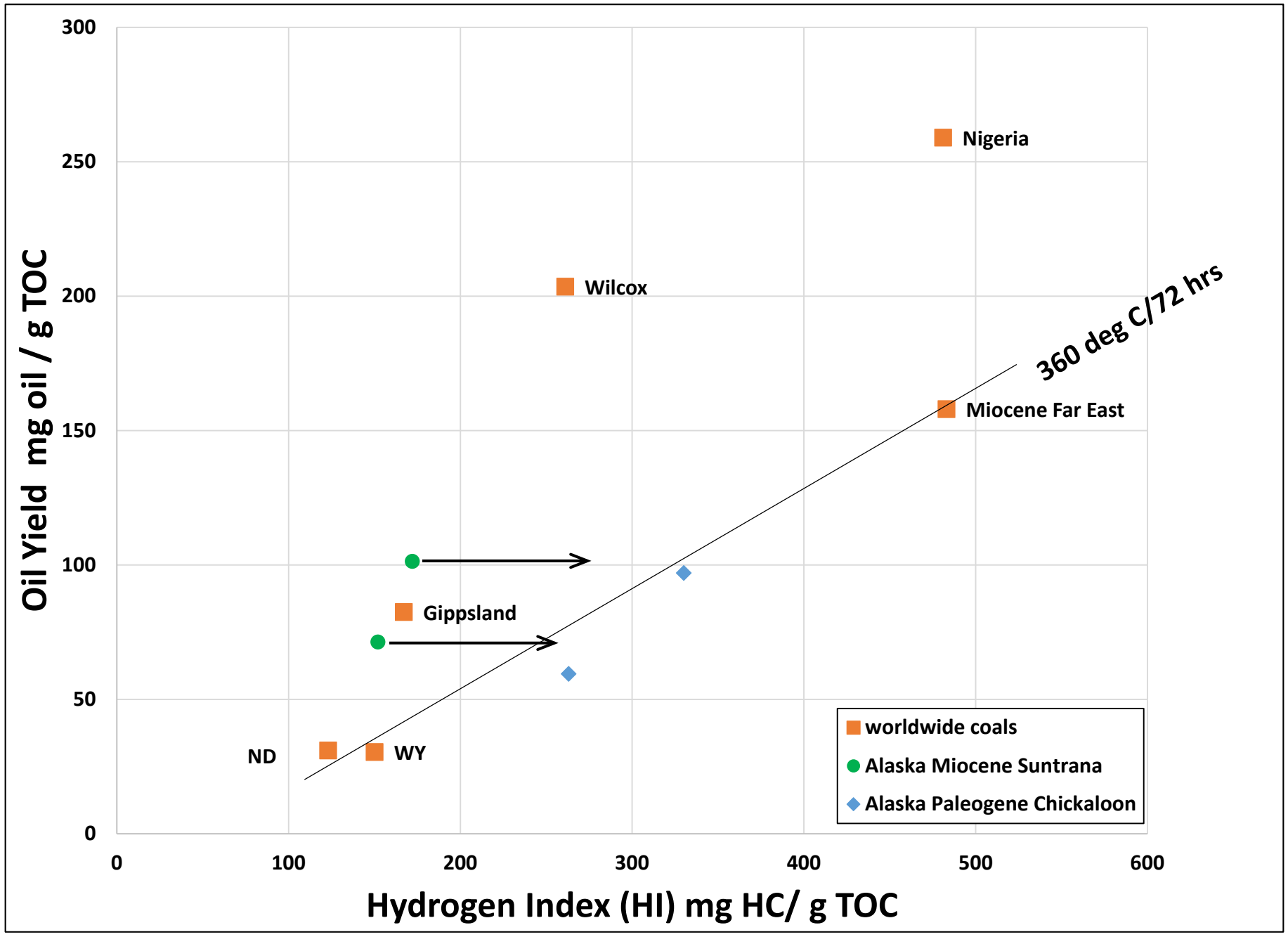
Miocene lignite (Far East)

- 55% TOC
- 483 HI
- 158 mg/g TOC at 360°C/72hrs

Latrobe Gp (Gippsland Basin, Australia)

- 59.4% TOC
- 167 HI
- 49 mg/g rock at 350°C/72 hrs


Oil Yield mg oil / g TOC
Hydrogen Index (HI) mg HC/ g TOC
0
50
100
150
200
250
300
0
100
200
300
400
500
600
Nigeria
Wilcox
Miocene Far East
Gippsland
ND
WY
360 deg C/72 hrs
worldwide coals
Alaska Miocene Suntrana
Alaska Paleogene Chickaloon


Oil Yield mg oil / g TOC
Hydrogen Index (HI) mg HC/ g TOC
300
250
200
150
100
50
0
0
100
200
300
400
500
600
Nigeria
Wilcox
Miocene Far East
Gippsland
ND
WY
360 deg C/72 hrs
worldwide coals
Alaska Miocene Suntrana
Alaska Paleogene Chickaloon

Summary

- Four Tertiary coals from Nenana/Susitna area of Alaska -
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- All four coals generated oil – 60 to 101 mg oil/gram TOC
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Given sufficient burial history (time-temperature) these coals could generate and expel oil

The end

Check Clayton review