UTAH GEOLOGICAL SURVEY
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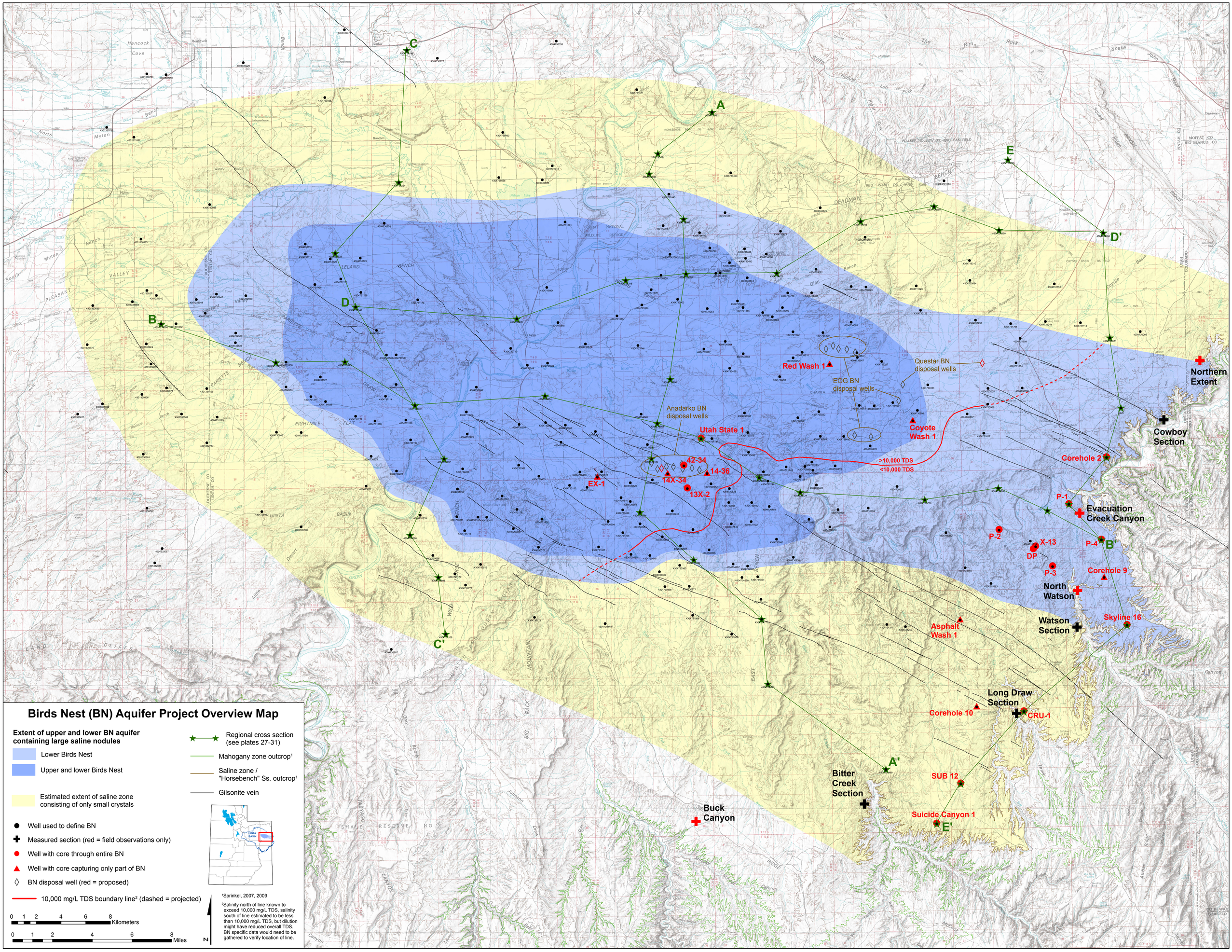
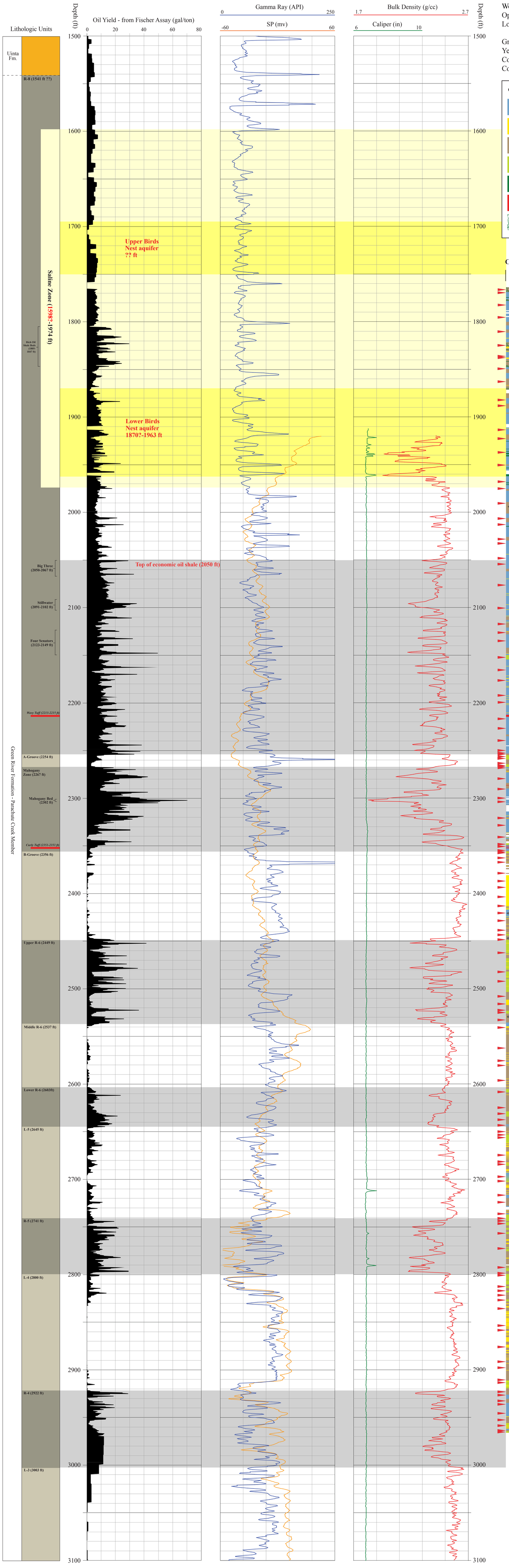


EX-1 CORE LOG



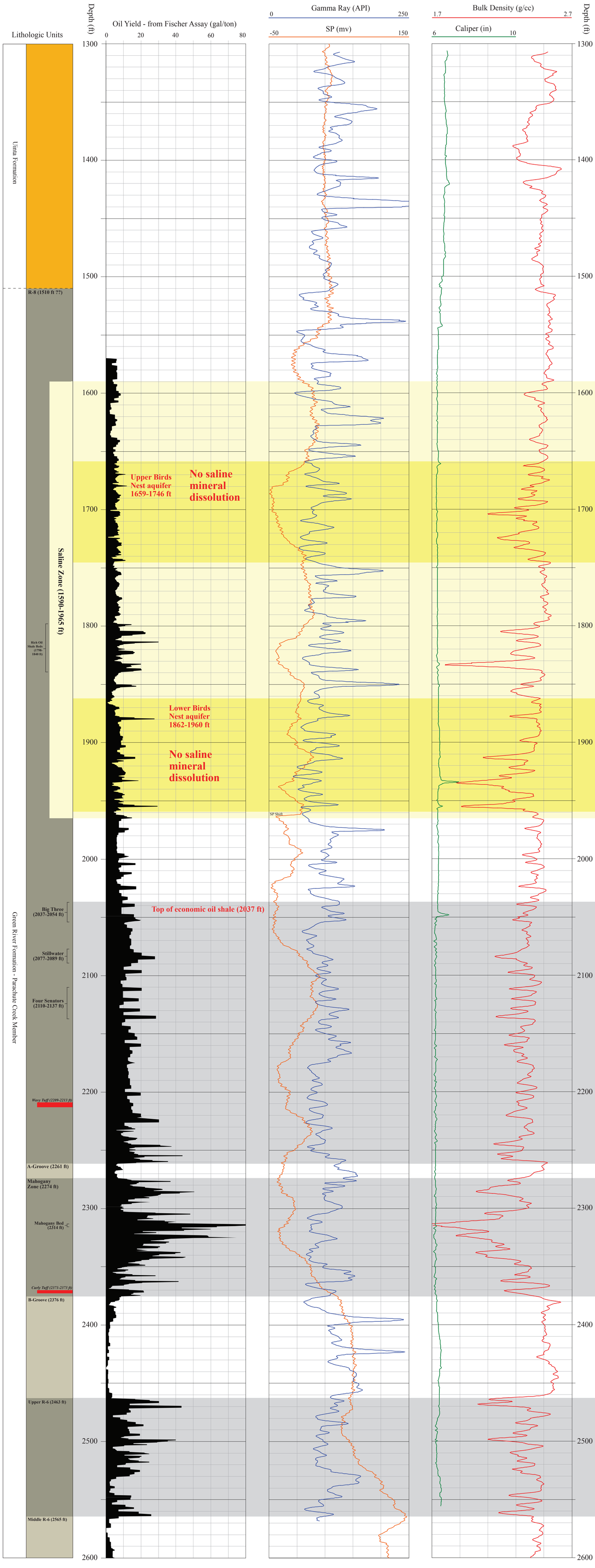
Well name: EX-1 (U043)
Operator: Western Oil Shale Corp.
Location: Section 36, T. 9 S., R. 20 E., SLBLM
UTM E 618562, UTM N 4427091 (NAD 83)
Ground elevation: 4941 ft
Year drilled: 1969
Cored interval: 1764 - 2966 ft (slabbed)
Core location: UGS and USGS Core Research Centers

Core Log Explanation

- Calcareous mudstone - slightly dolomitic
- Siltstone / very fine sandstone - often bitumen stained
- Clay-rich mudstone - slightly calcareous/dolomitic
- Dolomitic mudstone - slightly clay-rich
- Nahcolite bed ($NaHCO_3$)
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Sample analyzed with XRF
- Nahcolite nodule
- Small shortite/nahcolite crystals
- Pyrite/ Marcasite/ Pyrrhotite crystals
- Flat/planar lamination
- Low angle lamination
- Wavy lamination
- Ripples
- Soft sediment deformation/ convolute bedding
- Dewatering structure
- Load casts
- Burrows/bioturbation
- Worm
- Snail
- Scour with massive fill
- Mudrock intraclast
- Organic-rich interval
- Plant material
- Bone fragments
- *Lithophypoderma* sp. ("botfly" larvae)
- Gar fish scales
- Shell debris
- Algal influenced lamination
- Stylolites
- Near-vertical fracture - often bitumen filled
- Insects

Core Log

UTAH STATE 1 CORE LOG



Well name: Utah State 1 (U102)
Operator: Tosco Corp.
Location: Section 26, T. 9 S., R. 21 E., SLBLM
UTM E 626967, UTM N 4430197 (NAD 83)
Ground elevation: 4911 ft
Year drilled: 1974
Cored interval: 1570 - 2600 ft (slabbed)
Core location: Utah Core Research Center

Core Log Explanation

- Calcareous mudstone - slightly dolomitic
- Siltstone / very fine sandstone - often bitumen stained
- Clay-rich mudstone - slightly calcareous/dolomitic
- Dolomitic mudstone - slightly clay-rich
- Nahcolite bed ($NaHCO_3$)
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Sample analyzed with XRF
- Nahcolite nodule
- Small shortite/nahcolite crystals
- Pyrite/ Marcasite/ Pyrrhotite crystals
- Flat/planar lamination
- Low angle lamination
- Wavy lamination
- Ripples
- Soft sediment deformation/ convolute bedding
- Dewatering structure
- Load casts
- Burrows/bioturbation
- Worm
- Snail
- Scour with massive fill
- Mudrock intraclast
- Organic-rich interval
- Plant material
- Bone fragments
- *Lithophypoderma* sp. ("botfly" larvae)
- Gar fish scales
- Shell debris
- Algal influenced lamination
- Stylolites
- Near-vertical fracture - often bitumen filled
- Insects

Core Log

clay | silt | sand (vf, f, m, c)

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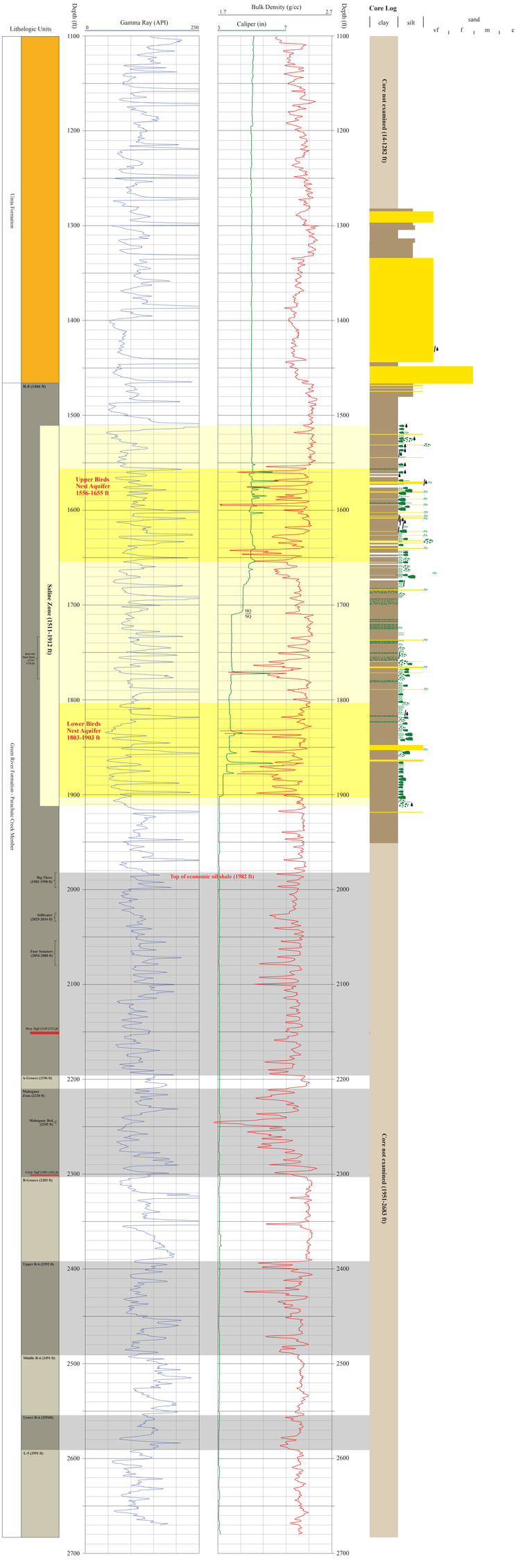
UTAH STATE 42-34 CORE LOG

Well name: Utah State 42-34 (U113)
Operator: Tosco Corp.
Location: Section 34, T. 9 S., R. 21 E., SLBLM
UTM E 625568, UTM N 4428012 (NAD 83)
Ground elevation: 5030 ft
Year drilled: 1981
Cored interval: 14-2683 ft (1550-1900 ft slabbed)
Core location: USGS Core Research Center

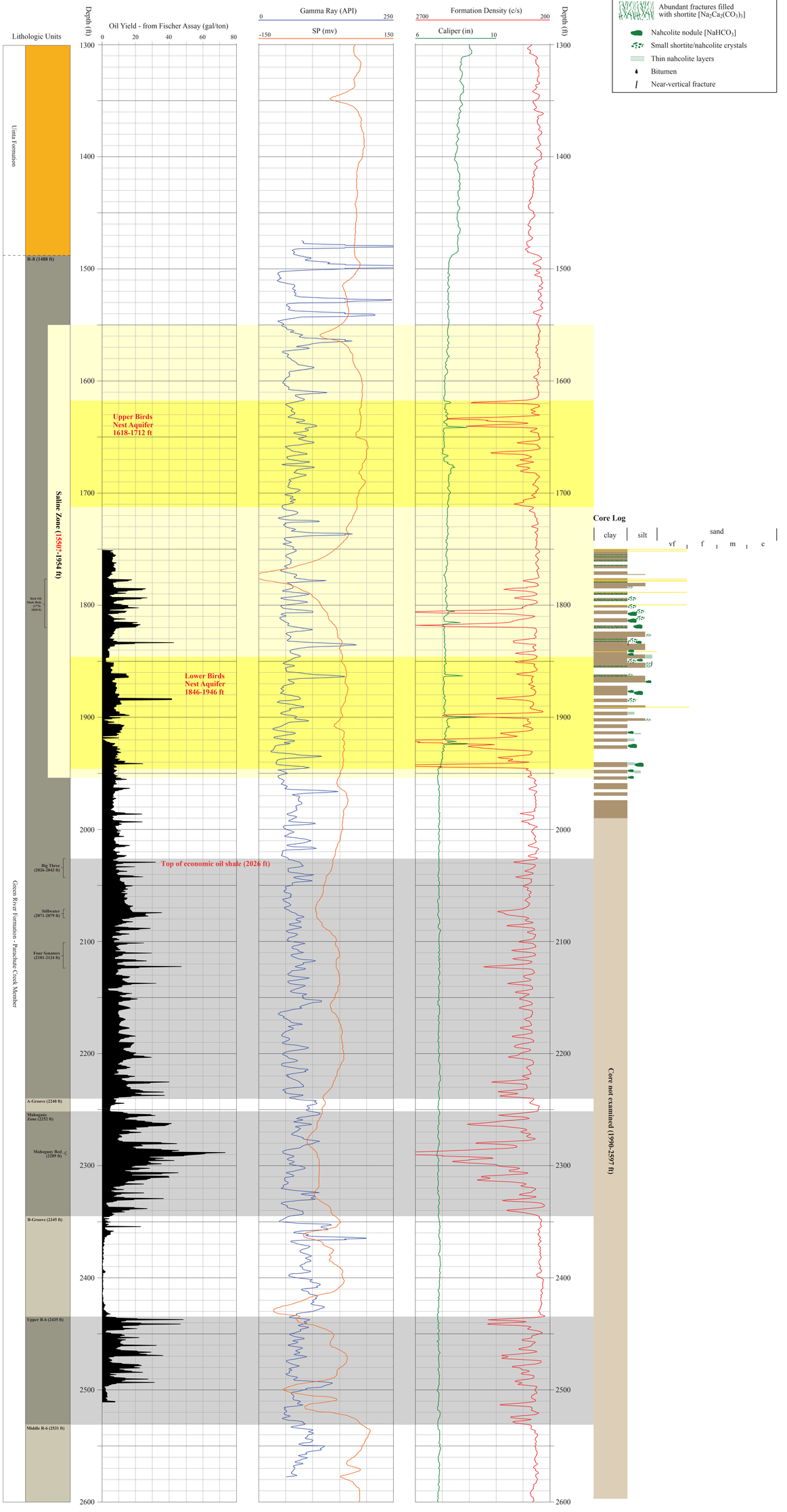
Core Log Explanation

- Calcareous/dolomitic mudstone - varying amounts of siliciclastics and clays
- Siltstone / very fine sandstone
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Nahcolite nodule [$NaHCO_3$]
- Small shortite/nahcolite crystals
- Thin nahcolite layers
- Bitumen
- Near-vertical fracture



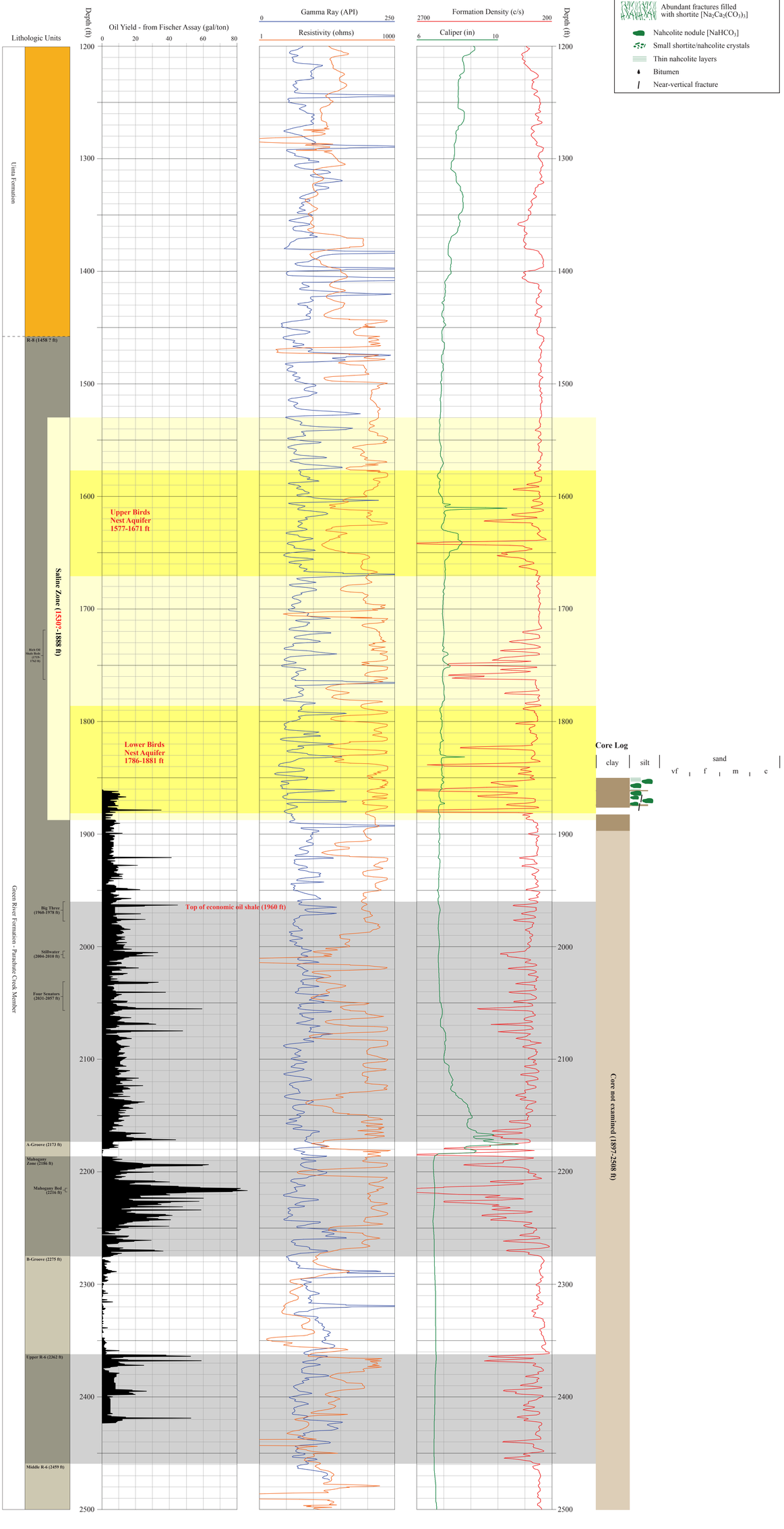
14X-34 CORE LOG

Well name: 14X-34 (U110)
Operator: Shell Oil Co.
Location: Section 34, T. 9 S., R. 21 E., SLBLM
UTM E 624255, UTM N 4427363 (NAD 83)
Ground elevation: 5047 ft
Year drilled: 1964
Cored interval: 1750-2597 ft
Core location: USGS Core Research Center



14-36 CORE LOG

Well name: 14-36 (U108)
Operator: Shell Oil Co.
Location: Section 36, T. 9 S., R. 21 E., SLBLM
UTM E 627444, UTM N 4427386 (NAD 83)
Ground elevation: 5100 ft
Year drilled: 1964
Cored interval: 1850-2508 ft
Core location: USGS Core Research Center



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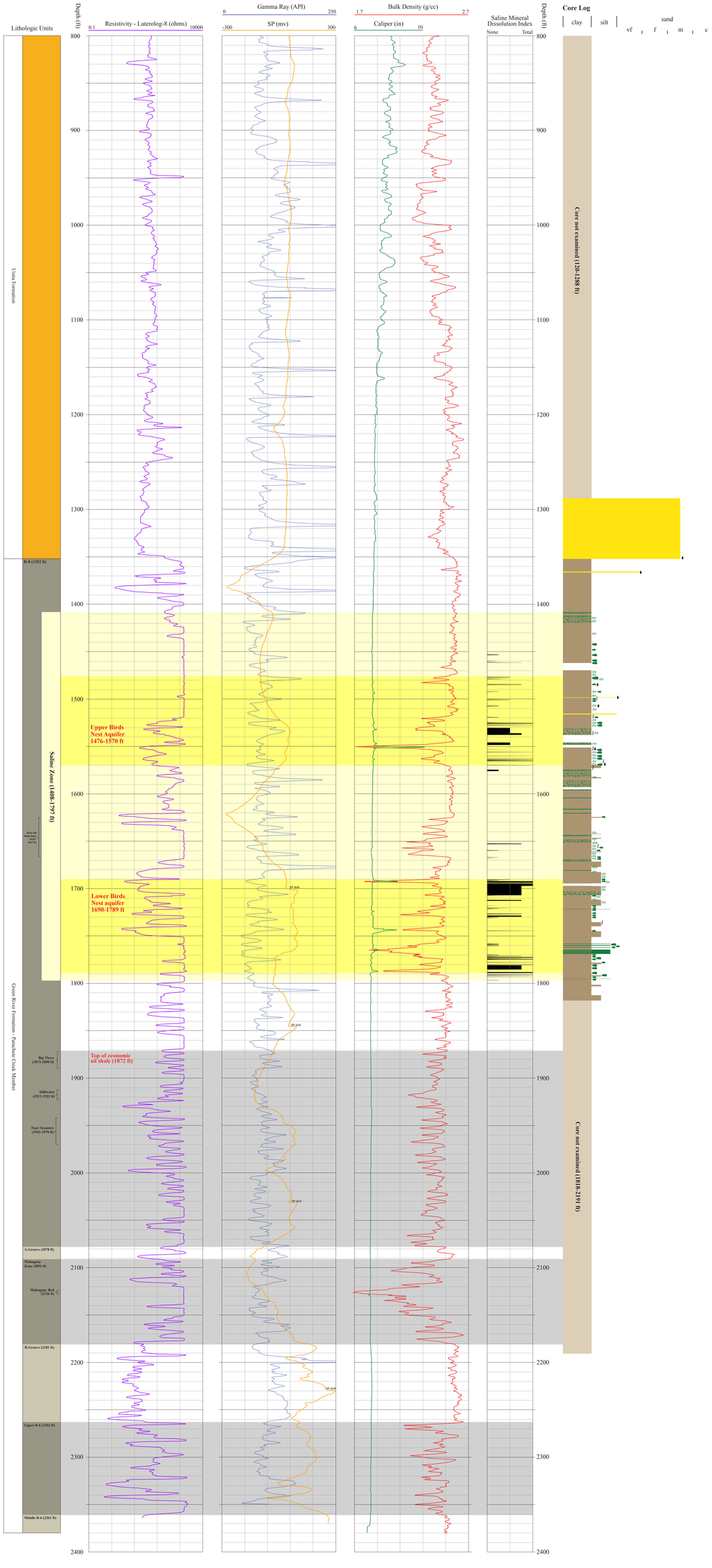
UTAH STATE 13X-2 CORE LOG

Well name: Utah State 13X-2 (U112)
Operator: Tosco Corp.
Location: Section 2, T. 10 S., R. 21 E., SLBLM
UTM E 625850, UTM N 4426165 (NAD 83)
Ground elevation: 5064 ft
Year drilled: 1977
Cored interval: 120-2191 ft (1200-2191 ft slabbed)
Core location: UGS and USGS Core Research Center

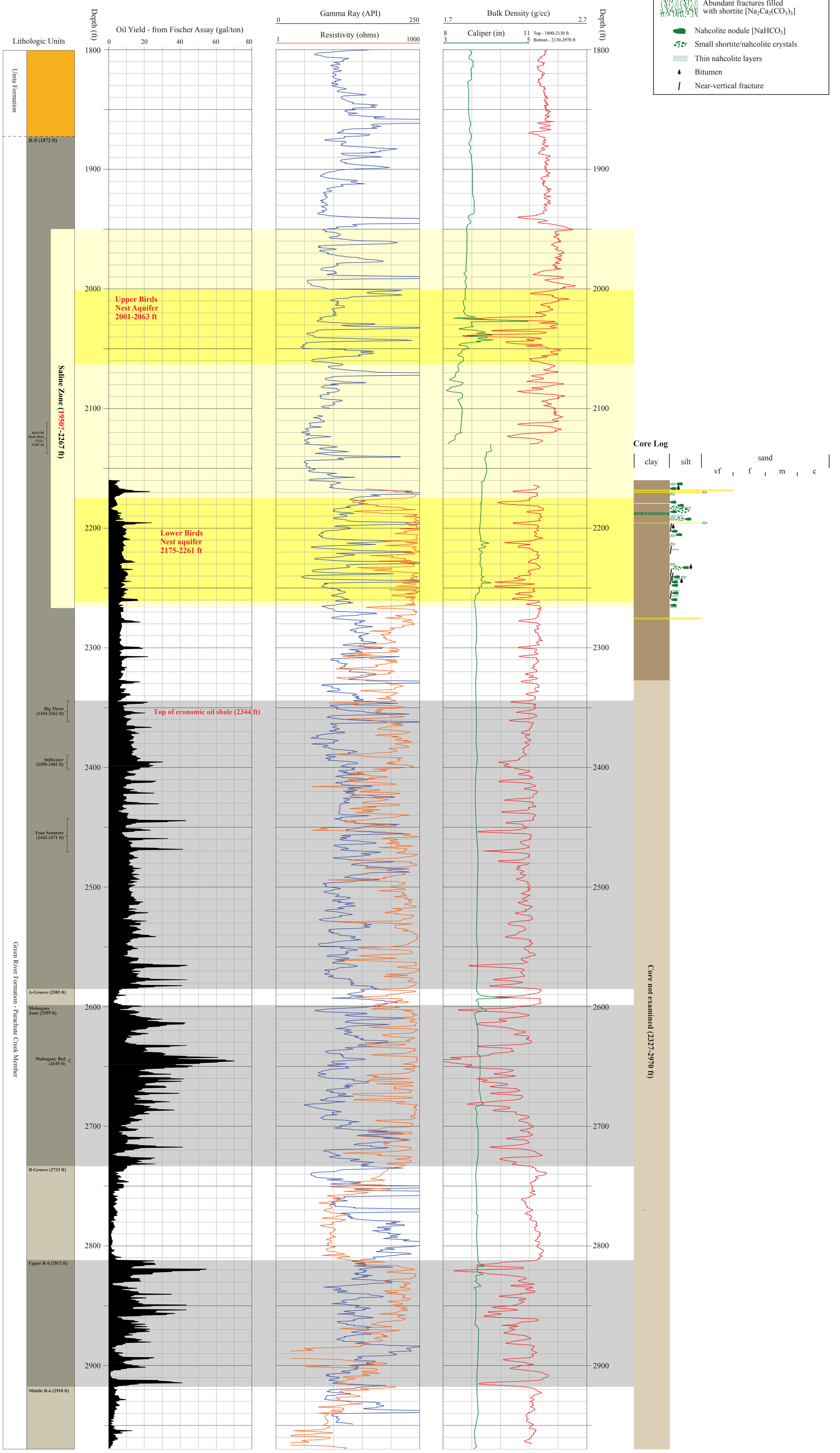
Core Log Explanation

- Calcareous/dolomitic mudstone - varying amounts of siliciclastics and clays
- Siltstone / very fine sandstone
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Nahcolite nodule [$NaHCO_3$]
- Small shortite/nahcolite crystals
- Thin nahcolite layers
- Bitumen
- Near-vertical fracture

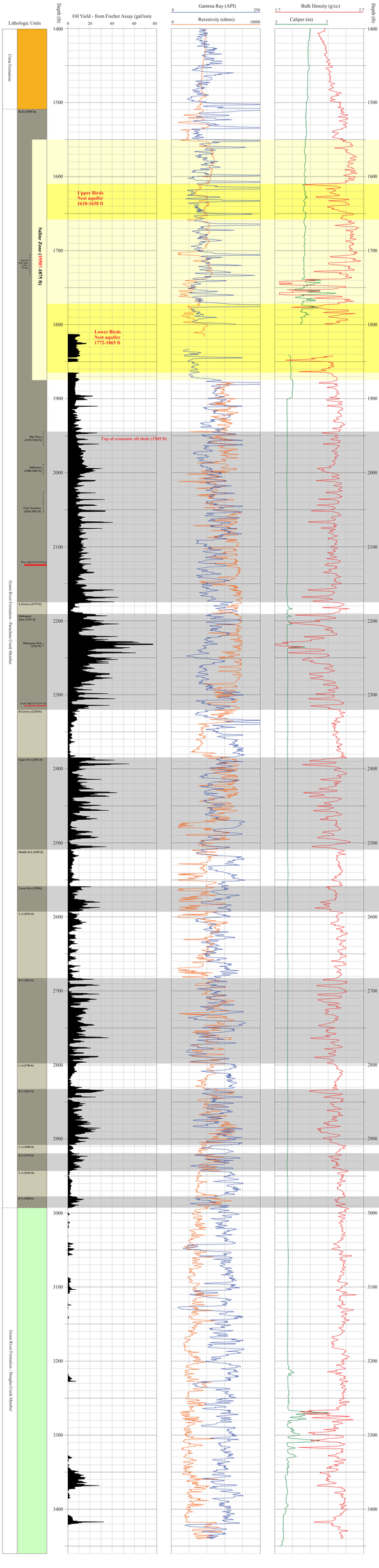


RED WASH 1 CORE LOG

Well name: Red Wash 1 (U045)
Operator: USGS
Location: Section 1, T. 9 S., R. 22 E., SLBLM
UTM E 637362, UTM N 4436212 (NAD 83)
Ground elevation: 4810 ft
Year drilled: 1981
Cored interval: 2160-2970 ft
Core location: USGS Core Research Center



COYOTE WASH 1 CORE LOG



Well name: Coyote Wash 1 (U044)
Operator: USGS
Location: Section 22, T. 9 S., R. 23 E., SLBLM
UTM E 644096, UTM N 4431654 (NAD 83)
Ground elevation: 5067 ft
Year drilled: 1981
Cored interval: 1817-3460 ft (slabbed)
Core location: USGS Core Research Center

Core Log Explanation

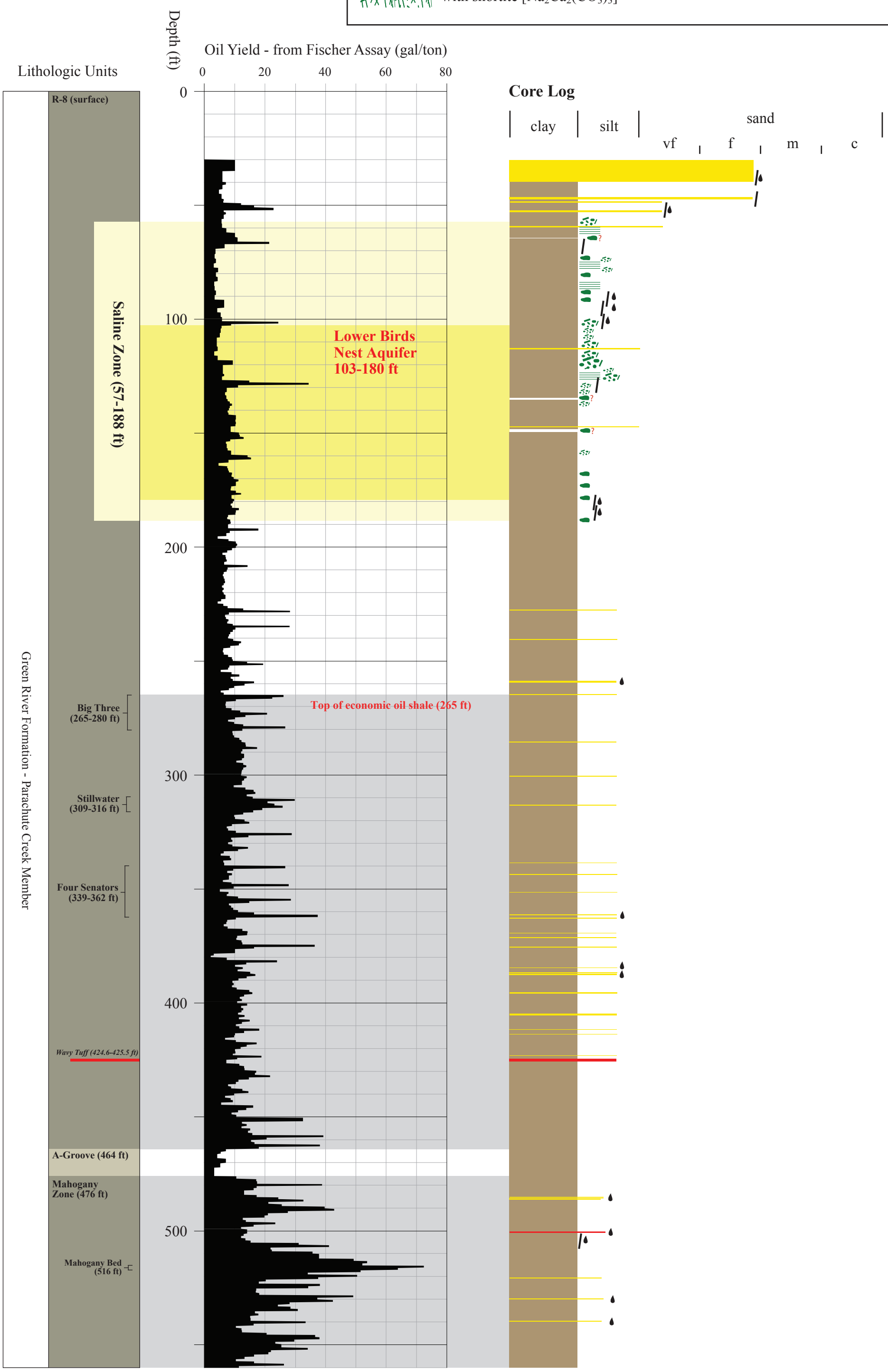
- Calcareous mudstone - slightly dolomitic
- Siltstone / very fine sandstone - often bitumen stained
- Clay-rich mudstone - slightly calcareous/dolomitic
- Dolomitic mudstone - slightly clay-rich
- Nahcolite bed ($NaHCO_3$)
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2CO_3O_4$]
- Sample analyzed with XRF
- Nahcolite nodule
- Small shortite/nahcolite crystals
- Pyrite/ Marcasite/ Pyrrhotite crystals
- Flat/planar lamination
- Low angle lamination
- Wavy lamination
- Ripples
- Soft sediment deformation/ convolute bedding
- Dewatering structure
- Load casts
- Burrows/bioturbation
- Worm
- Snail
- Scour with massive fill
- Mudrock intraclast
- Organic-rich interval
- Plant material
- Bone fragments
- *Lithophipoderma* sp. ("bodfly" larvae)
- Gar fish scales
- Shell debris
- Algal influenced lamination
- Stylolites
- Near-vertical fracture - often bitumen filled
- Insects

COREHOLE 2 CORE LOG

Well name: Corehole 2 (U028)
Operator: National Farmer's Union
Location: Section 32, T. 9 S., R. 25 E., SLBLM
UTM E 659784, UTM N 4428684 (NAD 83)
Ground elevation: 5507 ft
Year drilled: 1958
Cored interval: 30-560 ft (slabbed)
Core location: Utah Core Research Center

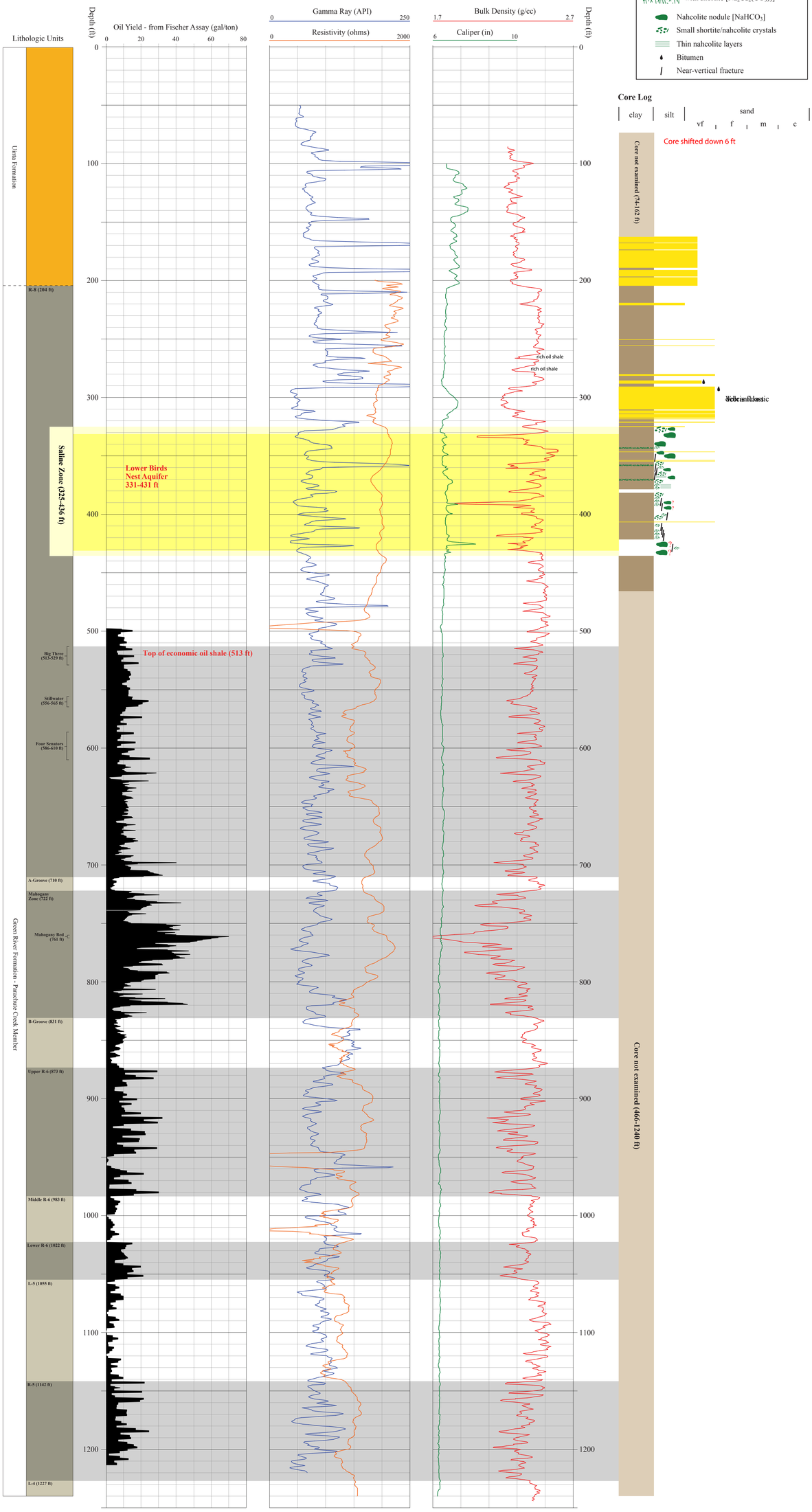
Core Log Explanation

- Calcareous/dolomitic mudstone - varying amounts of siliciclasticsand clays
- Siltstone / very fine sandstone
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Nahcolite nodule [$NaHCO_3$]
- Small shortite/nahcolite crystals
- Thin nahcolite layers
- Bitumen
- Near-vertical fracture



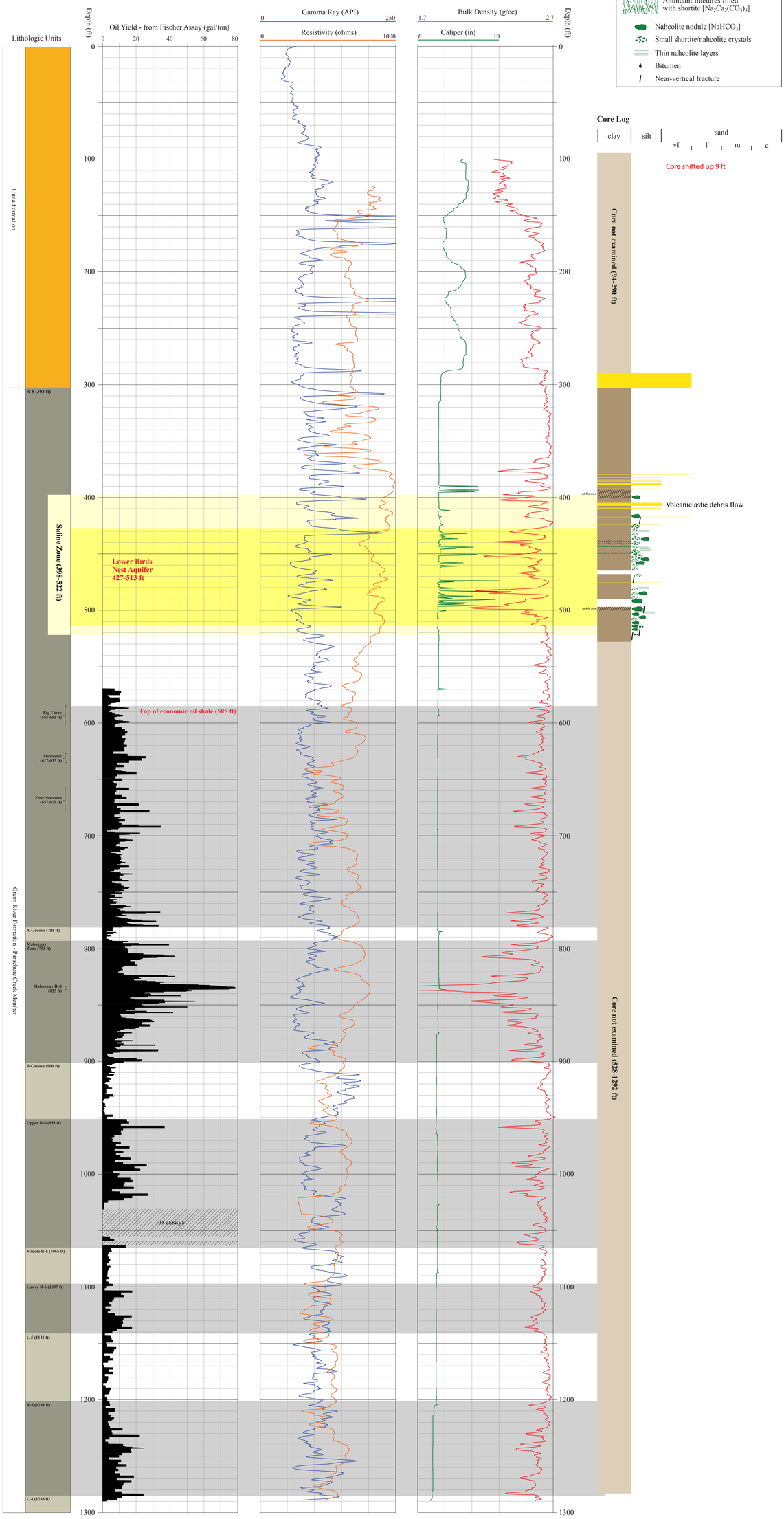
P-1 CORE LOG

Well name: P-1 (U056)
Operator: White River Shale Co.
Location: Section 12, T. 10 S., R. 24 E., SLBLM
UTM E 656732, UTM N 4424894 (NAD 83)
Ground elevation: 5284 ft
Year drilled: 1974
Cored interval: 74-1240 ft
Core location: USGS Core Research Center



P-2 CORE LOG

Well name: P-2 (U057)
Operator: White River Shale Co.
Location: Section 17, T. 10 S., R. 24 E., SLBLM
UTM E 651084, UTM N 4422804 (NAD 83)
Ground elevation: 4991 ft
Year drilled: 1974
Cored interval: 94-1292 ft
Core location: USGS Core Research Center

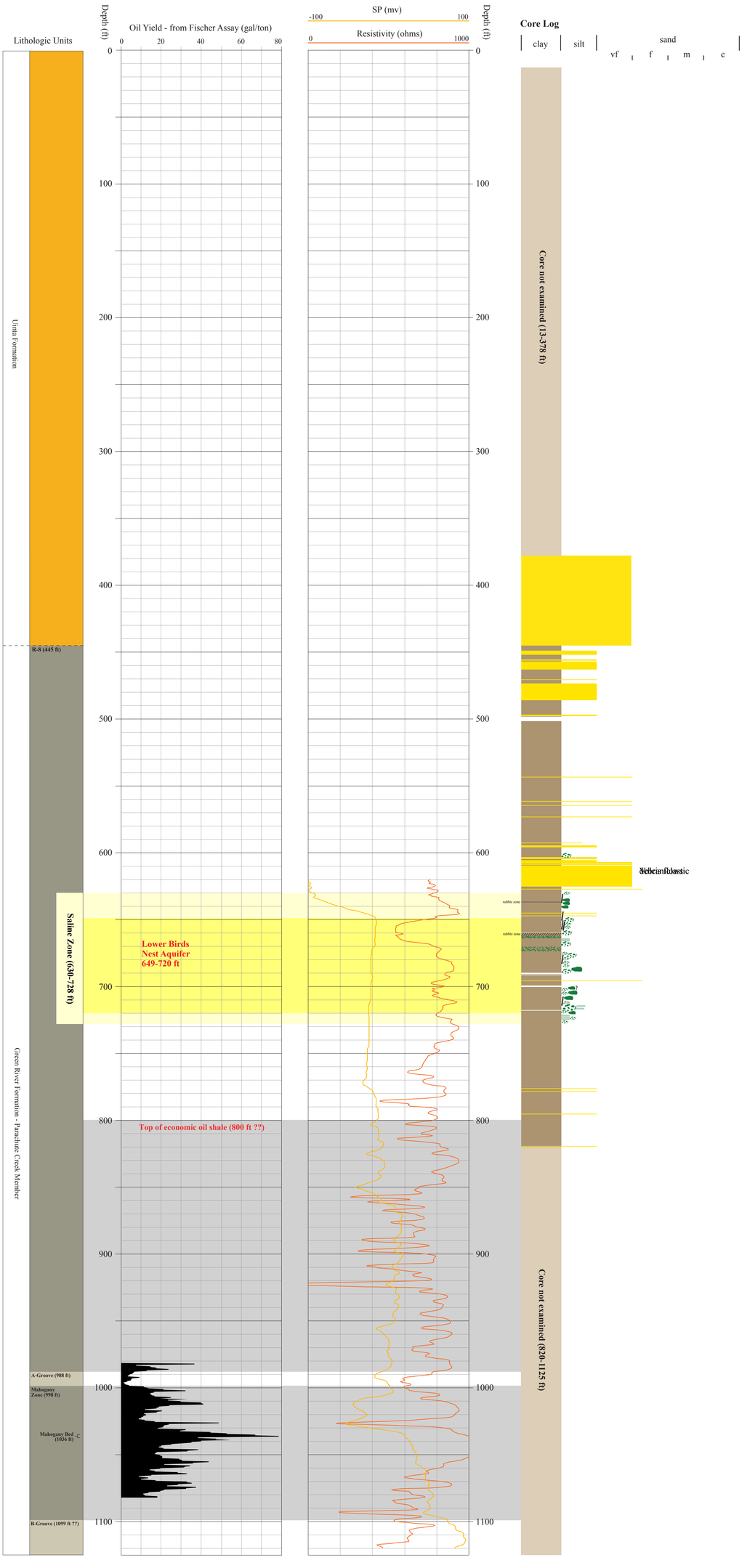


X-13 CORE LOG

Well name: X-13 (U130)
Operator: White River Shale Co.
Location: Section 22, T. 10 S., R. 24 E., SLBLM
UTM E 654044, UTM N 4421465 (NAD 83)
Ground elevation: 5484 ft
Year drilled: 1976
Cored interval: 13-1125 ft
Core location: USGS Core Research Center

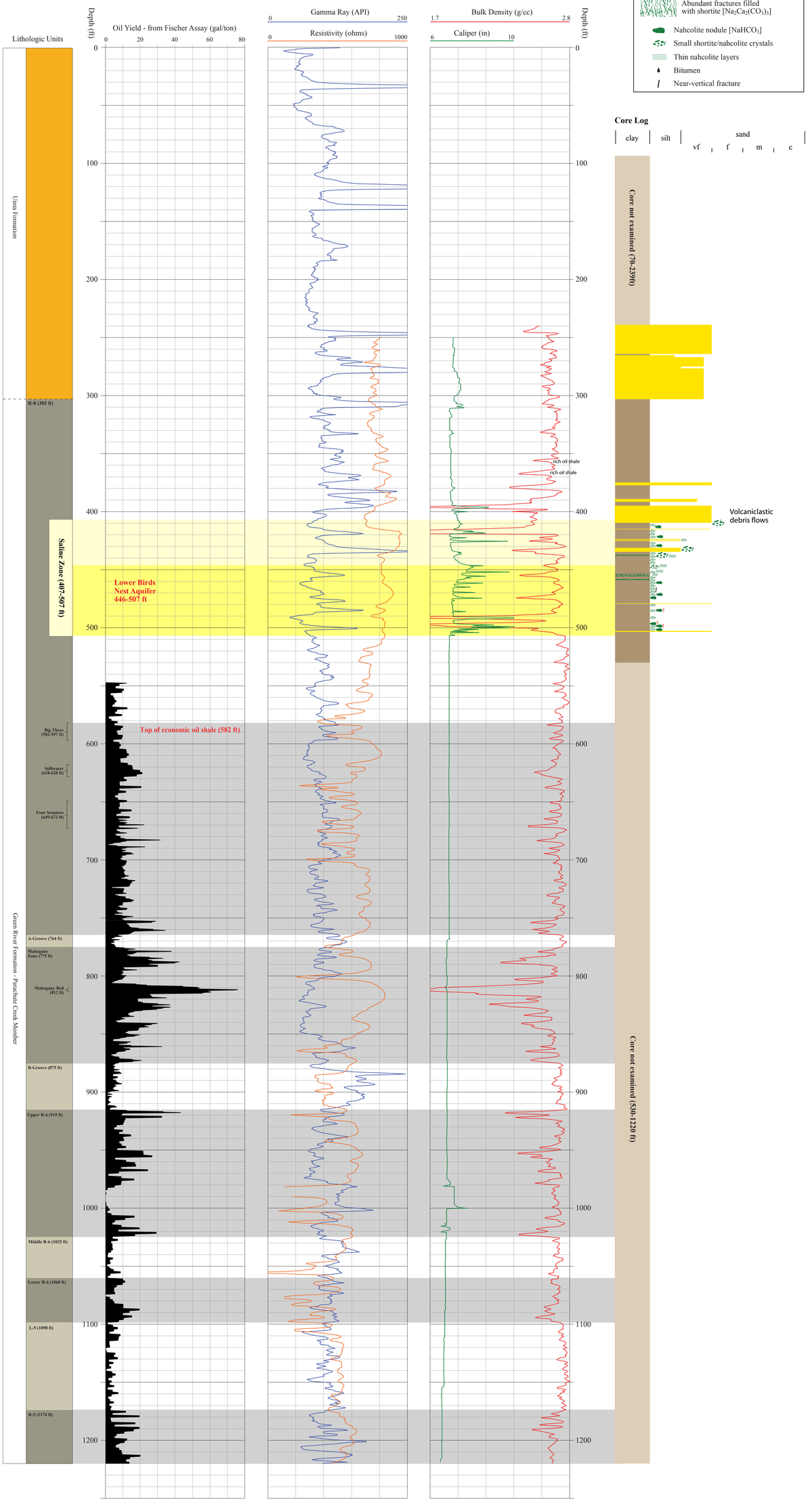
Core Log Explanation

- Calcareous/dolomitic mudstone - varying amounts of siliciclastics and clays
- Siltstone / very fine sandstone
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Nahcolite nodule [$NaHCO_3$]
- Small shortite/nahcolite crystals
- Thin nahcolite layers
- Bitumen
- Near-vertical fracture



P-3 CORE LOG

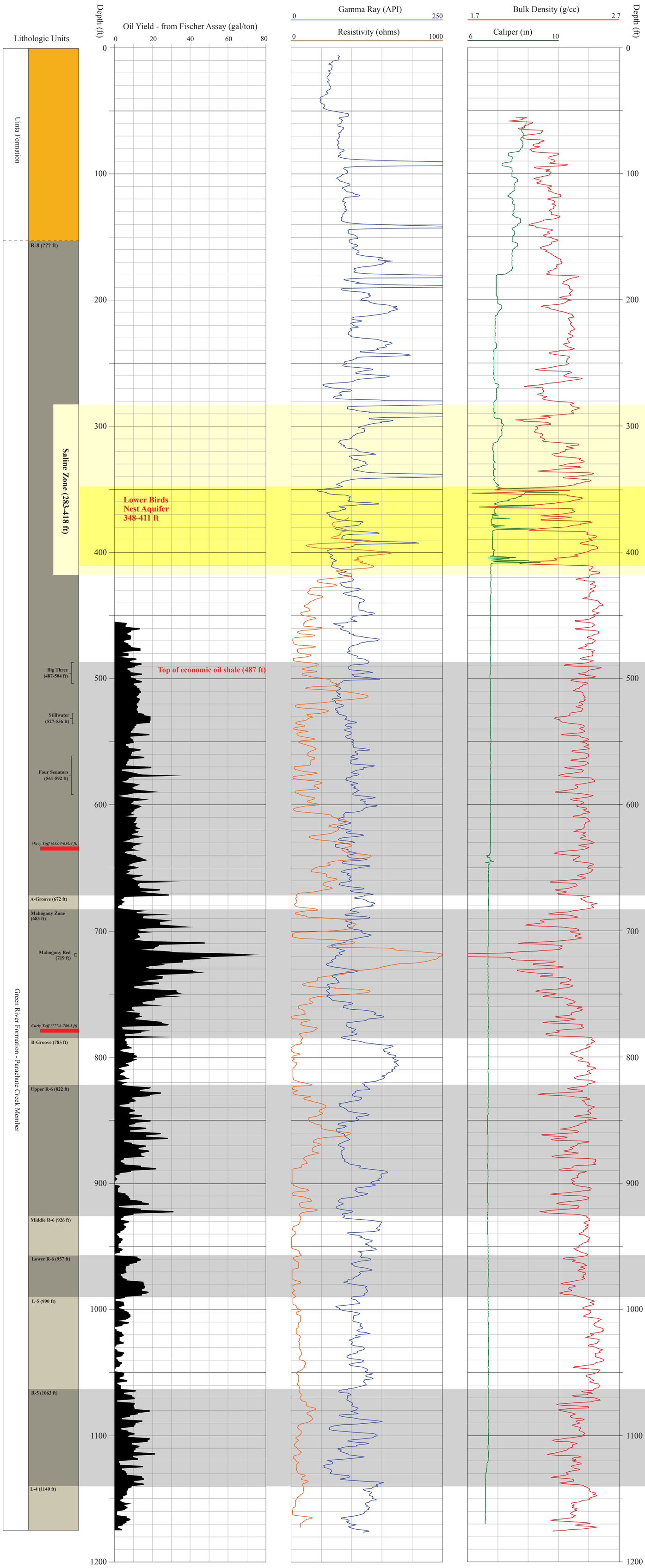
Well name: P-3 (U058)
Operator: White River Shale Co.
Location: Section 26, T. 10 S., R. 24 E., SLBLM
UTM E 655414, UTM N 4421465 (NAD 83)
Ground elevation: 5490 ft
Year drilled: 1974
Cored interval: 70-1220 ft
Core location: USGS Core Research Center



P-4 CORE LOG

Well name: P-4 (U059)
Operator: White River Shale Project
Location: Section 19, T. 10 S., R. 25 E., SLBLM
UTM E 659365, UTM N 4418979 (NAD 83)

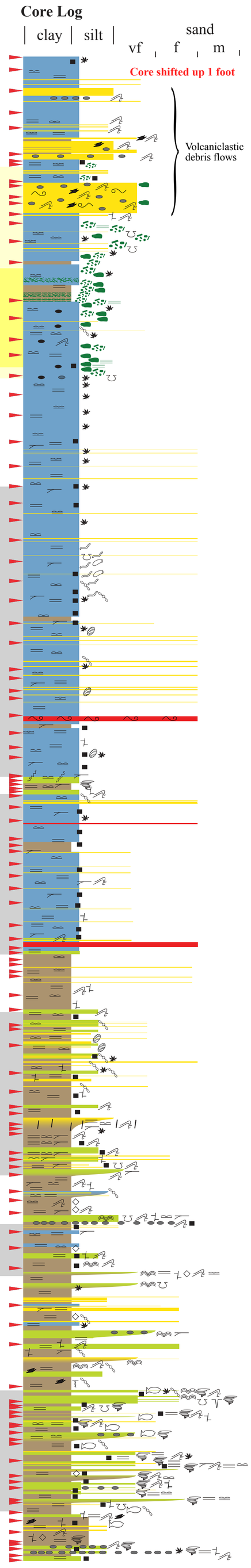
Ground elevation: 5719 ft
Year drilled: 1974
Core interval: 214-1173 ft
Core location: Utah Core Research Center



Core Log Explanation

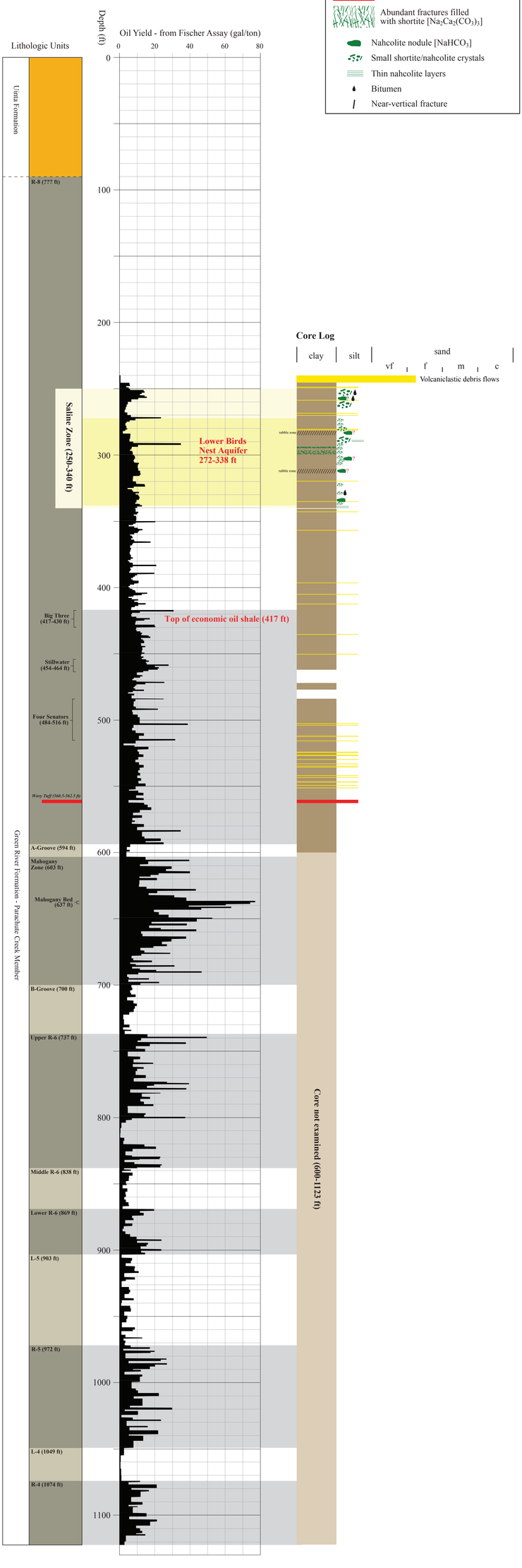
- Calcareous mudstone - slightly dolomitic
- Siltstone / very fine sandstone - often bitumen stained
- Clay-rich mudstone - slightly calcareous/dolomitic
- Dolomitic mudstone - slightly clay-rich
- Nahcolite bed ($NaHCO_3$)
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Sample analyzed with XRF
- Nahcolite nodule
- Small shortite/nahcolite crystals
- Pyrite/ Marcasite/ Pyrrhotite crystals
- Flat/planar lamination
- Low angle lamination
- Wavy lamination
- Ripples
- Soft sediment deformation/ convolute bedding
- Dewatering structure
- Load casts
- Burrows/bioturbation
- Worm
- Snail
- Scour with massive fill
- Mudrock intraclast
- Organic-rich interval
- Plant material
- Bone fragments
- *Lithophypoderma* sp. ("botfly" larvae)
- Gar fish scales
- Shell debris
- Algal influenced lamination
- Stylolites
- Near-vertical fracture - often bitumen filled
- Insects

Core Log



COREHOLE 9 CORE LOG

Well name: Corehole 9 (U029)
Operator: National Farmer's Union
Location: Section 32, T. 10 S., R. 25 E., SLBLM
UTM E 659586, UTM N 4418979 (NAD 83)
Ground elevation: 5746 ft
Year drilled: 1959
Cored interval: 240-1123 ft (slabbed)
Core location: Utah Core Research Center

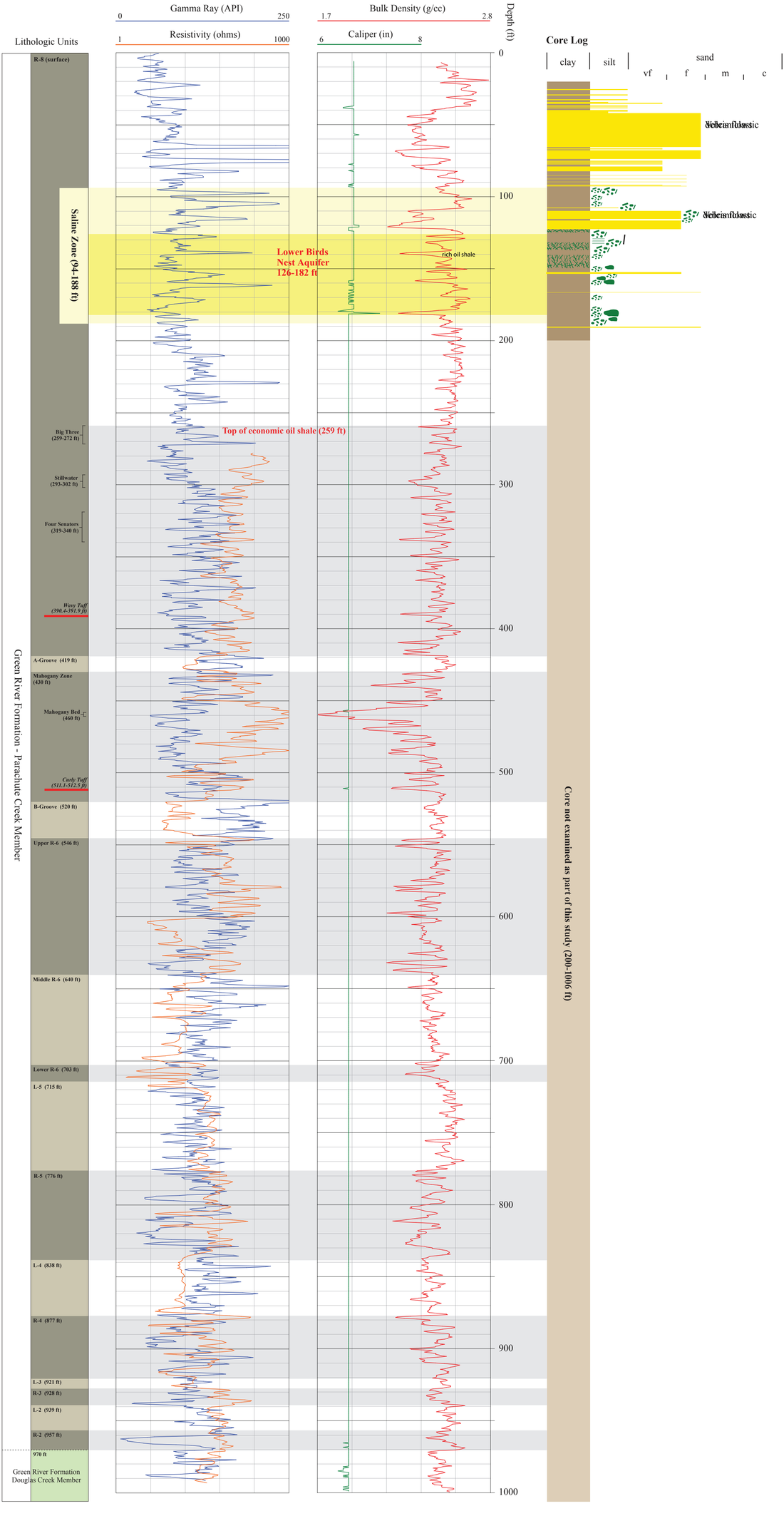


SKYLINE 16 CORE LOG

Well name: Skyline 16
Operator: UGS - University of Utah
Location: Section 10, T. 11 S., R. 25 E., SLBLM
UTM E 661445, UTM N 4415109 (NAD 83)
Ground elevation: 6014 ft
Year drilled: 2010
Cored interval: 20-1006 ft (slabbed)
Core location: Utah Core Research Center

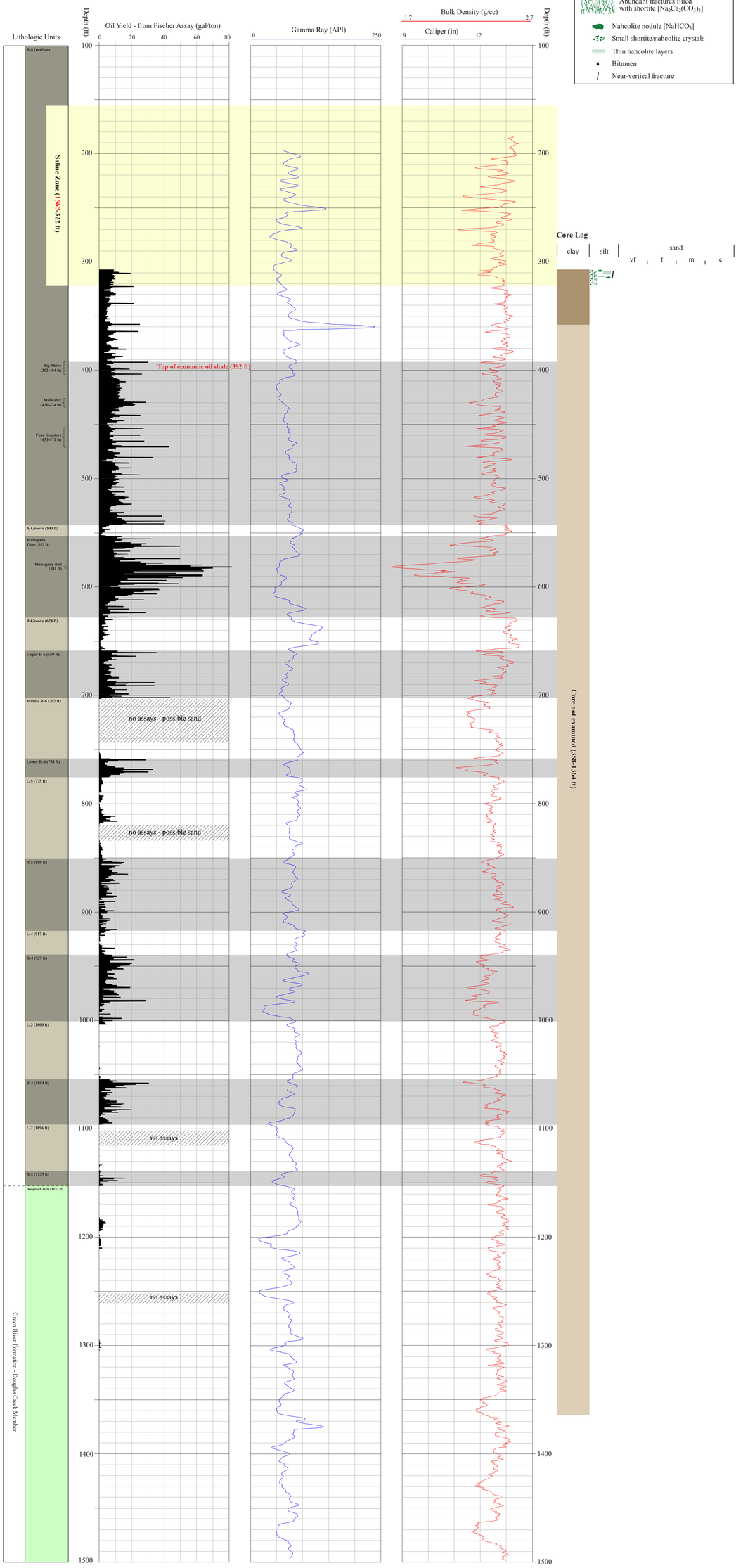
Core Log Explanation

- Calcareous/dolomitic mudstone - varying amounts of siliciclastics and clays
- Siltstone / very fine sandstone
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Nahcolite nodule [$NaHCO_3$]
- Small shortite/nahcolite crystals
- Thin nahcolite layers
- Bitumen
- Near-vertical fracture



ASPHALT WASH 1 CORE LOG

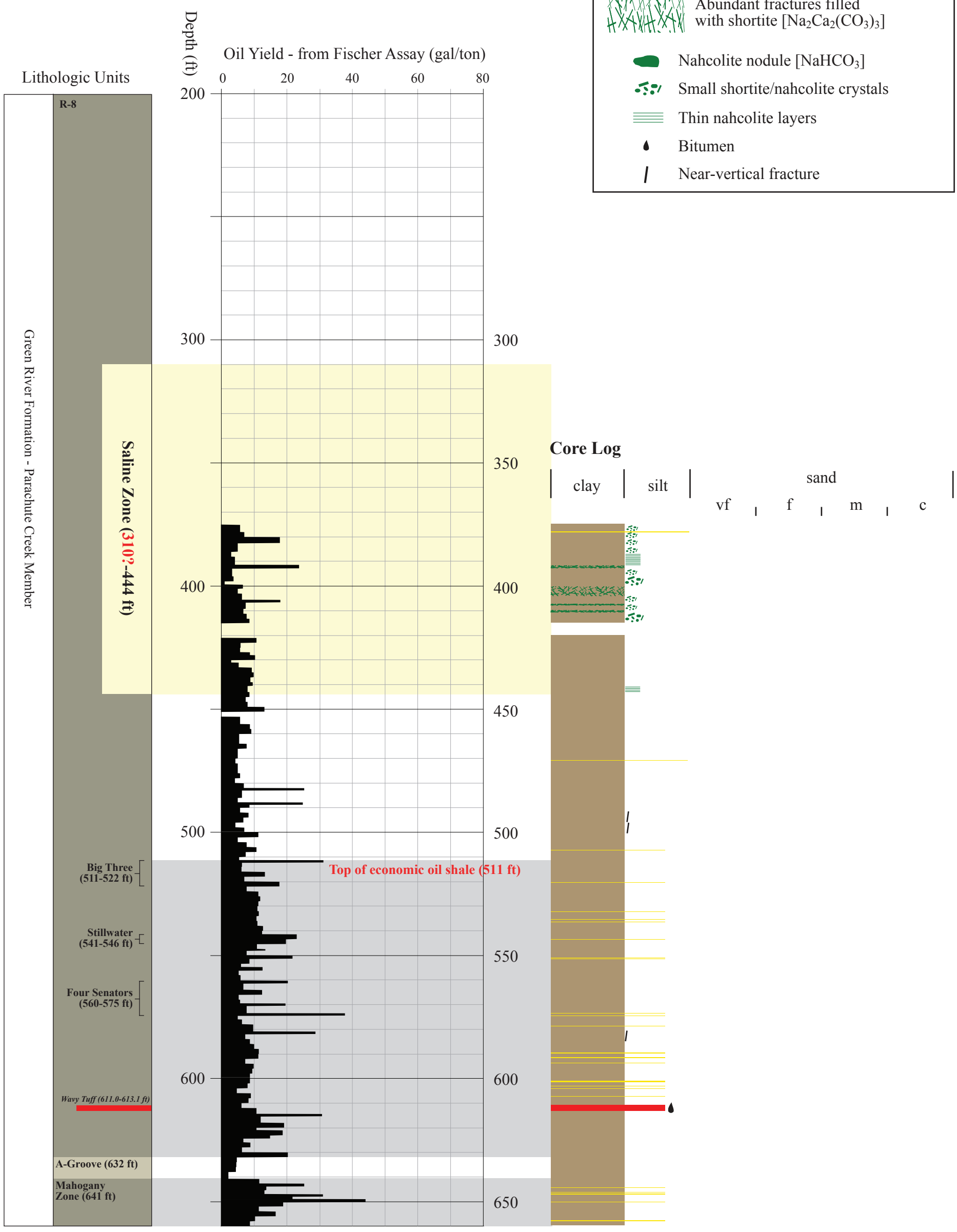
Well name: Asphalt Wash 1 (U086)
Operator: USGS
Location: Section 7, T. 11 S., R. 24 E., SLBLM
UTM E 647934, UTM N 4415544 (NAD 83)
Ground elevation: 5250 ft
Year drilled: 1976
Cored interval: 307-1364, 2007-2088 ft (slabbed)
Core location: USGS Core Research Center



logs continue to 2600 ft, additional core and assays from 2007-2088 ft

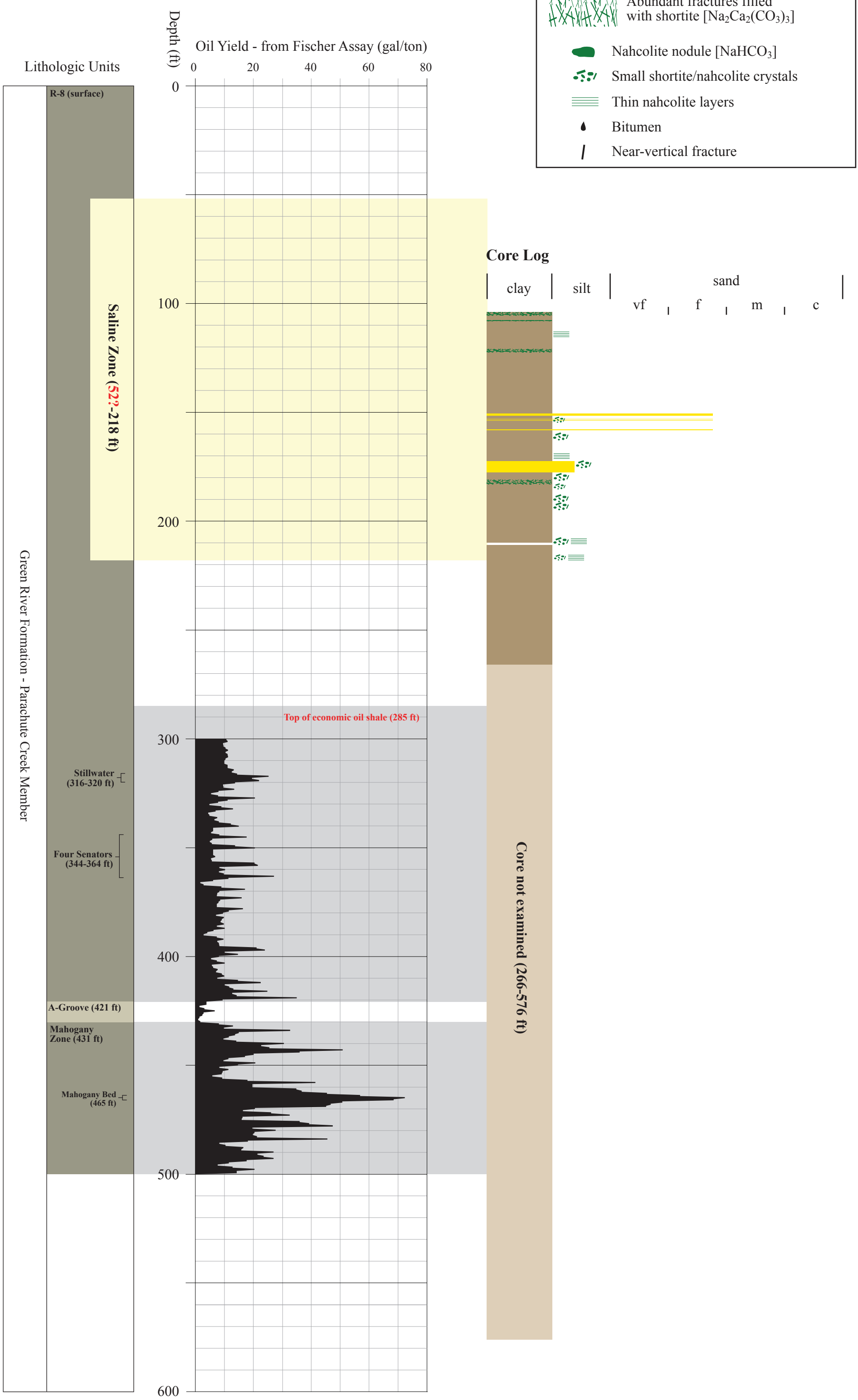
COREHOLE 10 CORE LOG

Well name: Corehole 10 (U124)
Operator: National Farmer's Union
Location: Section 32, T. 11 S., R. 24 E., SLBLM
UTM E 649269, UTM N 4408511 (NAD 83)
Ground elevation: 6215 ft
Year drilled: 1960
Cored interval: 375-660 ft (slabbed)
Core location: Utah Core Research Center



SUICIDE CANYON 1 CORE LOG

Well name: Suicide Canyon 1 (U087)
Operator: Arco
Location: Section 36, T. 12 S., R. 23 E., SLBLM
UTM E 646039, UTM N 4399044 (NAD 83)
Ground Elevation: 6362 ft
Year drilled: 1965
Cored interval: 104-576 ft (slabbed)
Core location: USGS Core Research Center

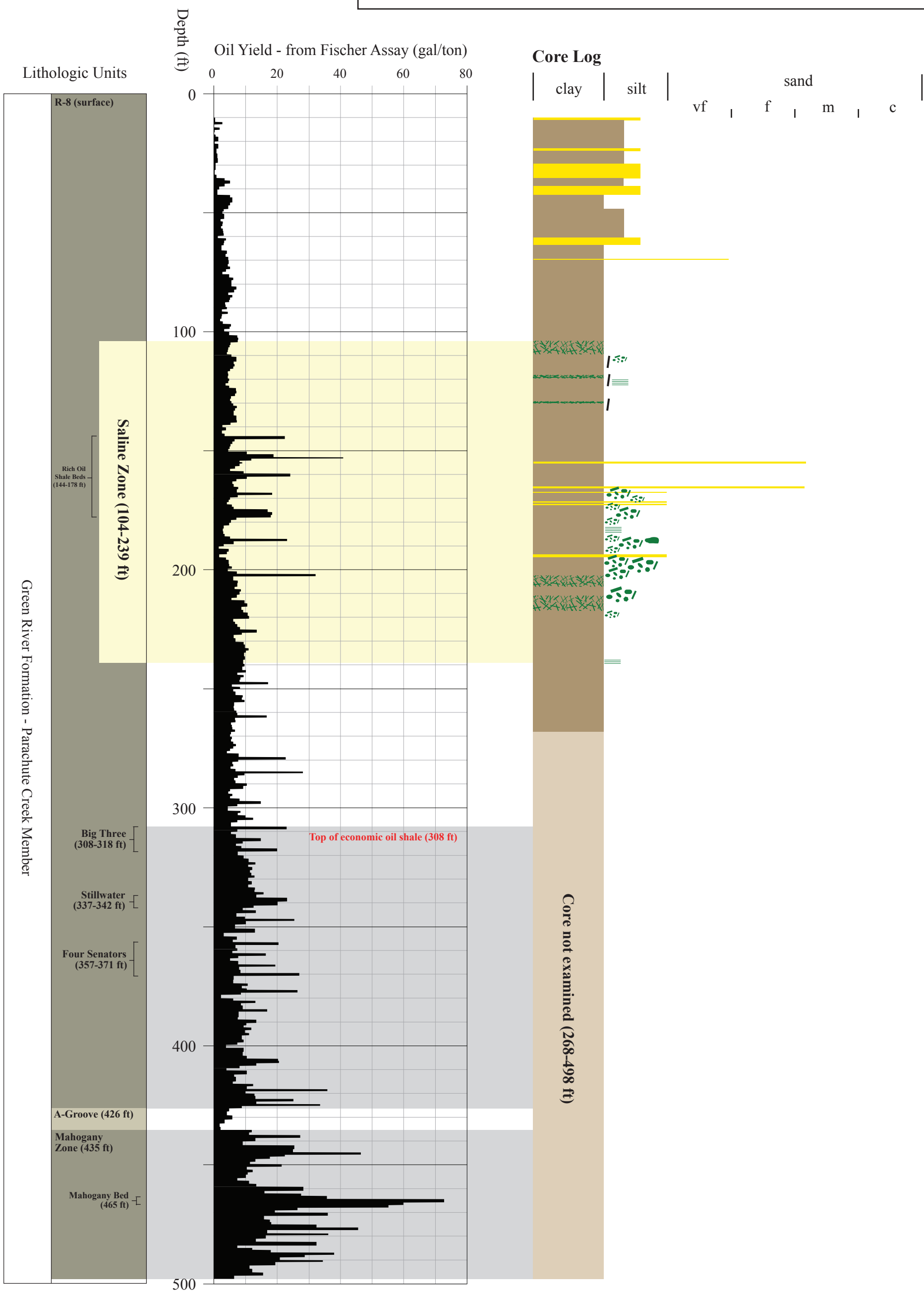


CRU-1 CORE LOG

Well name: CRU-1 (U055)
Operator: USGS
Location: Section 3, T. 12 S., R. 24 E., SLBLM
UTM E 653097, UTM N 4408125 (NAD 83)
Ground Elevation: 6137 ft
Year drilled: 1976
Cored interval: 14-498 ft (slabbed)
Core location: USGS Core Research Center

Core Log Explanation

- Calcareous/dolomitic mudstone - varying amounts of siliciclastics and clays
- Siltstone / very fine sandstone
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Nahcolite nodule [$NaHCO_3$]
- Small shortite/nahcolite crystals
- Thin nahcolite layers
- Bitumen
- Near-vertical fracture

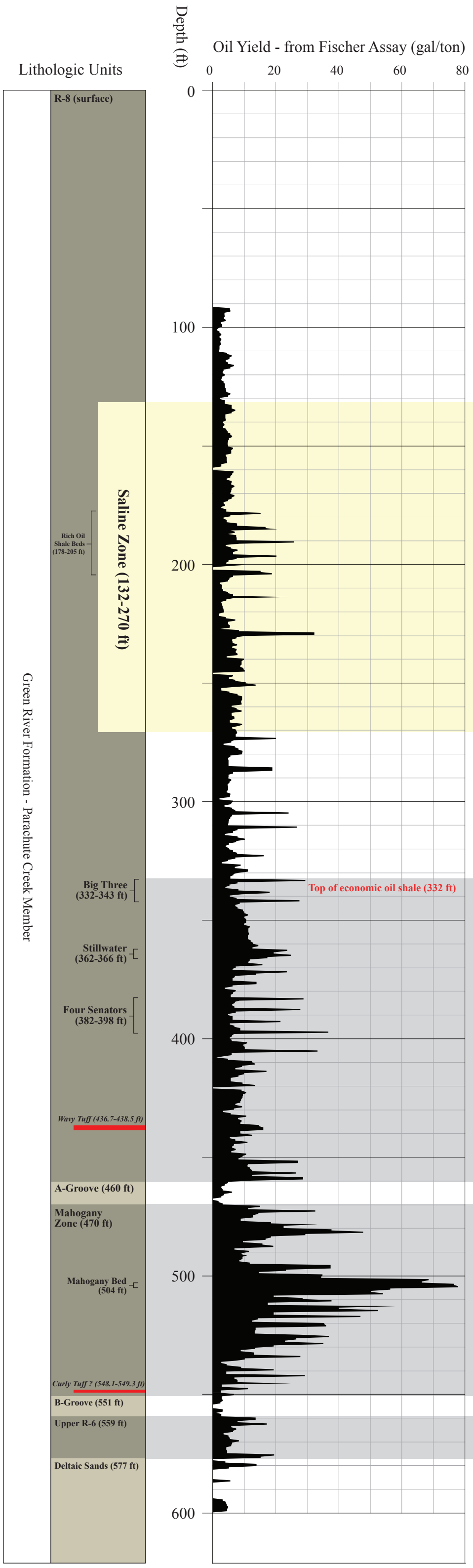


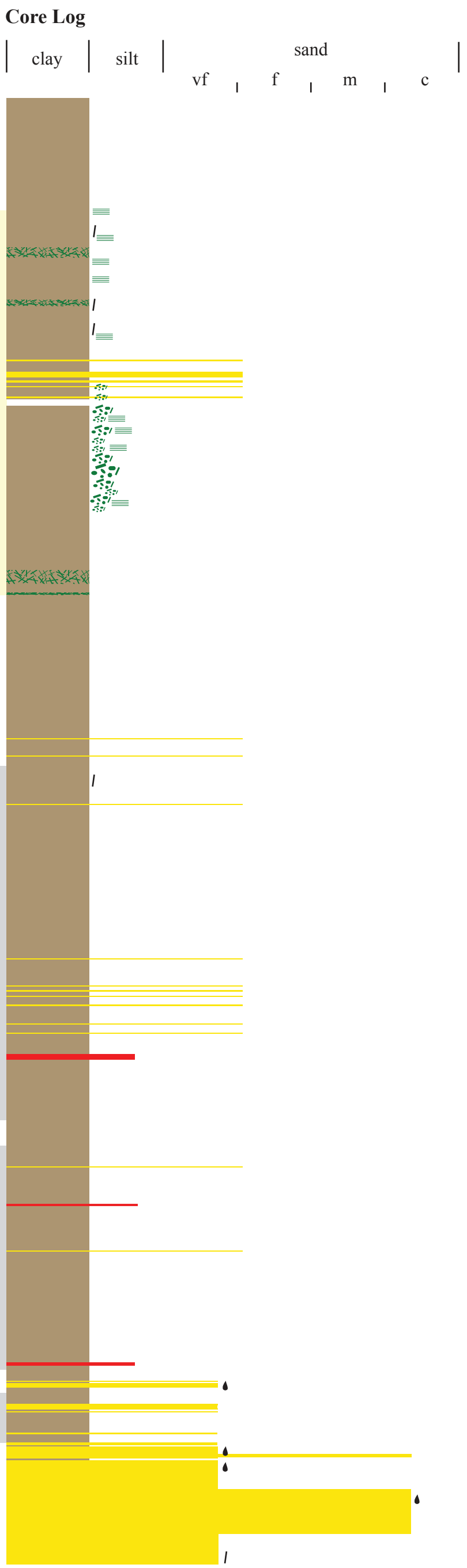
SOUTH UINTA BASIN 12 CORE LOG

Well name: S. Uinta Basin 12 (U080)
Operator: U.S. ERDA-LERC
Location: Section 19, T. 12 S., R. 24 E., SLBLM
UTM E 647985, UTM N 4402283 (NAD 83)
Ground elevation: 6261 ft
Year drilled: 1977
Cored interval: 91-621 ft (slabbed)
Core location: Utah Core Research Center

Core Log Explanation

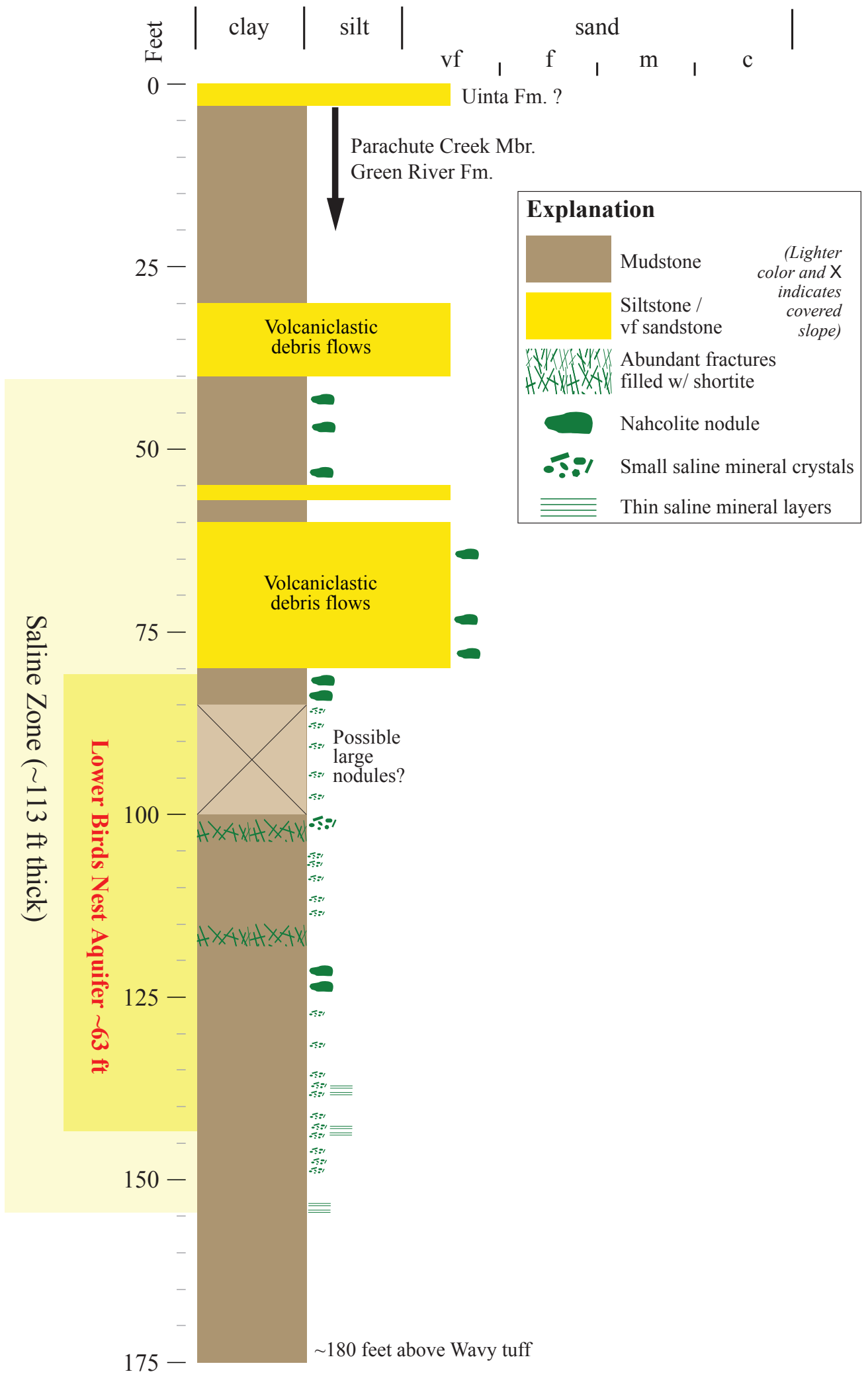
- Calcareous/dolomitic mudstone - varying amounts of siliciclastics and clays
- Siltstone / very fine sandstone
- Named ash / tuff
- Abundant fractures filled with shortite [$Na_2Ca_2(CO_3)_3$]
- Nahcolite nodule [$NaHCO_3$]
- Small shortite/nahcolite crystals
- Thin nahcolite layers
- Bitumen
- Near-vertical fracture





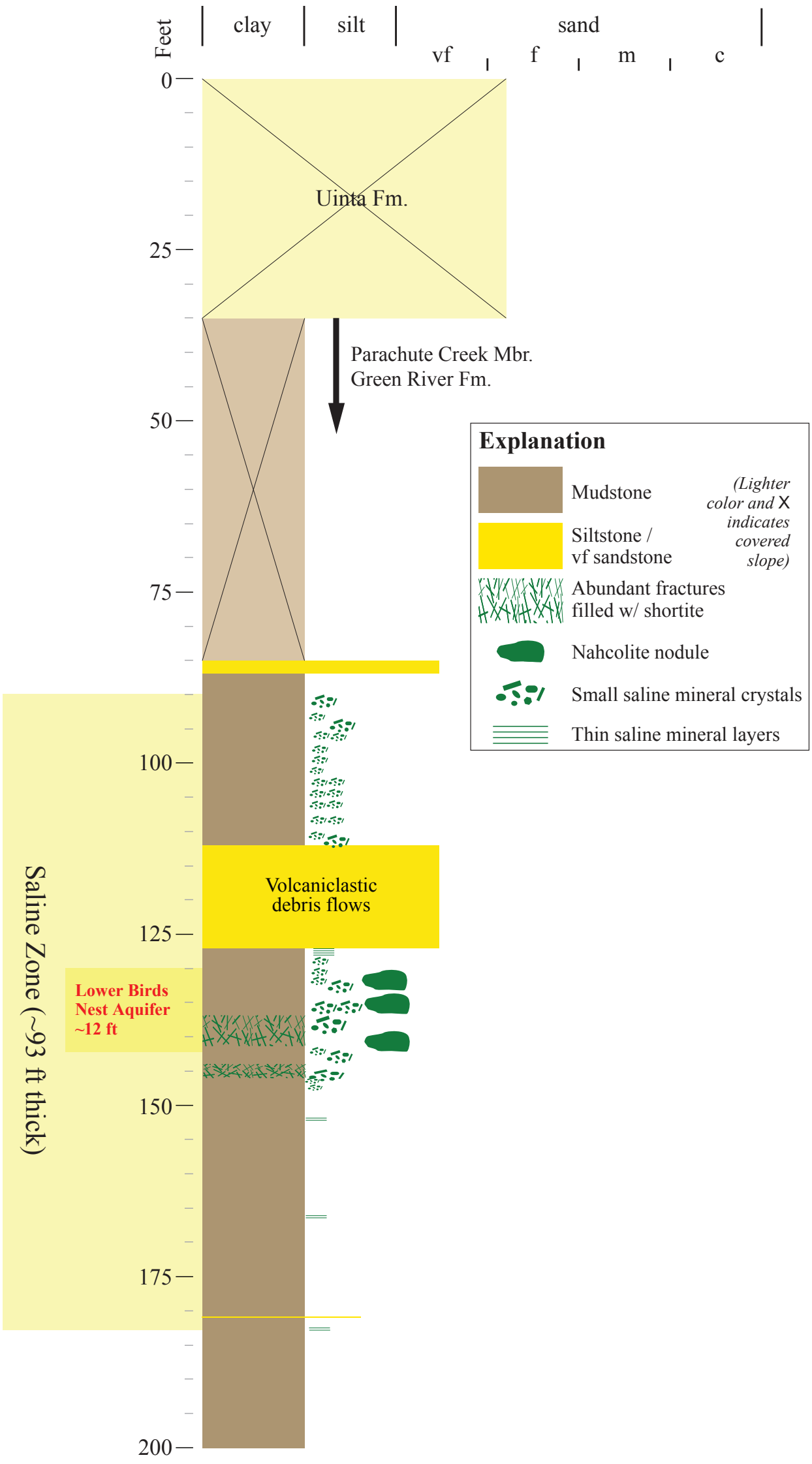
COWBOY MEASURED OUTCROP SECTION

Location: Section 23, T. 9 S., R. 25 E., SLBLM
UTM E 664369, UTM N 4431738 (NAD 83)



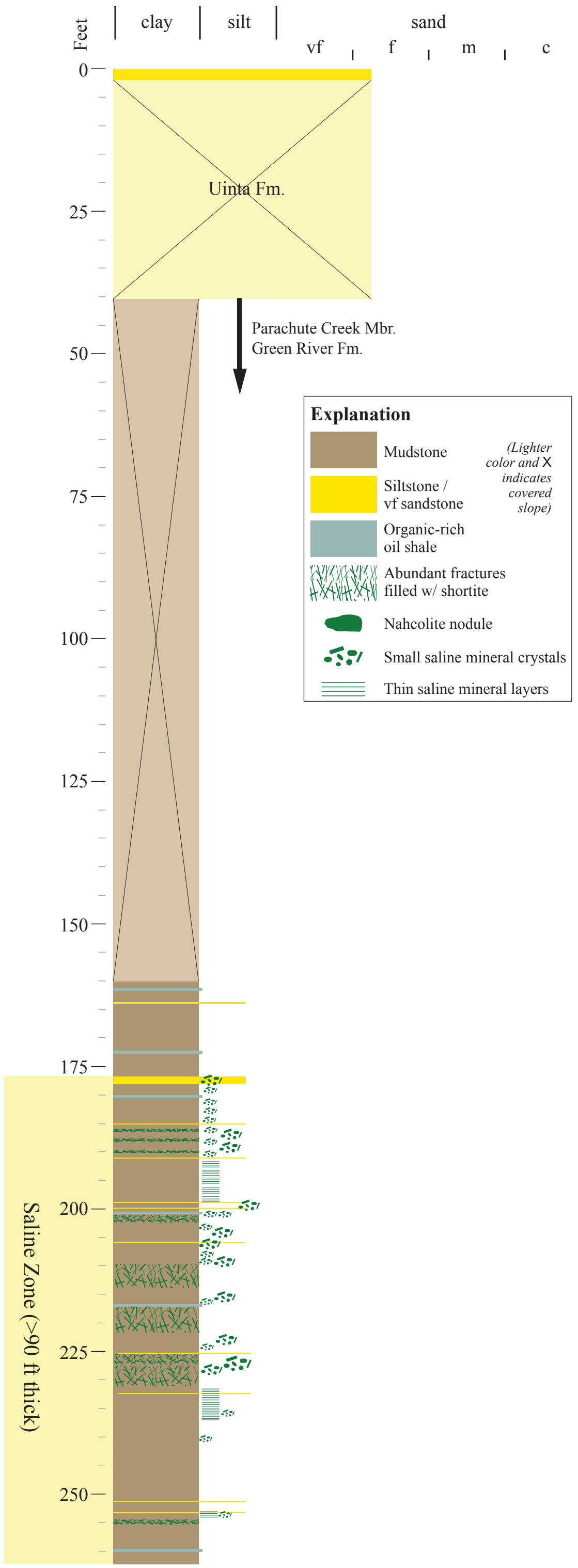
WATSON MEASURED OUTCROP SECTION

Location: Section 7, T. 11 S., R. 25 E., SLBLM
UTM E 657393, UTM N 4414955 (NAD 83)



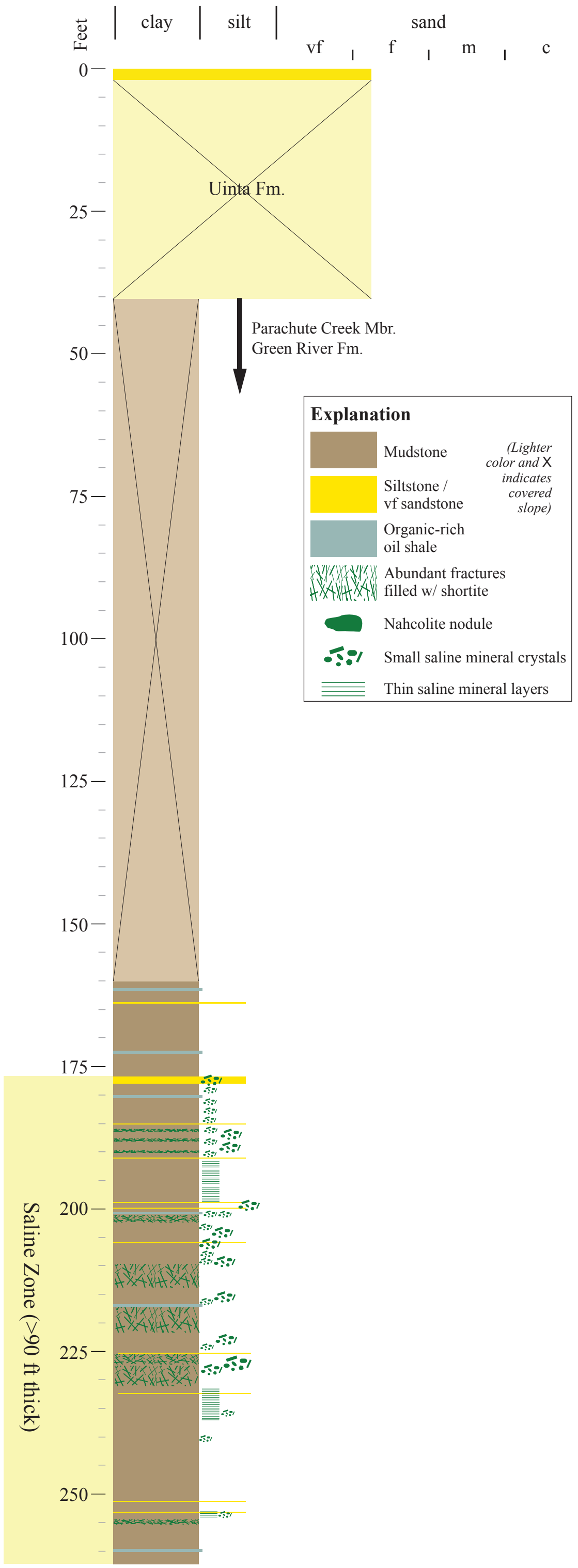
LONG DRAW MEASURED OUTCROP SECTION

Location: Section 3, T. 12 S., R. 24 E., SLBLM
UTM E 652475, UTM N 4407951 (NAD 83)



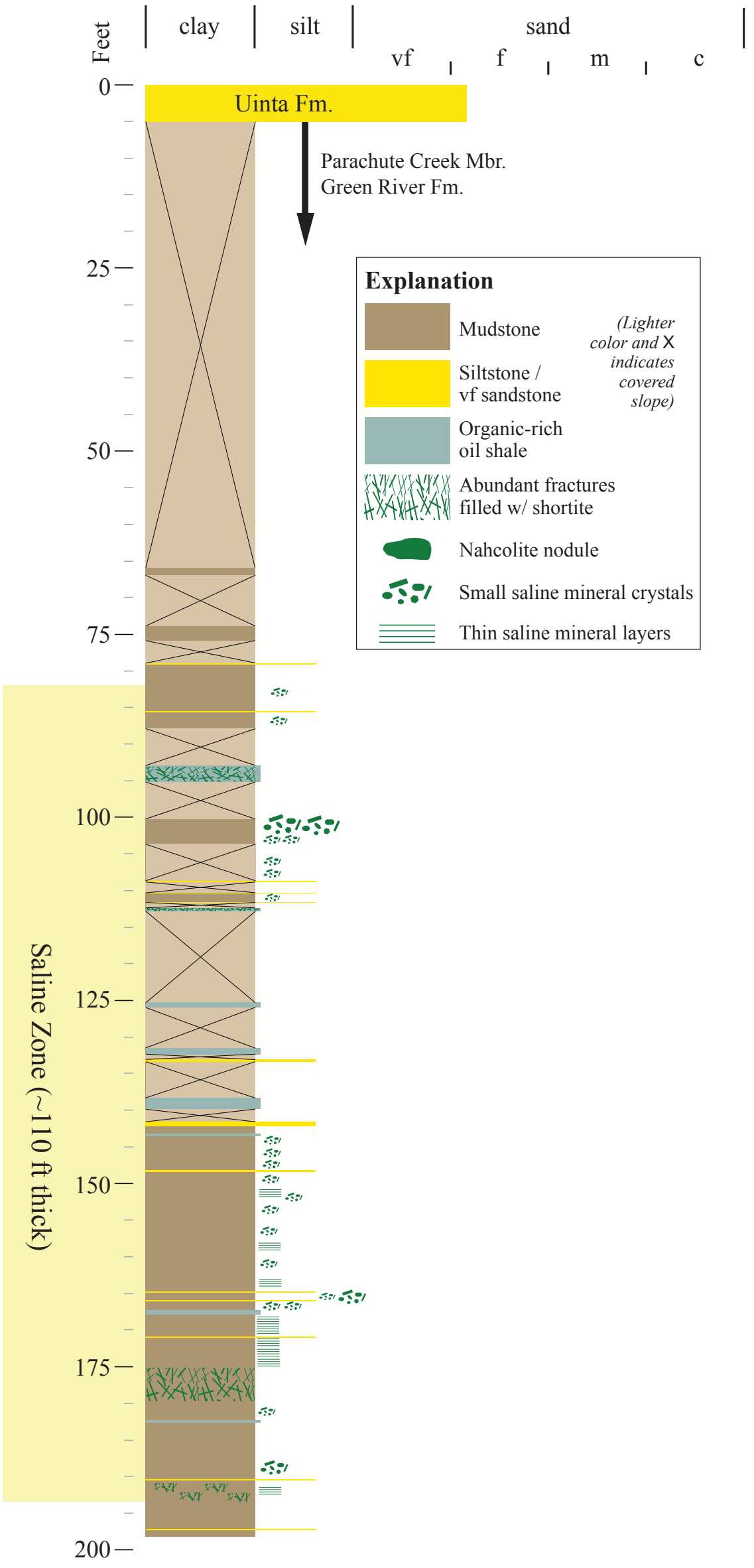
LONG DRAW MEASURED OUTCROP SECTION

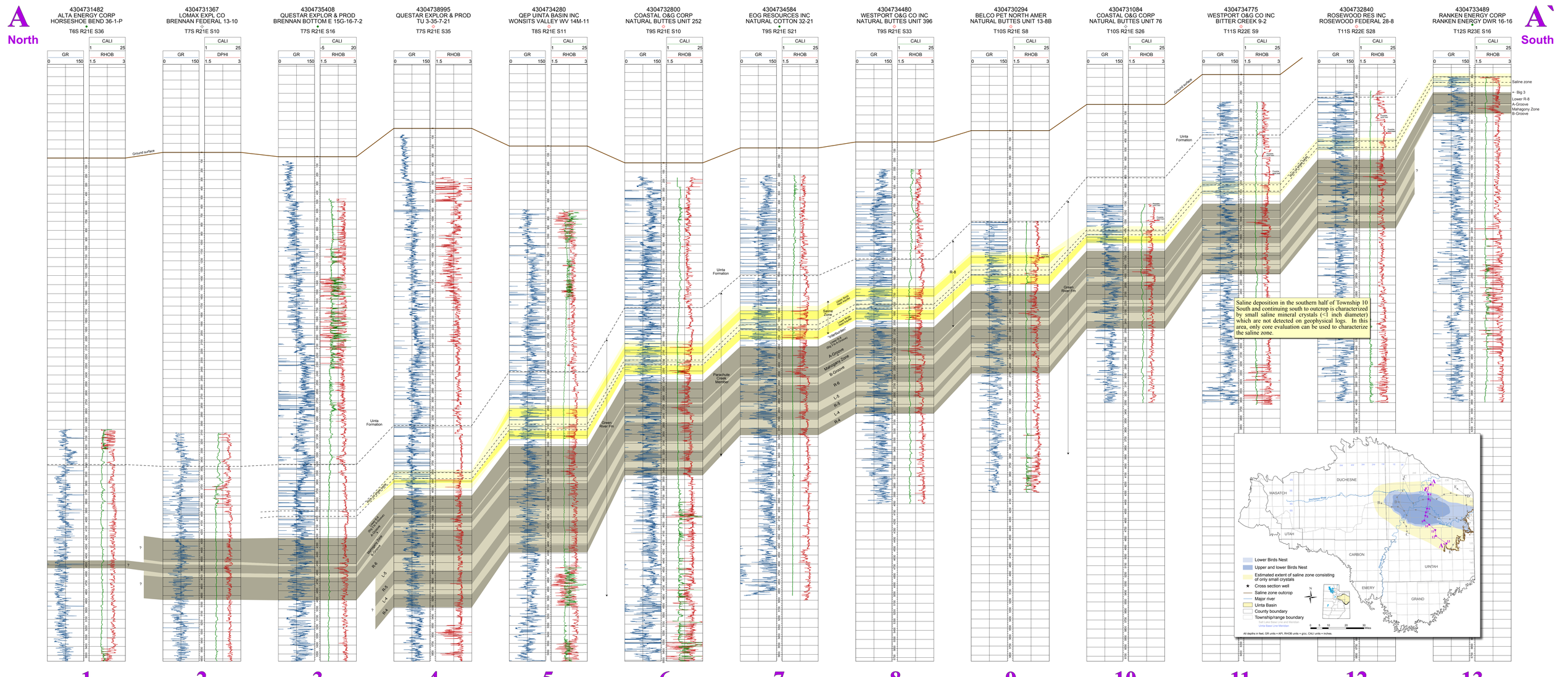
Location: Section 3, T. 12 S., R. 24 E., SLBLM
UTM E 652475, UTM N 4407951 (NAD 83)



BITTER CREEK MEASURED OUTCROP SECTION

Location: Section 29, T. 12 S., R. 23 E., SLBLM
UTM E 640194, UTM N 4400583 (NAD 83)




A
North
A`
South
4304731482
ALTA ENERGY CORP
HORSESHOE BEND 36-1-P
T6S R21E S36
4304731367
LOMAX EXPL CO
BRENNAN FEDERAL 13-10
T7S R21E S10
4304735408
QUESTAR EXPLOR & PROD
BRENNAN BOTTOM E 15G-16-7-2
T7S R21E S16
4304738995
QUESTAR EXPLOR & PROD
TU 3-35-7-21
T7S R21E S35
4304734280
QEP UINTA BASIN INC
WONSITS VALLEY WV 14M-11
T8S R21E S11
4304732800
COASTAL O&G CORP
NATURAL BUTTES UNIT 252
T9S R21E S10
4304734584
EOG RESOURCES INC
NATURAL COTTON 32-21
T9S R21E S21
4304734480
WESTPORT O&G CO INC
NATURAL BUTTES UNIT 396
T9S R21E S33
4304730294
BELCO PET NORTH AMER
NATURAL BUTTES UNIT 13-8B
T10S R21E S8
4304731084
COASTAL O&G CORP
NATURAL BUTTES UNIT 76
T10S R21E S26
4304734775
WESTPORT O&G CO INC
BITTER CREEK 9-2
T11S R22E S9
4304732840
ROSEWOOD RES INC
ROSEWOOD FEDERAL 28-8
T11S R22E S28
4304733489
RANKEN ENERGY CORP
RANKEN ENERGY DWR 16-16
T12S R23E S16
GR
CALI
RHOB
DPHI
Ground surface
Uinta Formation
Green River Fm
Parachute Creek Member
Saline Zone
Lower Birds Nest
Upper Birds Nest
"Washburn"
Lower Birds Nest
A-Groove
Mahogany Zone
B-Groove
R-8
R-6
L-5
R-5
L-4
R-4
Saline zone
Big 3
Lower R-8
A-Groove
Mahogany Zone
B-Groove
Saline deposition in the southern half of Township 10 South and continuing south to outcrop is characterized by small saline mineral crystals (<1 inch diameter) which are not detected on geophysical logs. In this area, only core evaluation can be used to characterize the saline zone.
DUCHESNE
WASATCH
UTAH
CARBON
UINTAH
EMERY
GRAND
Duchesne River
Lower Birds Nest
Upper and lower Birds Nest
Estimated extent of saline zone consisting of only small crystals
Cross section well
Saline zone outcrop
Major river
Uinta Basin
County boundary
Township/range boundary
SLB Salt Lake Base and Meridian
Uinta Base Line and Meridian
Miles
All depths in feet, GR units = API, RHOB units = g/cc, CALI units = inches.
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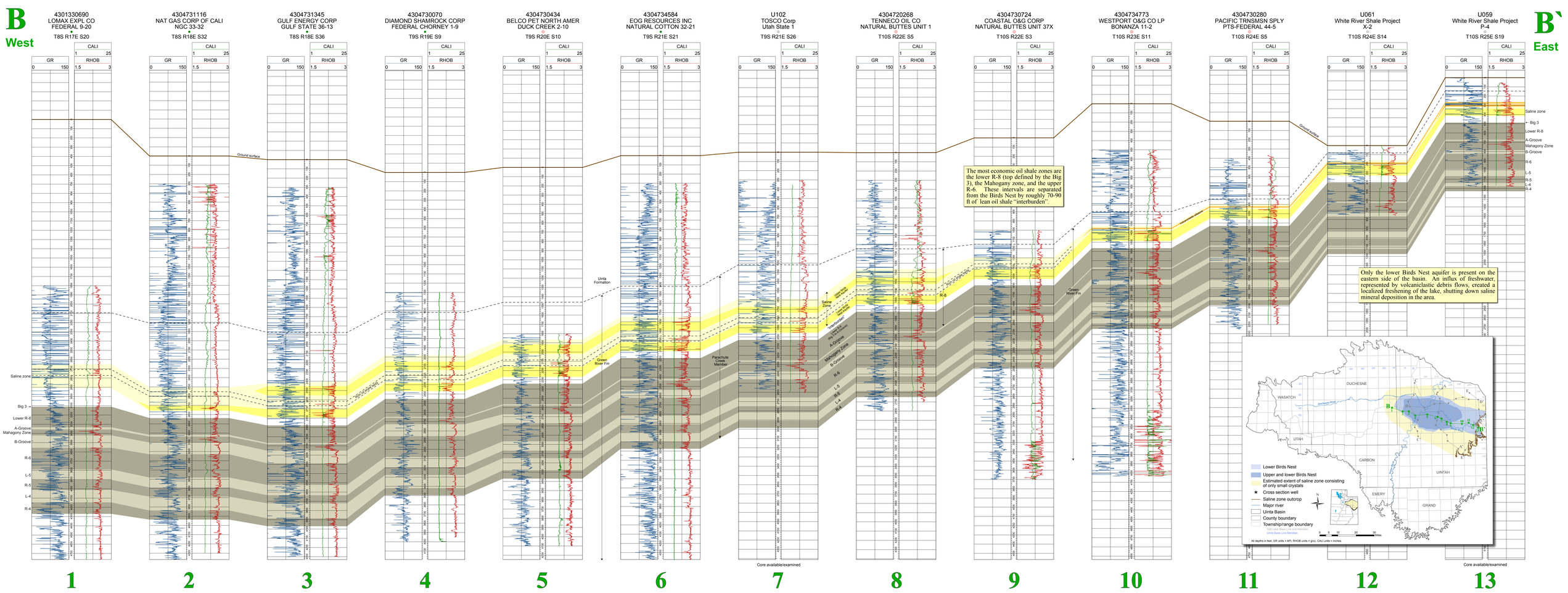
12
13


B
West
B`
East
4301330690
LOMAX EXPL CO
FEDERAL 9-20
T8S R17E S20
4304731116
NAT GAS CORP OF CALI
NGC 33-32
T8S R18E S32
4304731345
GULF ENERGY CORP
GULF STATE 36-13
T8S R18E S36
4304730070
DIAMOND SHAMROCK CORP
FEDERAL CHORNEY 1-9
T9S R19E S9
4304730434
BELCO PET NORTH AMER
DUCK CREEK 2-10
T9S R20E S10
4304734584
EOG RESOURCES INC
NATURAL COTTON 32-21
T9S R21E S21
U102
TOSCO Corp
Utah State 1
T9S R21E S26
4304720268
TENNECO OIL CO
NATURAL BUTTES UNIT 1
T10S R22E S5
4304730724
COASTAL O&G CORP
NATURAL BUTTES UNIT 37X
T10S R22E S3
4304734773
WESTPORT O&G CO LP
BONANZA 11-2
T10S R23E S11
4304730280
PACIFIC TRNSMSN SPLY
PTS-FEDERAL 44-5
T10S R24E S5
U061
White River Shale Project
X-2
T10S R24E S14
U059
White River Shale Project
P-4
T10S R25E S19
GR
RHOB
CALI
Ground surface
Uinta Formation
Green River Fm
Parachute Creek Member
Saline zone
Big 3
Lower R-8
A-Groove
Mahogany Zone
B-Groove
R-6
L-5
R-5
L-4
R-4
Core available/examined
The most economic oil shale zones are the lower R-8 (top defined by the Big 3), the Mahogany zone, and the upper R-6. These intervals are separated from the Birds Nest by roughly 70-90 ft of lean oil shale "interburden".
Only the lower Birds Nest aquifer is present on the eastern side of the basin. An influx of freshwater, represented by volcaniclastic debris flows, created a localized freshening of the lake, shutting down saline mineral deposition in the area.
DUCHESNE
WASATCH
UTAH
CARBON
UINTAH
EMERY
GRAND
Lower Birds Nest
Upper and lower Birds Nest
Estimated extent of saline zone consisting of only small crystals
Cross section well
Saline zone outcrop
Major river
Uinta Basin
County boundary
Township/range boundary
Salt Lake Base Line and Meridian
Uinta Base Line Meridian
All depths in feet, GR units = API, RHOB units = g/cc, CALI units = inches.
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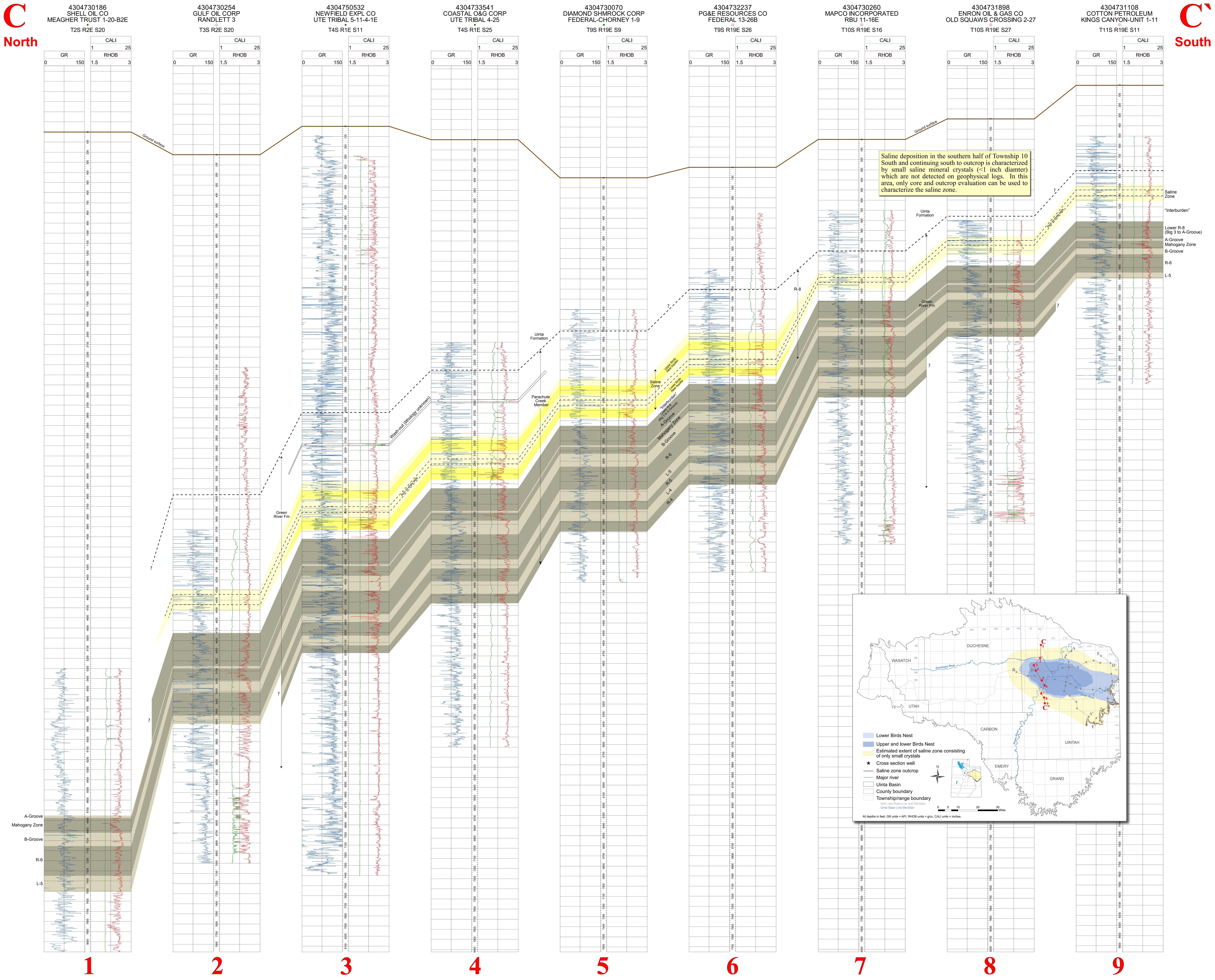
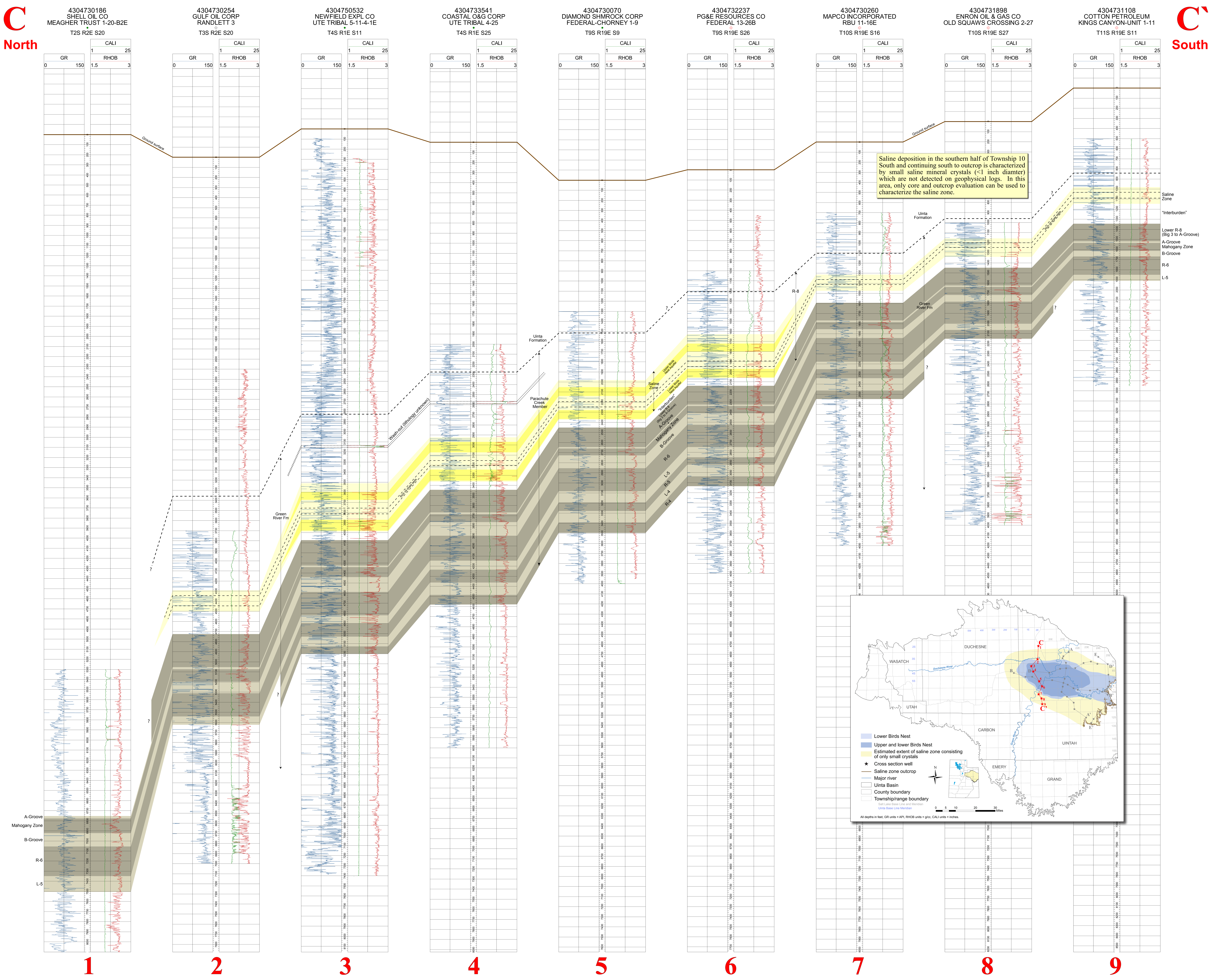
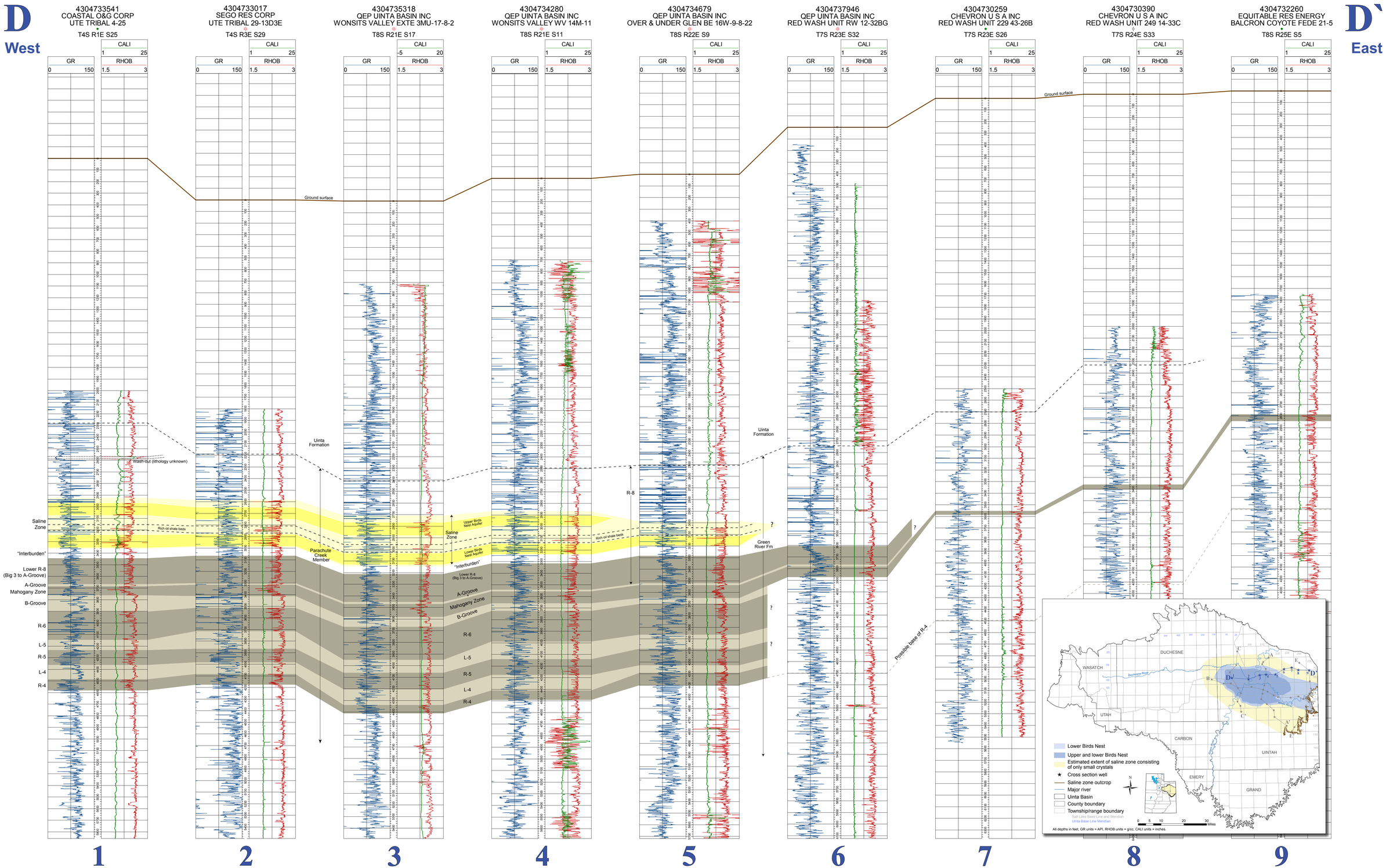
UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources



UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources

Plate 29
Utah Geological Survey Special Study 147
Geological Characterization of the Birds Nest Aquifer, Uinta Basin, Utah




D
West
D`
East
4304733541
COASTAL O&G CORP
UTE TRIBAL 4-25
T4S R1E S25
4304733017
SEGO RES CORP
UTE TRIBAL 29-13D3E
T4S R3E S29
4304735318
QEP UINTA BASIN INC
WONSITS VALLEY EXTE 3MU-17-8-2
T8S R21E S17
4304734280
QEP UINTA BASIN INC
WONSITS VALLEY WV 14M-11
T8S R21E S11
4304734679
QEP UINTA BASIN INC
OVER & UNDER GLEN BE 16W-9-8-22
T8S R22E S9
4304737946
QEP UINTA BASIN INC
RED WASH UNIT RW 12-32BG
T7S R23E S32
4304730259
CHEVRON U S A INC
RED WASH UNIT 229 43-26B
T7S R23E S26
4304730390
CHEVRON U S A INC
RED WASH UNIT 249 14-33C
T7S R24E S33
4304732260
EQUITABLE RES ENERGY
BALCRON COYOTE FEDE 21-5
T8S R25E S5
GR
CALI
RHOB
Ground surface
Uinta Formation
Wash-out (lithology unknown)
Saline Zone
Rich oil shale beds
"Interburden"
Lower R-8 (Big 3 to A-Groove)
A-Groove
Mahogany Zone
B-Groove
R-6
L-5
R-5
L-4
R-4
Parachute Creek Member
Upper Birds Nest Aquifer
Lower Birds Nest Aquifer
R-8
Green River Fm
Possible base of R-4
DUCHESNE
WASATCH
UTAH
CARBON
UINTAH
EMERY
GRAND
Duchesne River
Lower Birds Nest
Upper and lower Birds Nest
Estimated extent of saline zone consisting of only small crystals
Cross section well
Saline zone outcrop
Major river
Uinta Basin
County boundary
Township/range boundary
Salt Lake Base Line and Meridian
Uinta Base Line Meridian
Miles
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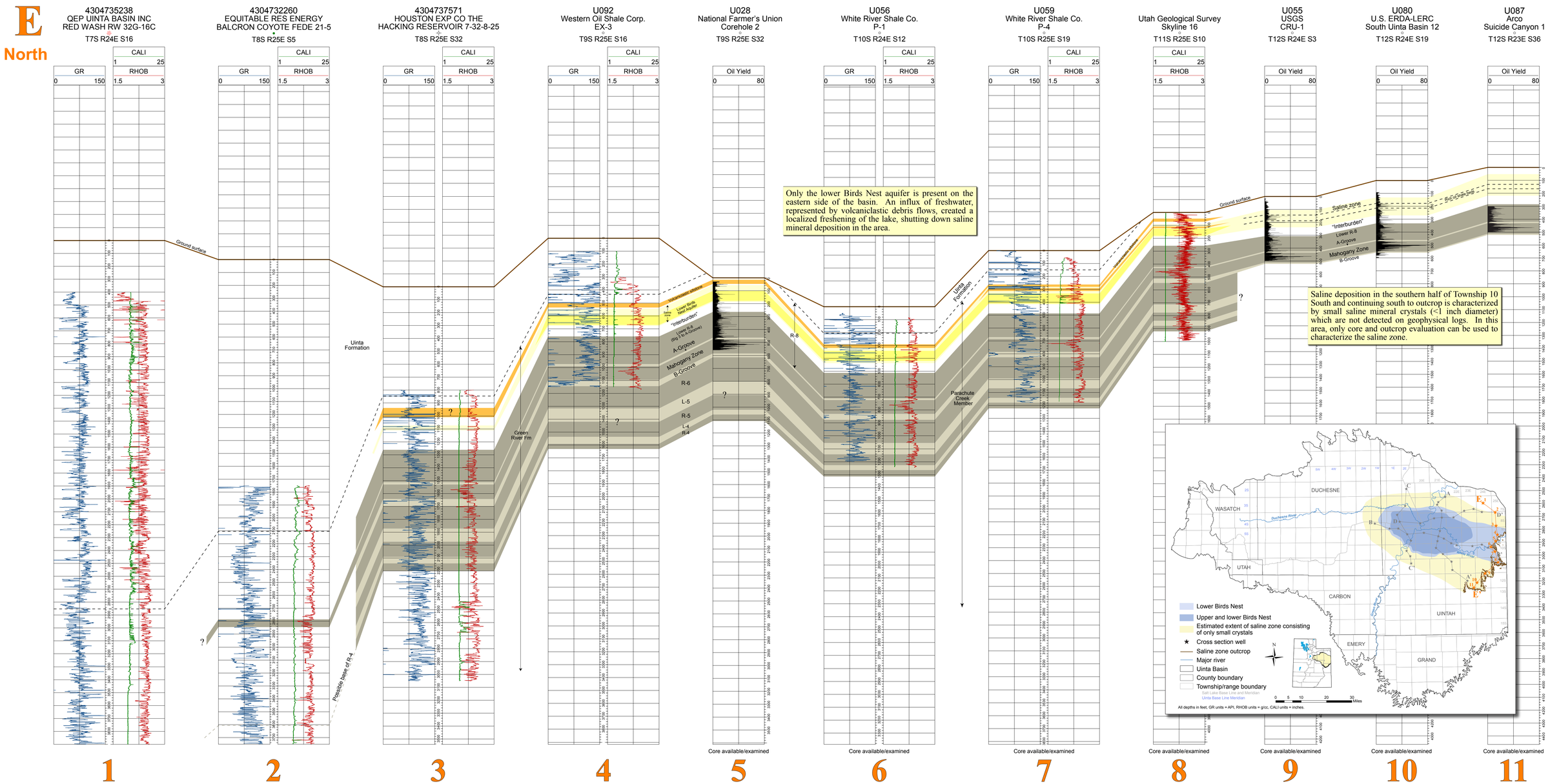
E
North
E`
South
4304735238
QEP UINTA BASIN INC
RED WASH RW 32G-16C
T7S R24E S16
4304732260
EQUITABLE RES ENERGY
BALCRON COYOTE FEDE 21-5
T8S R25E S5
4304737571
HOUSTON EXP CO THE
HACKING RESERVOIR 7-32-8-25
T8S R25E S32
U092
Western Oil Shale Corp.
EX-3
T9S R25E S16
U028
National Farmer's Union
Corehole 2
T9S R25E S32
U056
White River Shale Co.
P-1
T10S R24E S12
U059
White River Shale Co.
P-4
T10S R25E S19
Utah Geological Survey
Skyline 16
T11S R25E S10
U055
USGS
CRU-1
T12S R24E S3
U080
U.S. ERDA-LERC
South Uinta Basin 12
T12S R24E S19
U087
Arco
Suicide Canyon 1
T12S R23E S36
GR
CALI
RHOB
Oil Yield
Ground surface
Uinta Formation
Green River Fm
Possible base of R-4
Volcaniclastic debris
Lower Birds Nest Aquifer
"Interburden"
Lower R-8
(Big 3 to A-Groove)
A-Groove
Mahogany Zone
B-Groove
R-6
L-5
R-5
L-4
R-4
R-8
Parachute Creek Member
Saline zone
Core available/examined
1
2
3
4
5
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7
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9
10
11
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