KGS OFR 2008-34

Kansas Low-BTU Gas Compositions and Production Potential at Elmdale field, Chase County, Kansas

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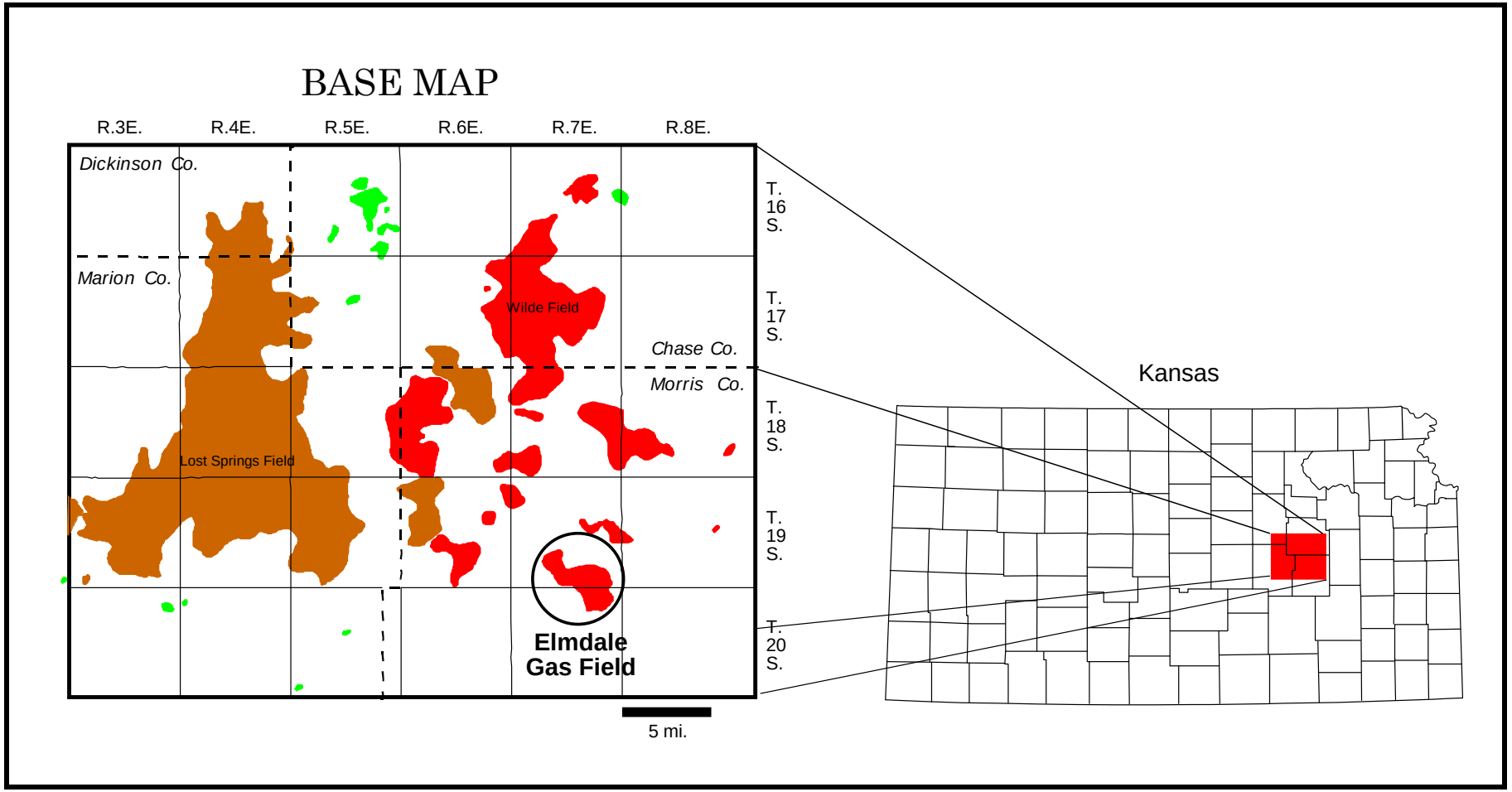
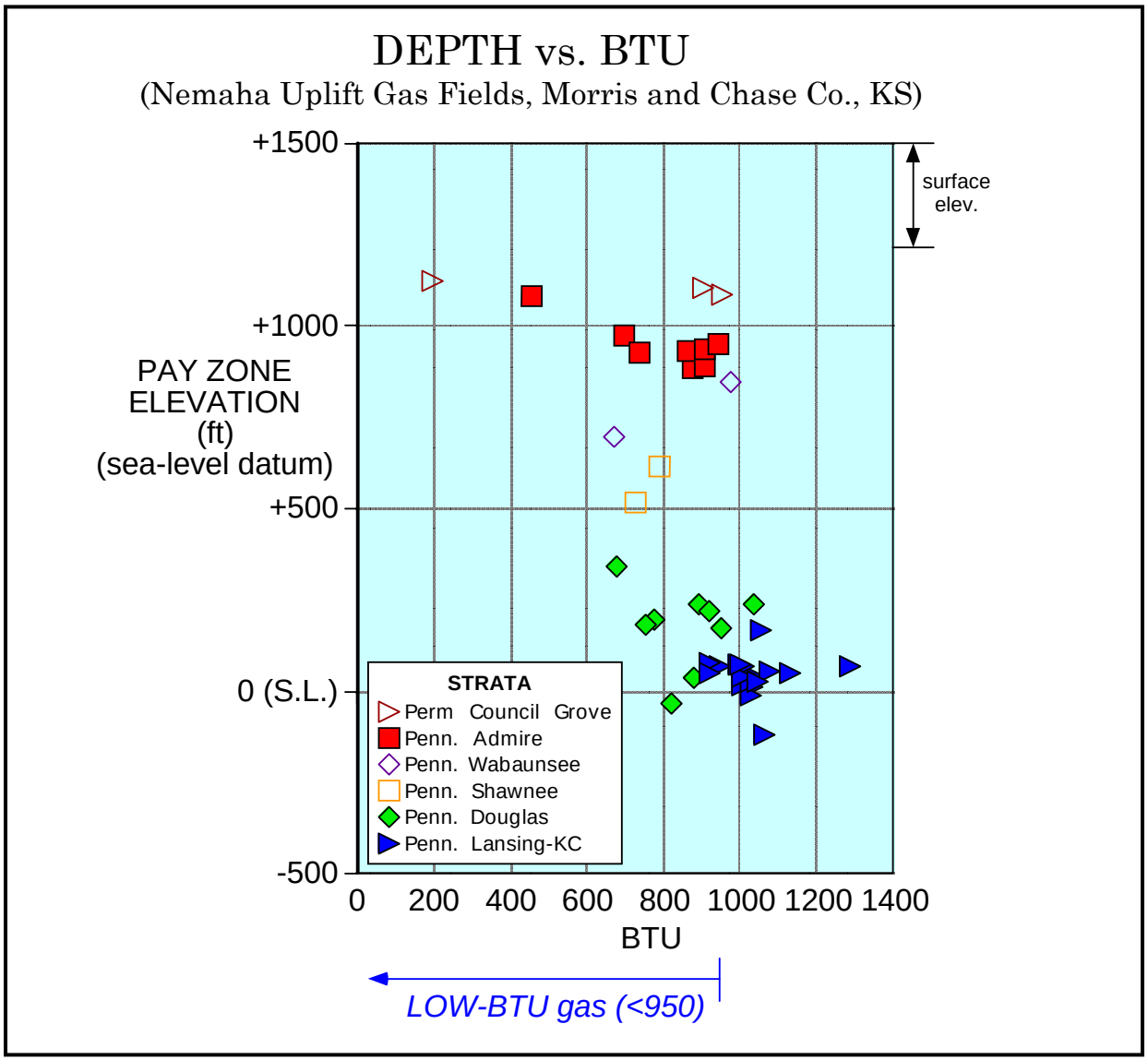
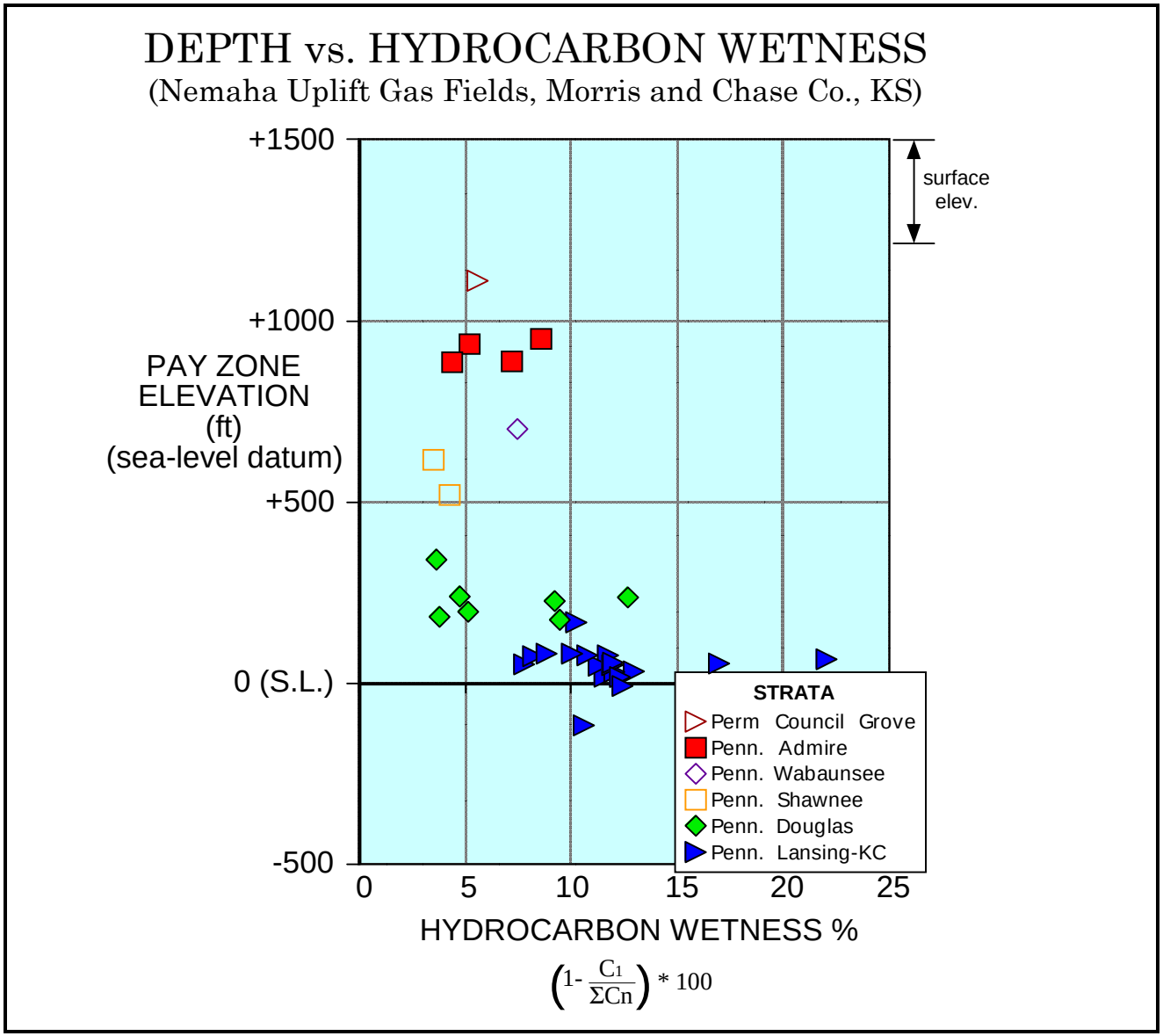


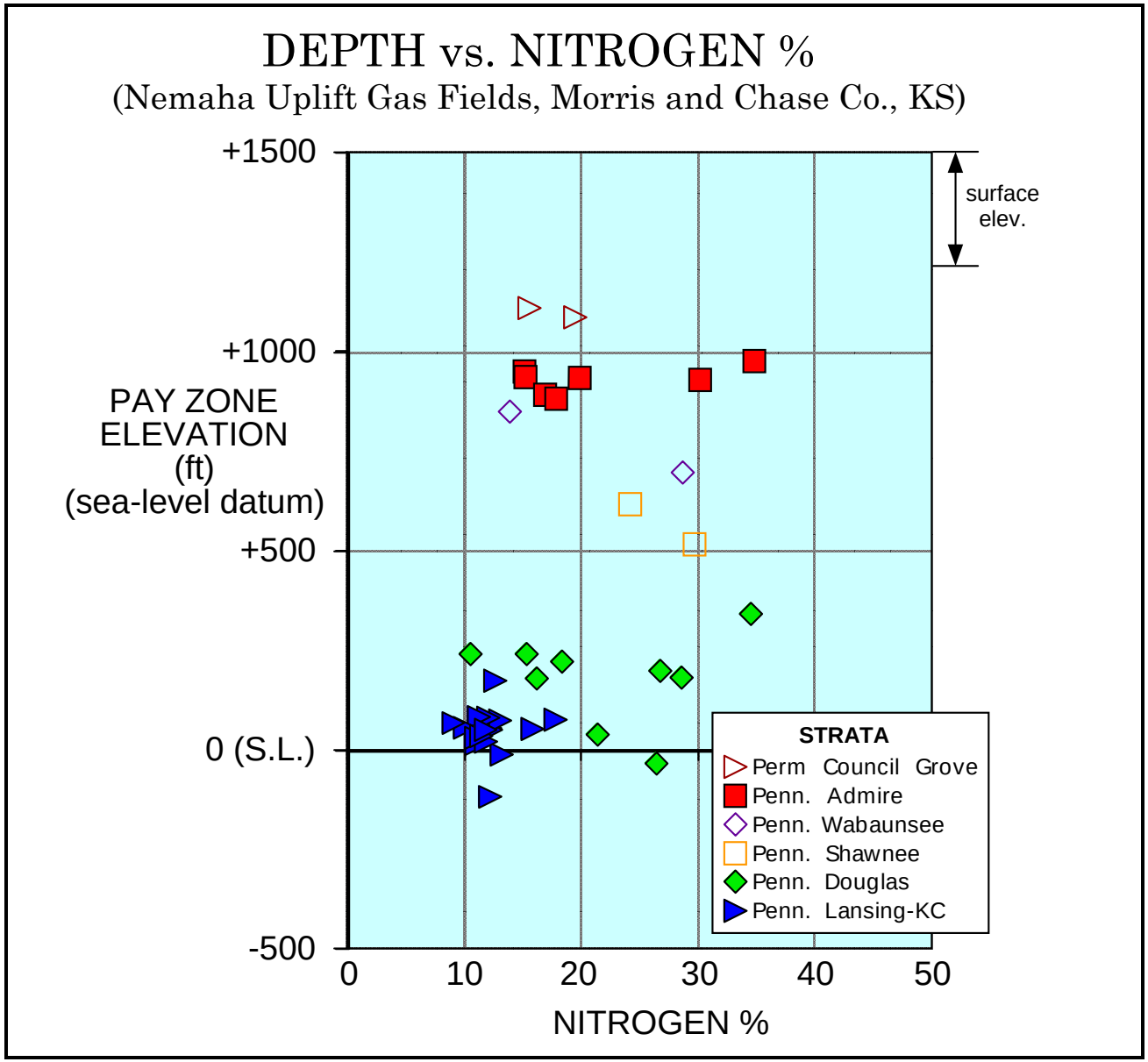
Fifty-four gas analyses were collected from published and private sources from the region of the Elmdale Gas Field in Kansas to survey the likely range of compositions of natural gas in this region and to determine what strata may contain low-BTU gas resources. Several pay zones, ranging in age from Permian to Mississippian, produce gas in the region.



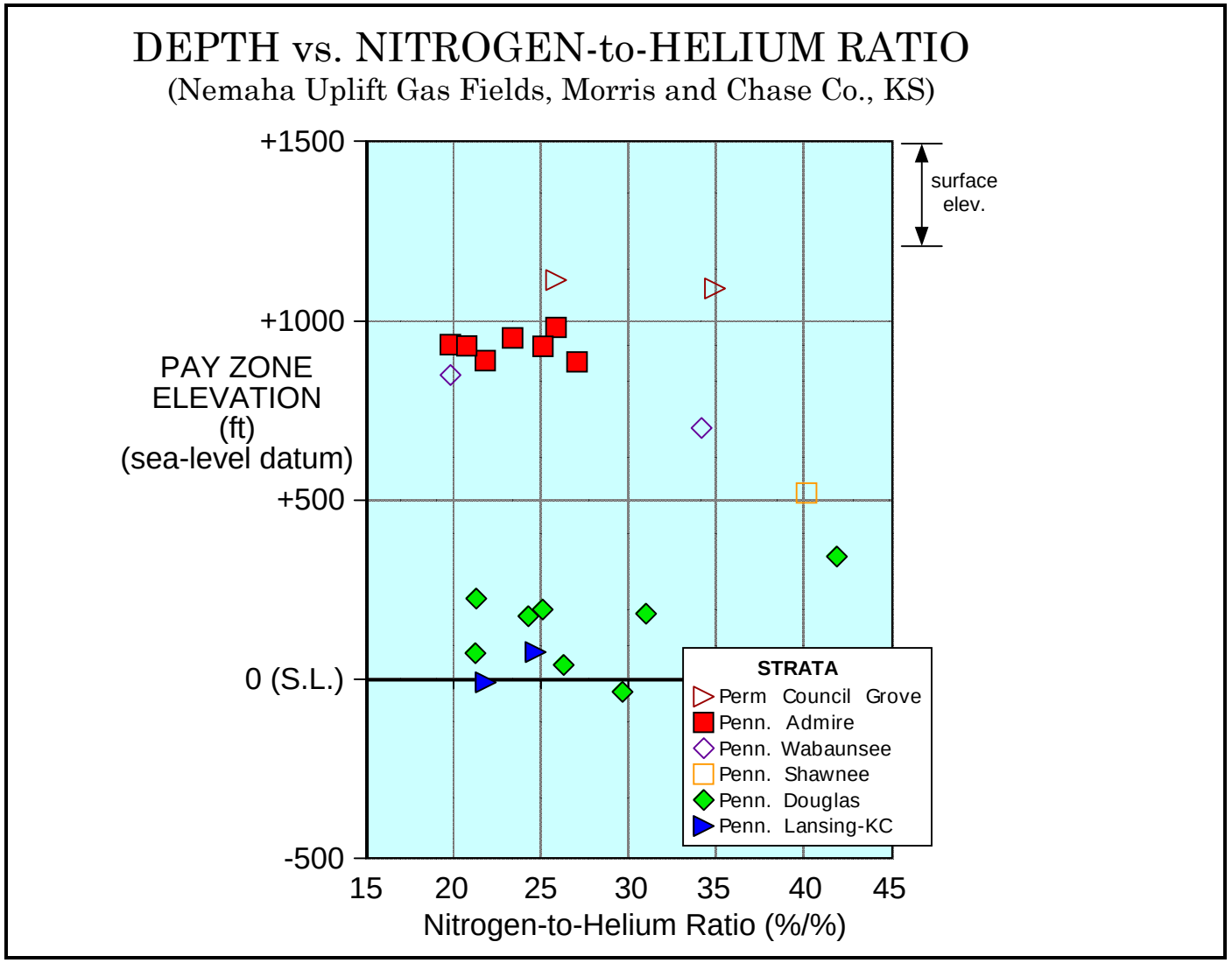
In general, the shallower pay zones contain low-BTU gas (i.e. <950 BTU/scf)



Hydrocarbon wetness, the ratio of heavier molecular-weight hydrocarbons to that of methane plus the heavier molecular-weight hydrocarbons, increases with increasing age and depth of the producing formation.



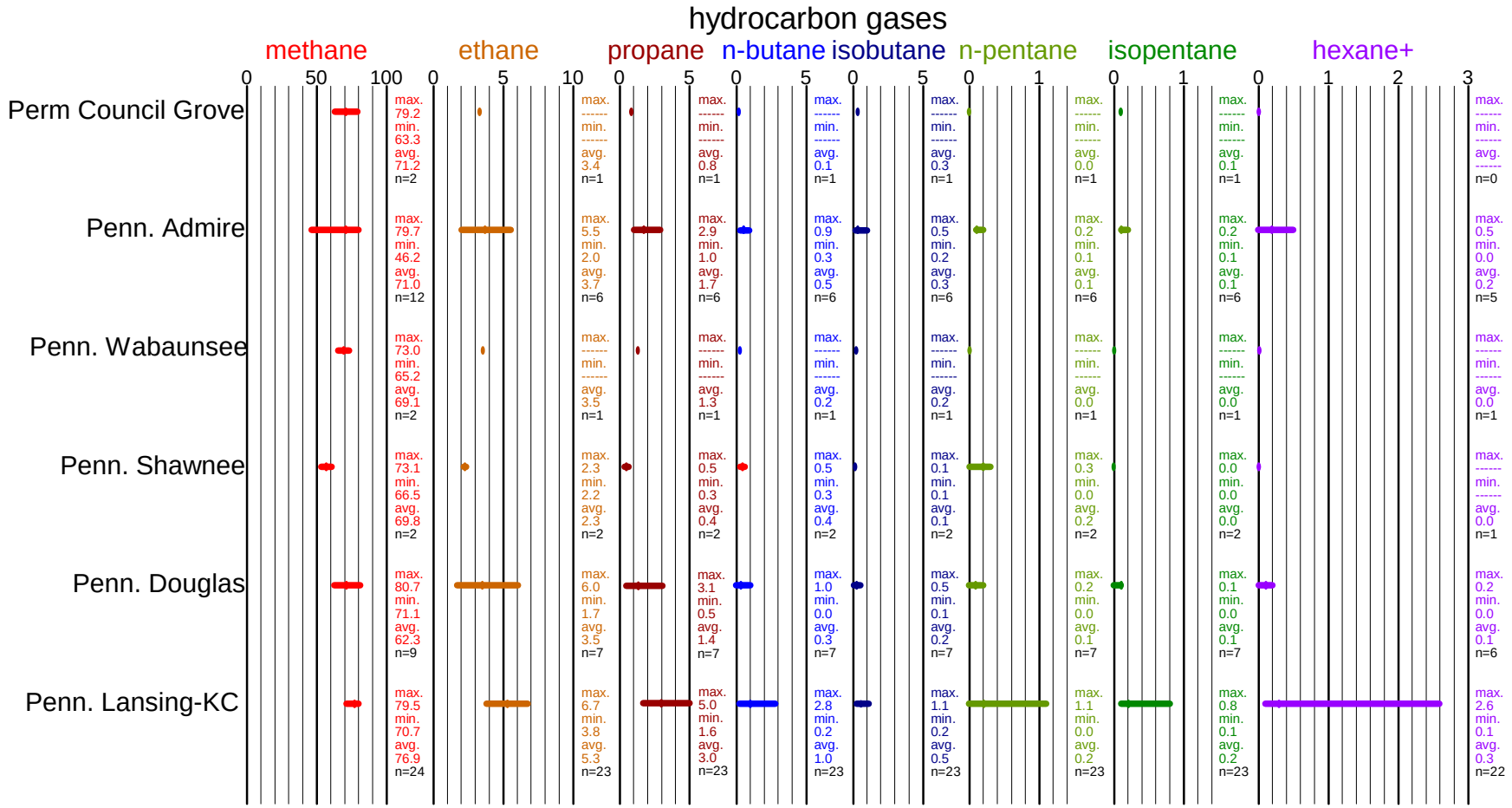
The presence of these heavier-molecular-weight hydrocarbons increase the heating value (BTU content) when natural gases contain them, and this partly account for the better BTU content of the deeper gases, in addition to the greater percentages on nitrogen in the shallower gases.



Nitrogen-to-helium ratios for all the gases essentially remains the same regardless of the age of the pay zone, suggesting a common source for these component gases. The greater percentages of nitrogen and helium in the shallower, low-BTU zones indicates that these zones will have better economics if helium is attempted to be recovered from the rejected noncombustible gases in the upgrading process.

PERCENTAGE RANGES in COMPONENT-GAS COMPOSITIONS

Gas fields on Nemaha Uplift
Morris and Chase Counties, KS



Compositional ranges of hydrocarbon and nonhydrocarbon gases – Part 1. The deeper formations have a greater range in composition, but this may be due to more samples being available.

PERCENTAGE RANGES in COMPONENT-GAS COMPOSITIONS

Gas fields on Nemaha Uplift
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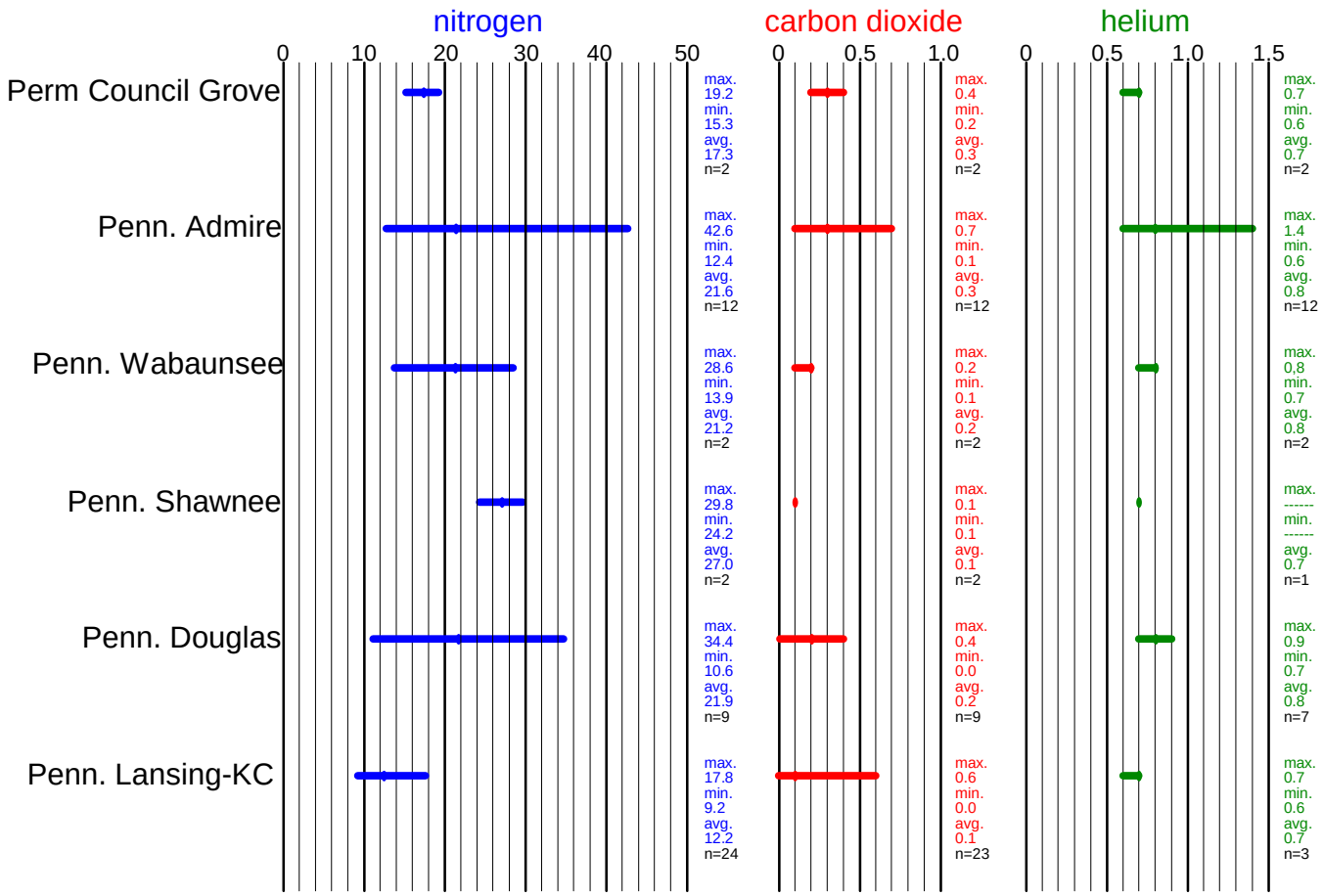
nonhydrocarbon gases



Compositional ranges of hydrocarbon and nonhydrocarbon gases – Part 2. The deeper formations have a greater range in composition, but this may be due to more samples being available.

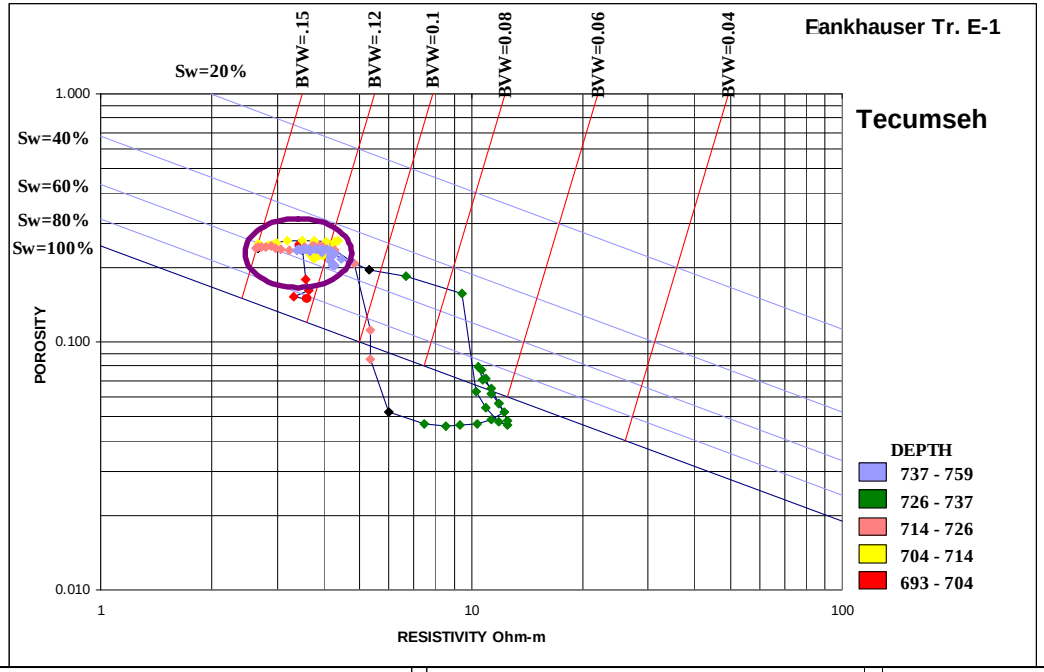
RESOURCE EVALUATION - I
LOW-BTU GAS – ELMDALE FIELD, CHASE COUNTY, KS

- **Wireline logs from 26 wells in and around Elmdale field were analyzed for resource evaluation**
- **Initial analysis at Frankhauser Trust E1 well – Tecumseh interval (704 to 714 ft)**
  - **Produced water free**
  - **Gas effect visible on neutron porosity**
  - **Separation between porosity and BVW (bulk-volume-water)**
    - **Implies water-free or production with minimal water**
  - **Low GR (gamma) values**
- **Above log analysis was used to define**
  - **Archie parameters – m = 1.8, a = 1, and Rw = 0.079**
    - **Used universally in analysis of other wells in the study**
  - **Petrophysical cut-offs**
    - **Porosity > 0.19, Sw < 0.60, Vshale < 85%, and BVW < 0.15**

RESOURCE EVALUATION - II

LOW-BTU GAS – ELMDALE FIELD, CHASE COUNTY, KS

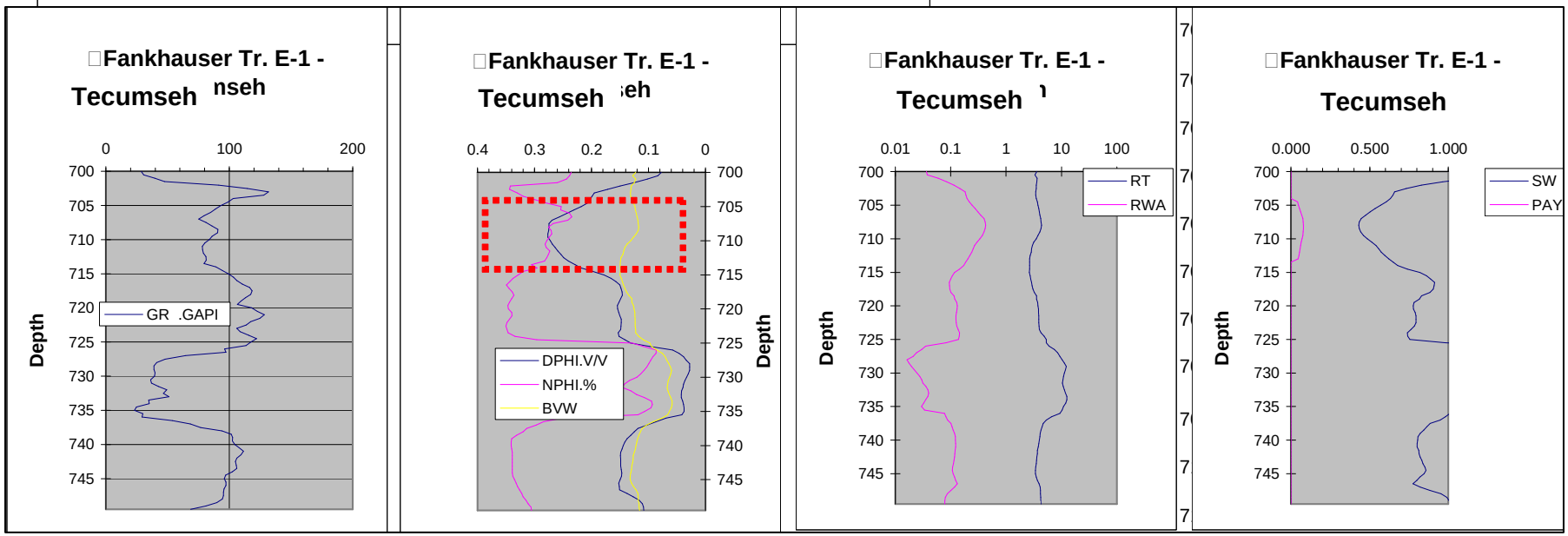
- **Most wells in study area produce pipeline quality gas from LKC (Lansing-Kansas City)**
- **Shallower sands that were analyzed at all wells for low-BTU potential include**
  - **Ireland, Douglas, Tecumseh, Calhoun, Severy, and White Clouds**
- **Porosity correction**
  - **Density and neutron porosity logs run on limestone matrix (2.71 g/cc) were corrected to sandstone matrix (2.65 g/cc)**
- **Gas Effect – neutron cross-over**
  - **Neutron Porosity < Density Porosity**
    - **Deeper invasion into low porosity zones often mask gas effects**
    - **Gas effects easily visible in high porosity zones with shallow invasion**
  - **Presence of Gas Effect – strong indicator of presence of gas**
  - **Absence of Gas Effect – does not necessarily mean that the zone is bereft of producible gas**
- **Zonal production potential prediction was based on respective log signatures**



Fankhauser Tr. E-1

Tecumseh (704-714 ft)

- Neutron gas effect, relatively low GR, and separation between density phi and BVW, Sw < 60%
- BVW clustering at low value (0.12) indicating larger pores, and no or limited water production
- **Gas zone – flowed water-free gas**



Log analysis of Tecumseh zone in Frankhauser Trust E1 well.

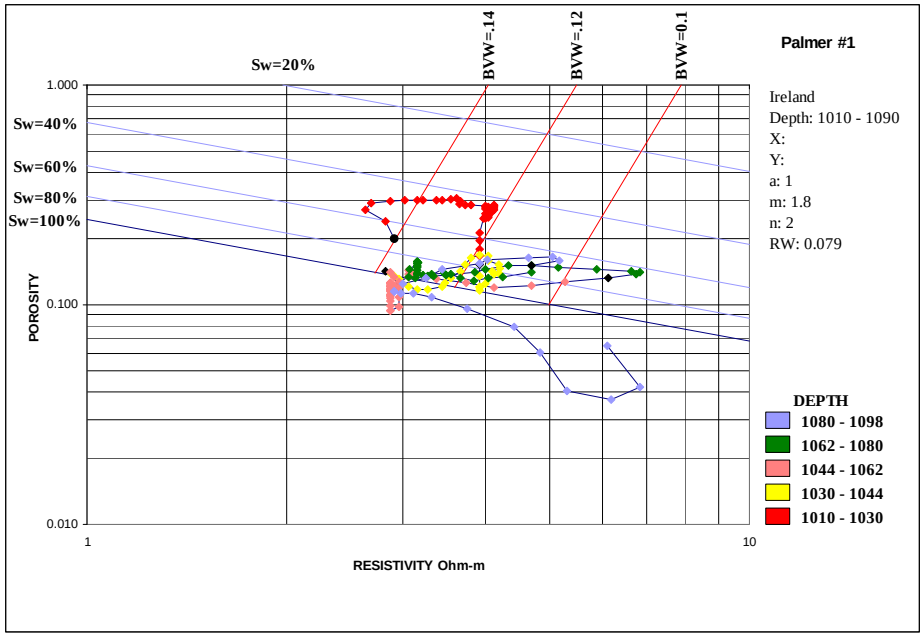
SUMMARY OF RESOURCE ANALYSIS

Well	API	Operator	Sec	Twn - S	Rng - E	pfeffer	Ireland	douglas	Techumseh	Calhoun	Severy	White Cloud
Palmer 1	15-017-20845	Range Oil Co	9	20	7	yes	gas	wet	gas	gas	gas in transition	wet
Donahue A1	15-017-20846	AEC	18	19	7				wet	wet	wet	
Stevens A1	15-017-20861	AEC	18	19	7		wet		wet	wet	wet	
Giger D1	15-017-20844	AEC	20	19	7	yes			trans	trans	wet	
Kohr A1	15-017-20842	AEC	21	19	7	yes	wet		wet	wet	trans	
Ward Ranch A1	15-017-20816	AEC	21	19	7	yes	wet		wet-coal	wet	wet-coal	
Mushrush B1	15-017-20810	AEC	23	19	7	no Rt						
Mushrush 26-1	15-017-20497-0001	Tejas Energy	26	19	7	yes		wet	wet	wet	wet	
Mushrush 26-2	15-017-20790	AEC	26	19	7	yes	wet		wet	trans-fine	trans & coal	
Noble 1	15-017-20868	AEC	27	19	7	yes	wet		wet	trans-fine	wet	
McCallum A1	15-017-20822	AEC	27	19	7	no Rt						
Thurston 1-27	15-017-20092-0001	AEC	27	19	7		wet		gas?	wet	gas?	
Giger A1	15-017-20823	AEC	28	19	7	yes	wet		wet	Gas+wtr	wet-coal	
Pretzer A1	15-017-20817	AEC	28	19	7	yes	wet		shaly	wet	wet	
Marshall A1	15-017-20811	AEC	28	19	7	yes	wet		shaly	wet	wet	
Davis/Giger B1 Gas Ur	15-017-20860	AEC	29	19	7	yes	wet	shaly	gas + transition	wet	wet + 2 ft coal	
Giger B1	15-017-20824	AEC	29	19	7	yes	wet	shaly	gas but no show	wet	trans + 2 ft coal	
Kissel 1-29	15-017-20081-0001	AEC	29	19	7	yes	gas	gas?	gas?	shaly	gas + 2 ft coal	
Fankhauser Trust E1	15-017-20843	AEC	32	19	7	yes	wet	wet	gas	shaly	shaly	
Fankhauser Trust D1	15-017-20841	AEC	33	19	7	yes	wet	shaly	gas?	wet?	wet-coal	
Wood A1	15-017-20828	AEC	33	19	7	yes	wet	show	gas?	wet	wet-coal	
Fankhauser 1-33	15-017-20091-0001	AEC	33	19	7	no Rt						
Starkey A1	15-017-20800	AEC	34	19	7	yes	wet	gas?	wet	trans-fine	gas+ 3ft+ coal	
McCallum-Simmons G	15-017-20858	AEC	34	19	7	yes	wet	trans	wet	wet	wet+coal	
Stauffer 1A-34	15-017-20762	Yellow Rose Energy	34	19	7	**na**						
Stauffer 3-34	15-017-20372	D&F Petr	34	19	7	na						
Stauffer 2-35	15-017-20090	Viking Intl Pet	35	19	7	yes	wet	gas -looks trans	wet	wet	wet	
Stauffer 8-35	15-017-20789	AEC	35	19	7	yes	wet	trans-shaly	tran-wet	trans	gas?	
Stauffer 5-35	15-017-20373-0001	Viking Intl Pet	35	19	7	not logged						
Spinden A1	15-017-20801	AEC	36	19	7	yes	trans	trans	wet	wet	trans	
Stauffer 3	15-017-20126	Jackman & Jackman	35	19	7							
Steerman A1	15-017-20830	AEC	1	20	7							
Reehling Trust B1	15-017-20809	AEC	1	20	7	yes	wet	shaly	wet	wet	wet	wet
Reehling Trust B3	15-017-20826	AEC	1	20	7	yes	wet	shaly	wet	wet	wet	wet

Summary of log analyses for wells in and around the Elmdale field, Chase County, Kansas.

RESOURCE EVALUATION - Example
PALMER 1 – ELMDALE FIELD, CHASE COUNTY, KS

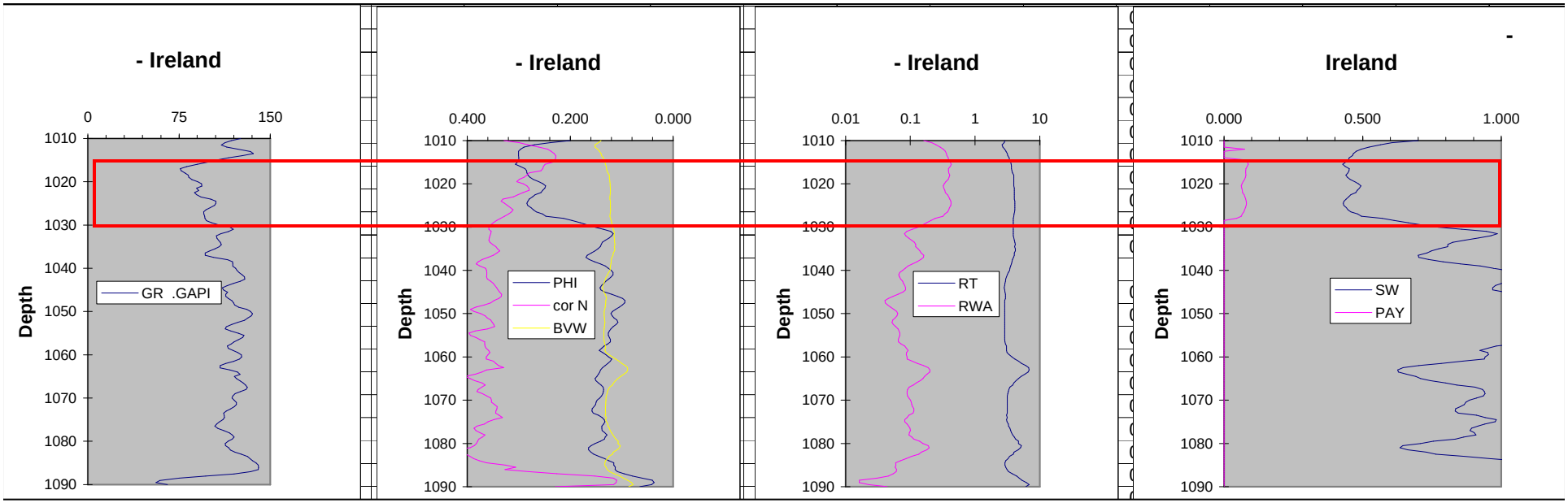
- **Analyzed zones marked in RED**
- **Ireland sand (1014 to 1030 ft) – Strong gas production potential**
  - **High porosity, low GR values, BVW cluster around 0.14**
  - **Gas effect on neutron log over lower part of the interval**
  - **Produces water-free low-BTU gas**
- **Tecumseh sand (744 to 754 ft) – Good indications of gas**
  - **Low BVW (< 0.1) and GR, gas effect on neutron**
  - **Tested significant volumes of low-BTU gas**
- **Calhoun sand (654 to 657 ft) – Some gas potential**
  - **Low BVW (< 0.14) and GR, minor gas effect on neutron, separation between porosity and BVW**
  - **No gas shows recorded during drilling**
- **Severy sand (570 to 578 ft) – Gas bearing potential**
  - **Gas effect on neutron, moderate GR, separation between density porosity and BVW**
  - **Transition zone visible**
  - **Tested significant volumes of low-BTU gas**



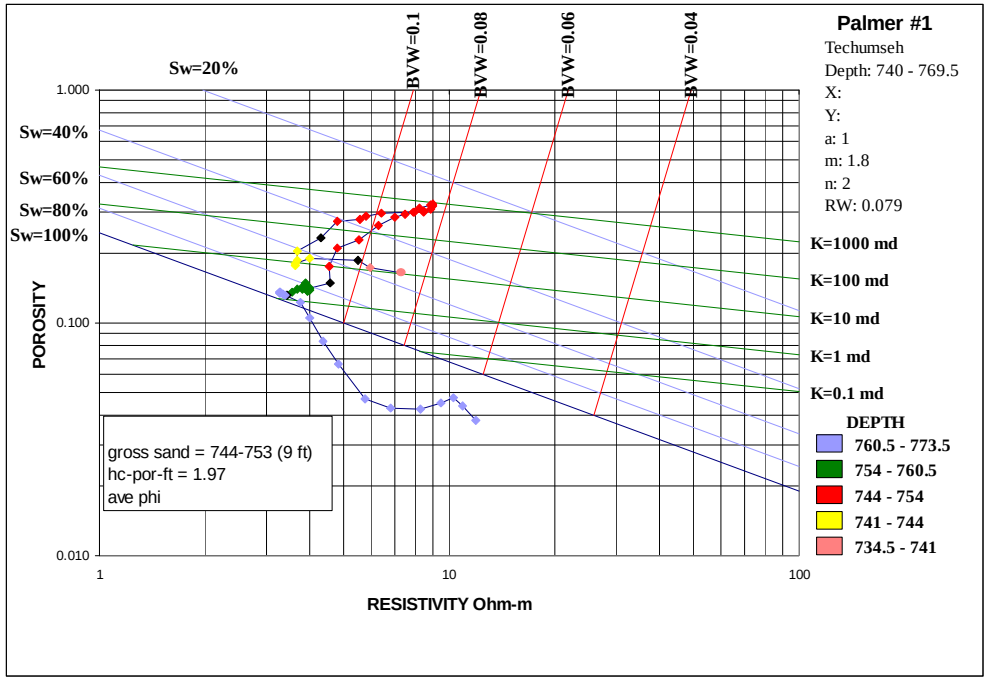
Palmer #1

Ireland (1014-1030 ft)

- **Strong gas indications** with high porosity, low BVW including clustering around 0.12, and lower GR
- Neutron gas effect on cleaner sandstone
- Sw < 60%
- Produces water-free low-BTU gas



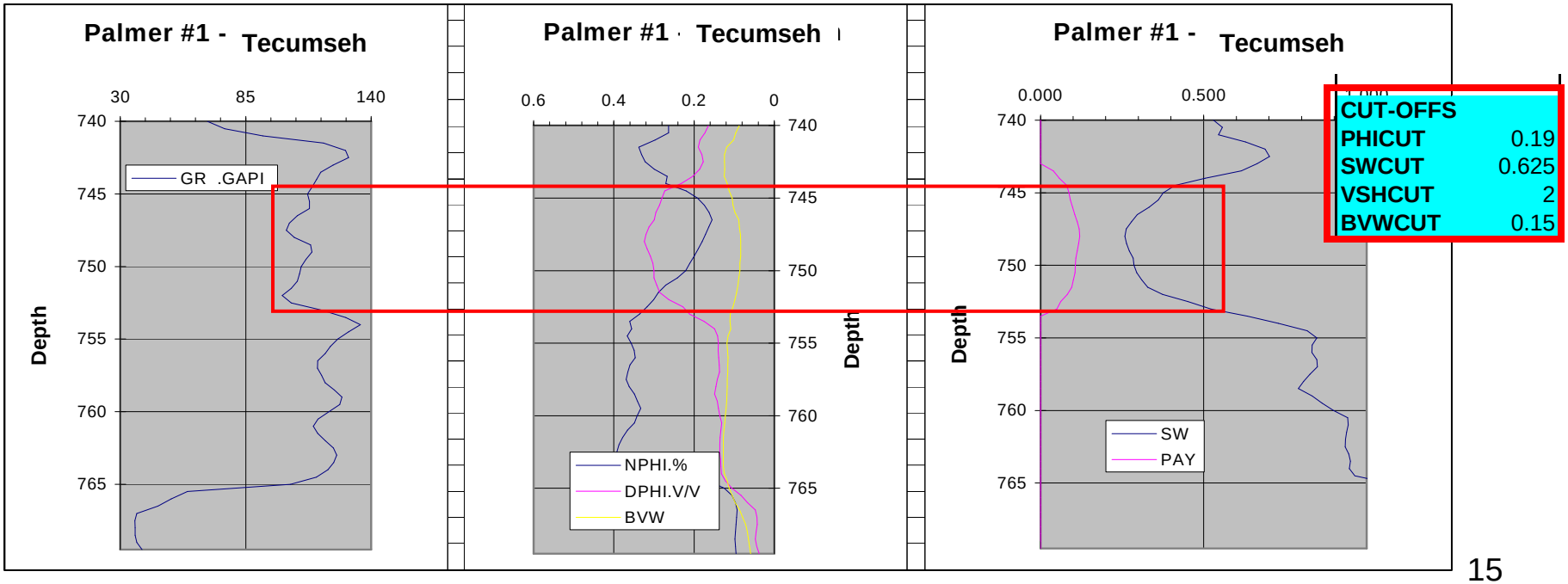
Log analysis of Ireland sand in Palmer #1 well.



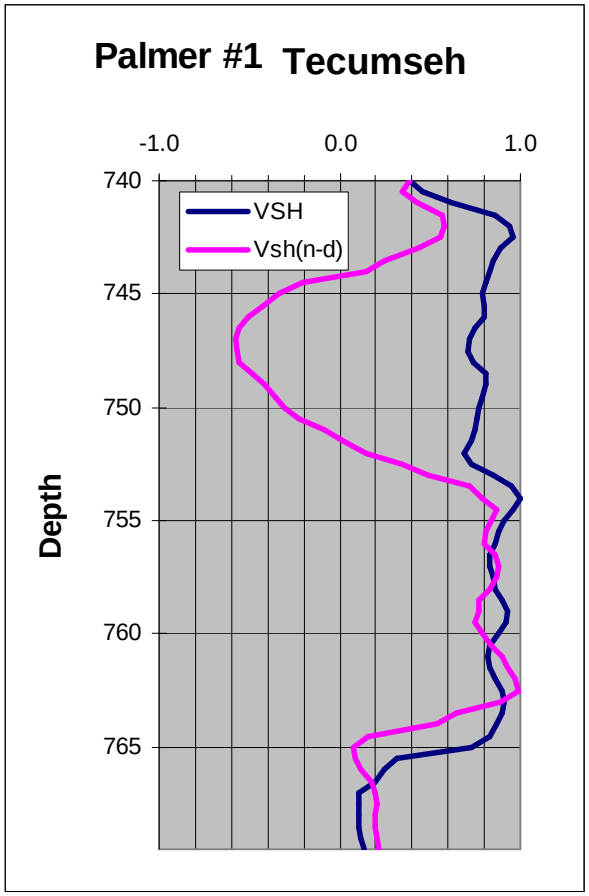
Palmer #1

Tecumseh (744-754 ft)

- **Good indications of gas pay** – relatively low GR, BVW cluster ~0.08, high porosity, gas effect on neutron log, Sw < 50%
- Tecumseh identified as pay using cut-offs defined at Frankhauser Trust E1 well

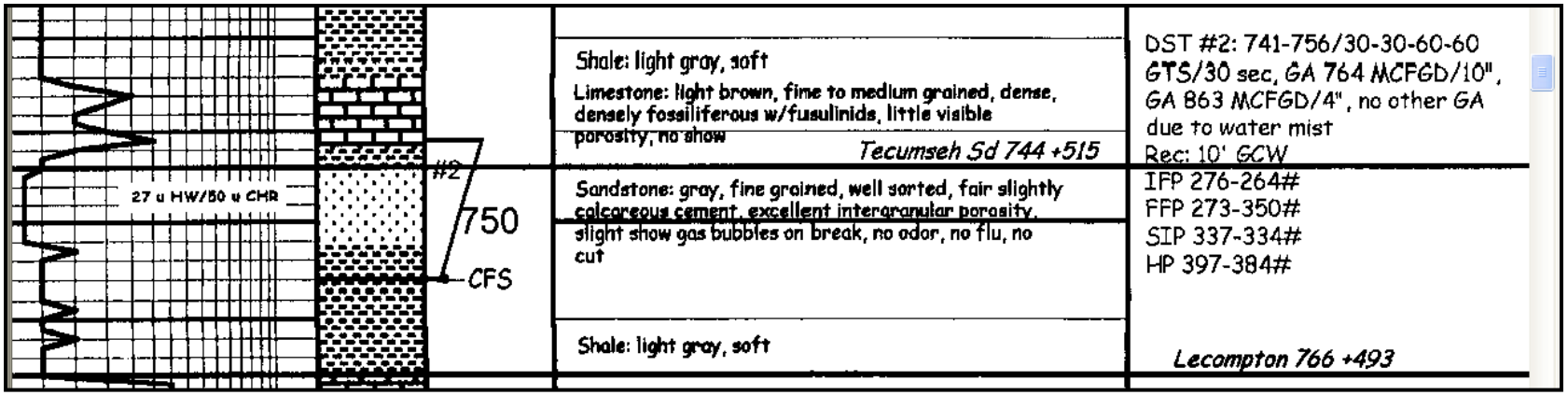


Log analysis of Tecumseh sand in Palmer 1 well.

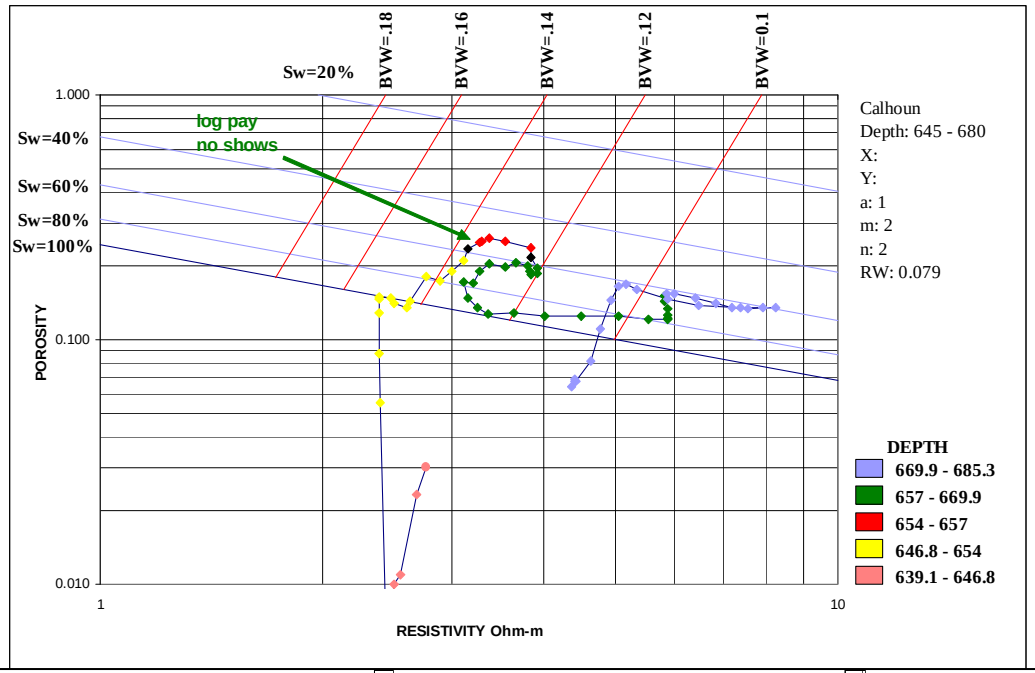


Palmer #1 – Tecumseh Sandstone

- **Gamma ray** does not recognize the fine-grained, well sorted, porous sand, probably due to K-rich mica content
- **Vsh** from **Neutron-density** overcorrect due to probable gas effect on neutron



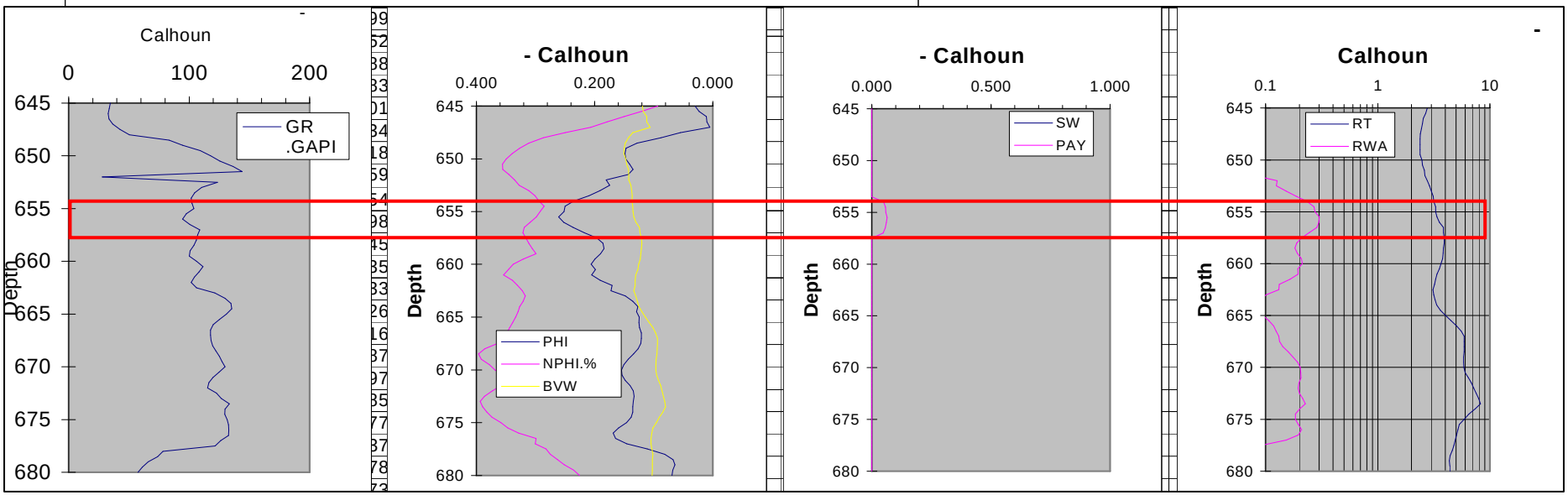
Comparison of Vshale calculated from gamma with that calculated from neutron-density porosities in Tecumseh sand in Palmer 1.



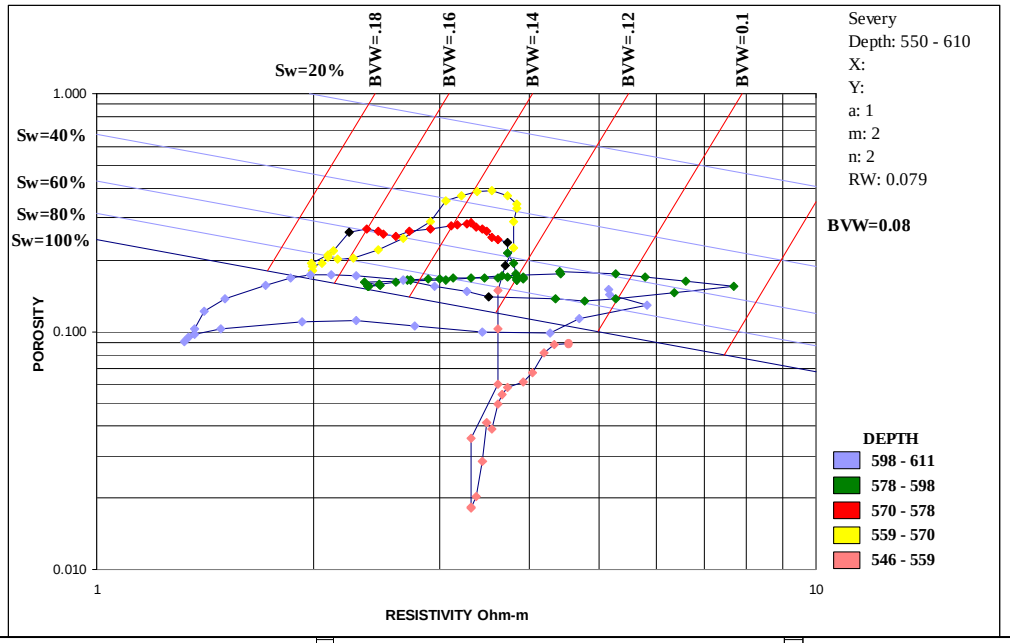
Palmer #1

Calhoun (654-657 ft)

- **Indications of gas pay** with low BVW (~0.13), possible gas effect on neutron log, Sw < 60%, separation between density porosity and BVW
- However, no shows observed during drilling through zone

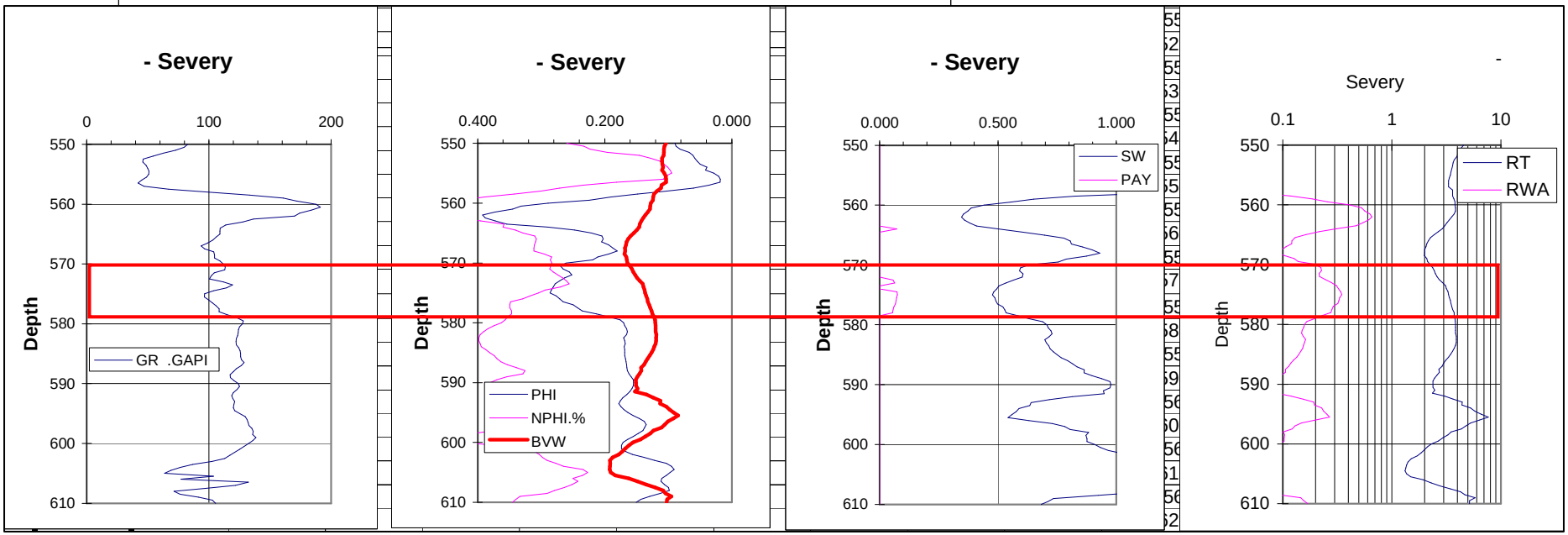


Log analysis of Calhoun sand in Palmer 1 well.

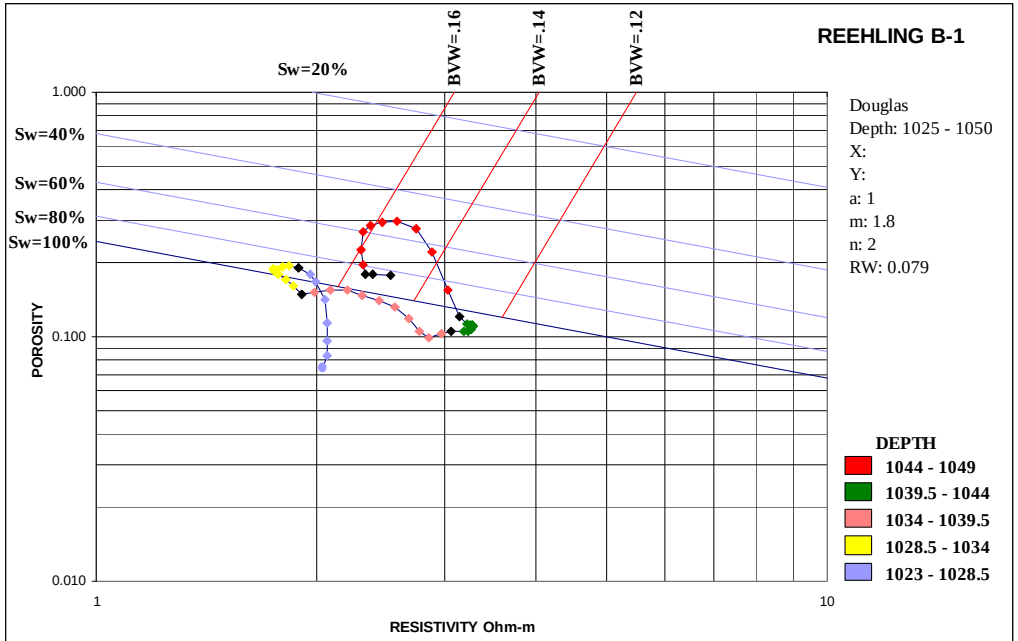


Palmer 1
Severy (570-578 ft)

- Gas effect on neutron, separation between density porosity and BVW, GR ~100 API, Sw < 60%
- Parts of the sand has BVW < 0.14
- **Possibly gas bearing**



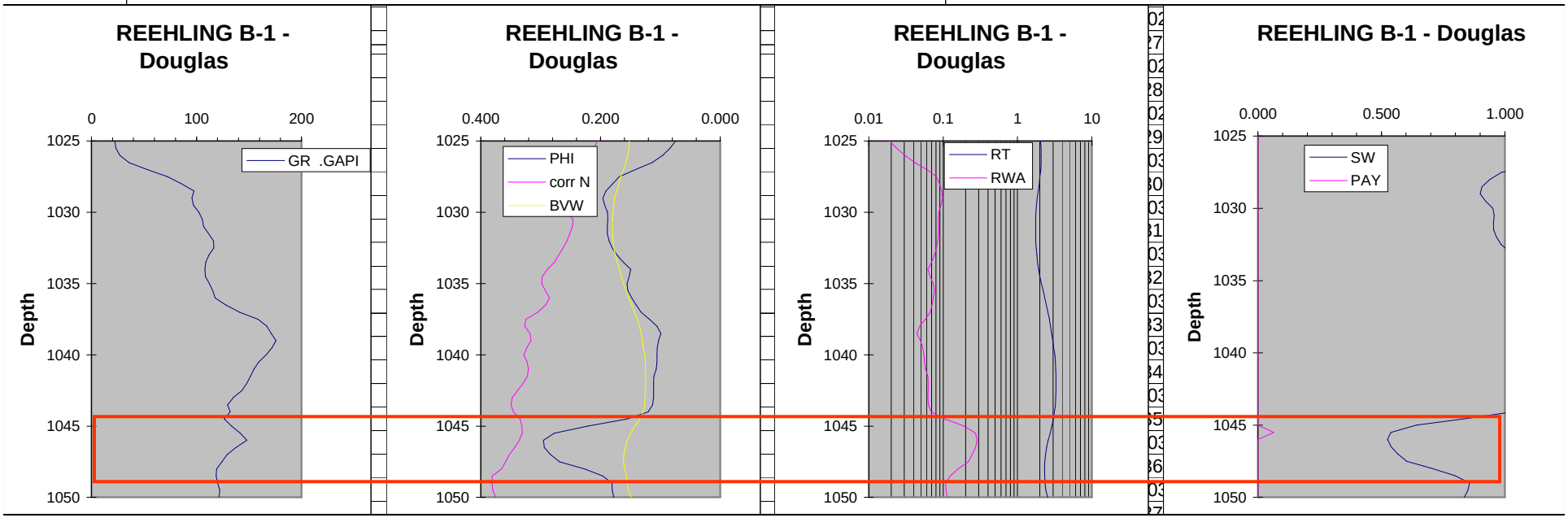
Log analysis of Severy sand in Palmer 1 well.



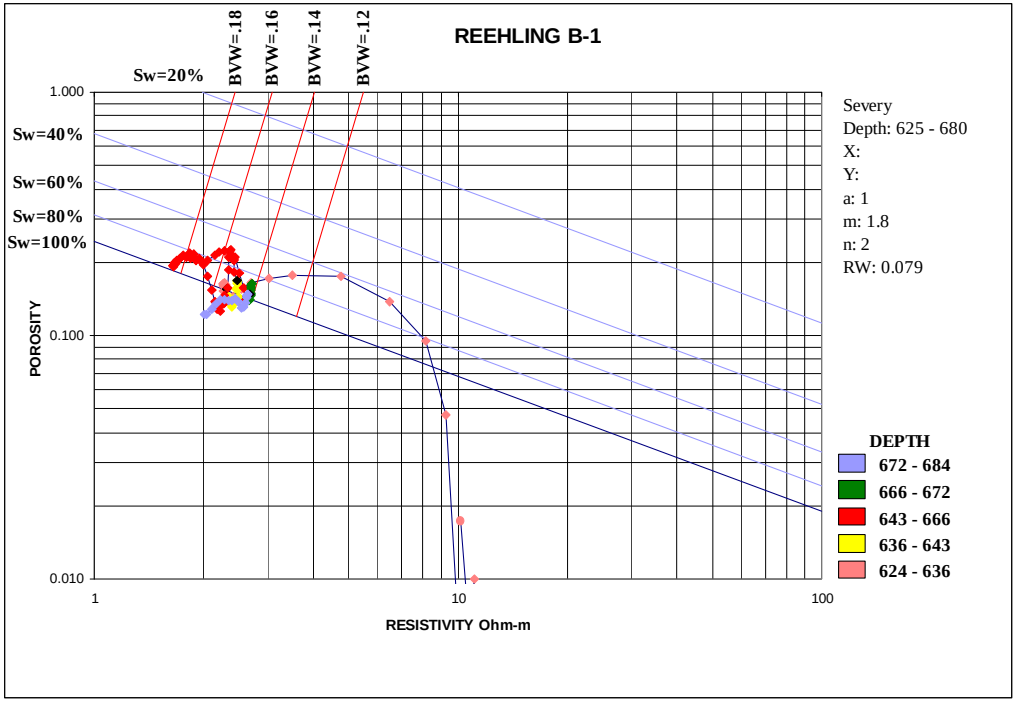
Reehling B-1

Douglas (1044-1049 ft)

- High porosity and separation between density porosity and BVW
- However, GR is > 100 API
- Zone appears to be shaly. Need to test to validate GR cut-off.
- **Poor prospect for gas - shaly**



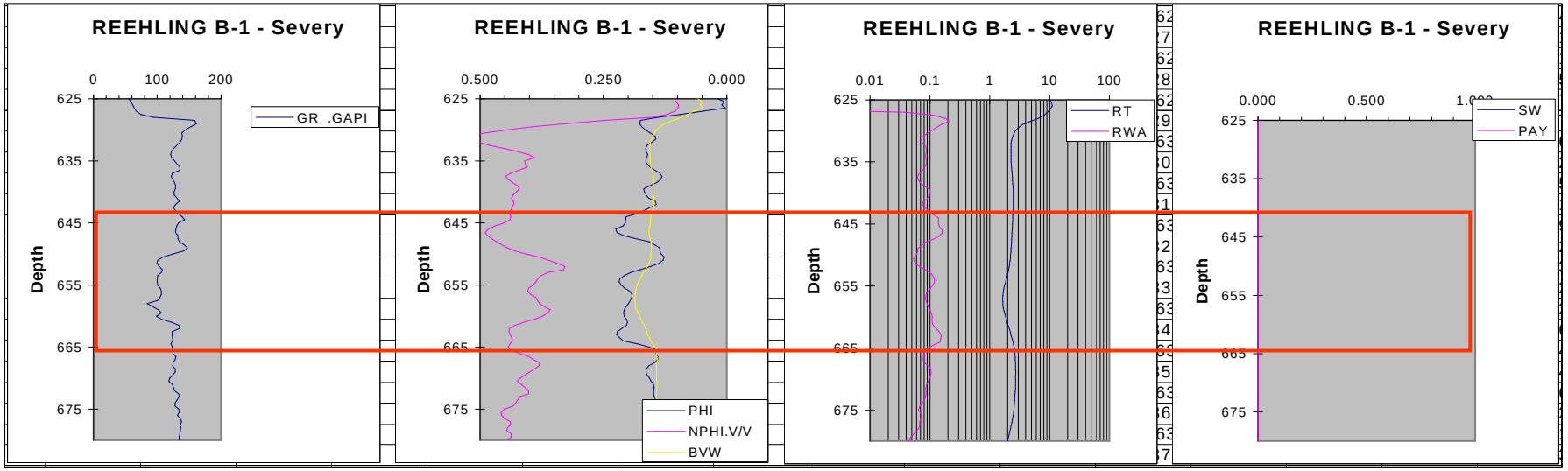
Log analysis of Douglas sand in Reehling B1 well.



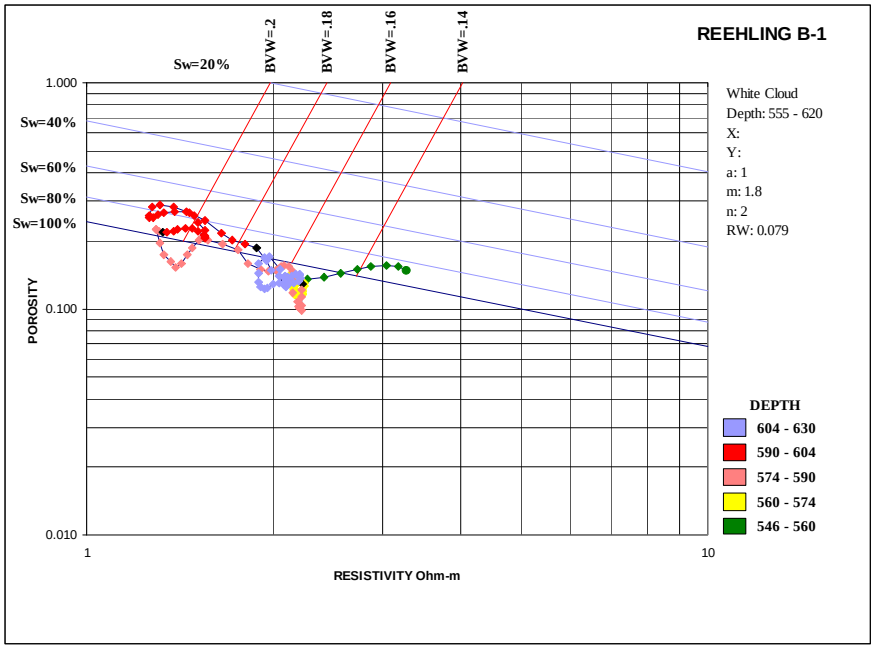
Reehling B-1

Severy (643-666 ft)

- High GR
- BVW and density porosity overlap
- Sw > 80%
- **Expected to be wet**



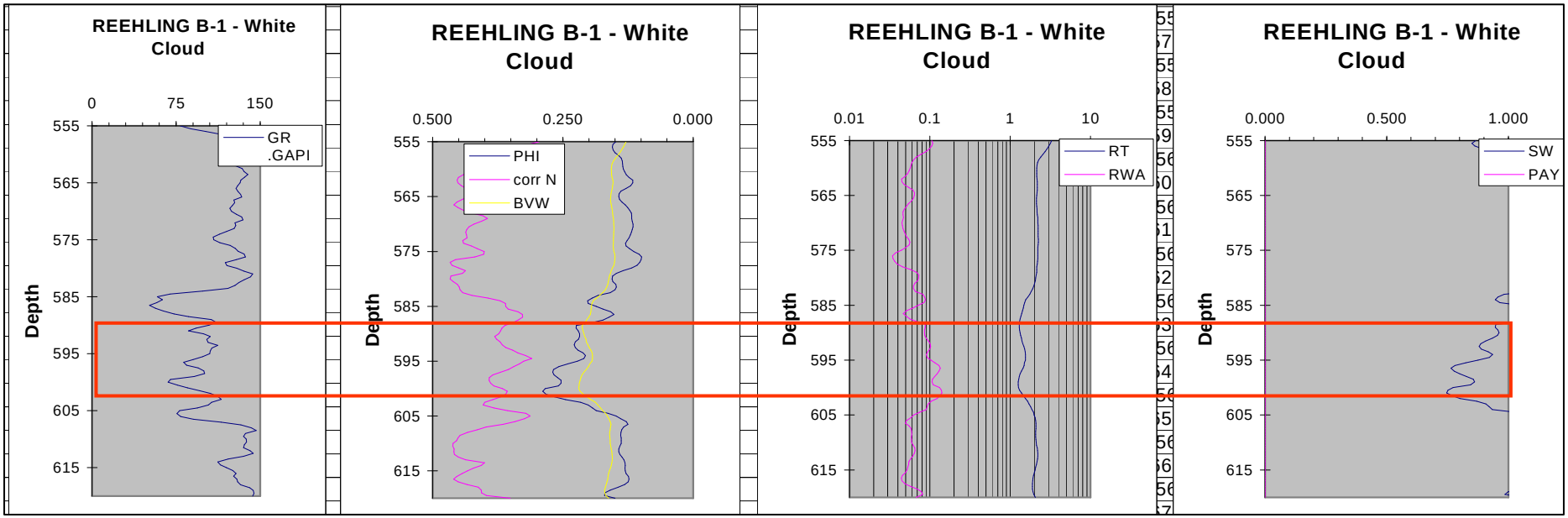
Log analysis of Severy sand in Reehling B1 well.



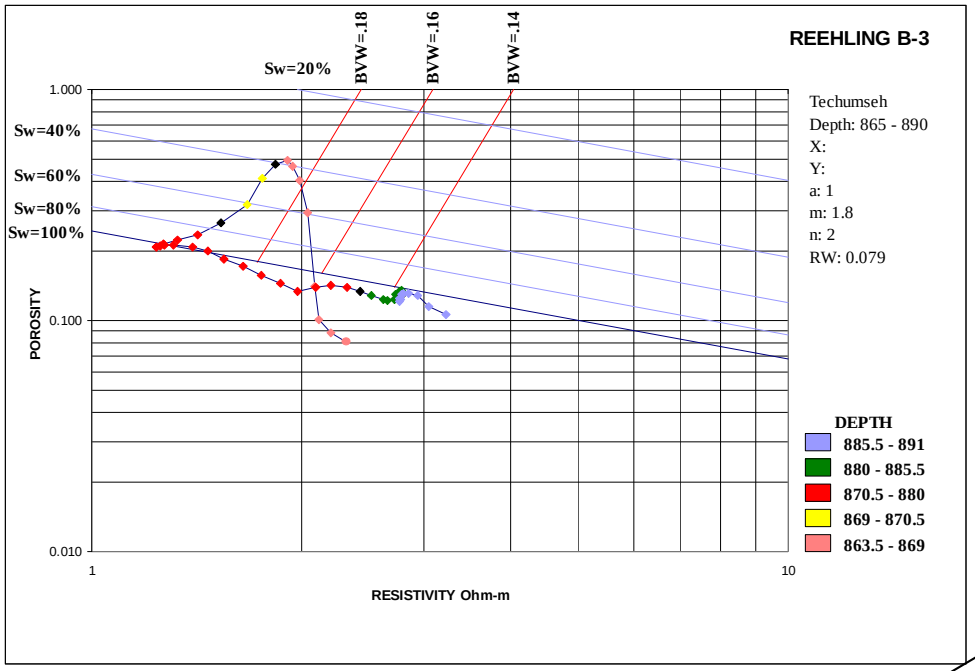
Reehling B-1

White Cloud (590-604 ft)

- High GR (~100 API), little seperation between density porosity and BVW
- Sw > 80%
- **Expected to be wet**



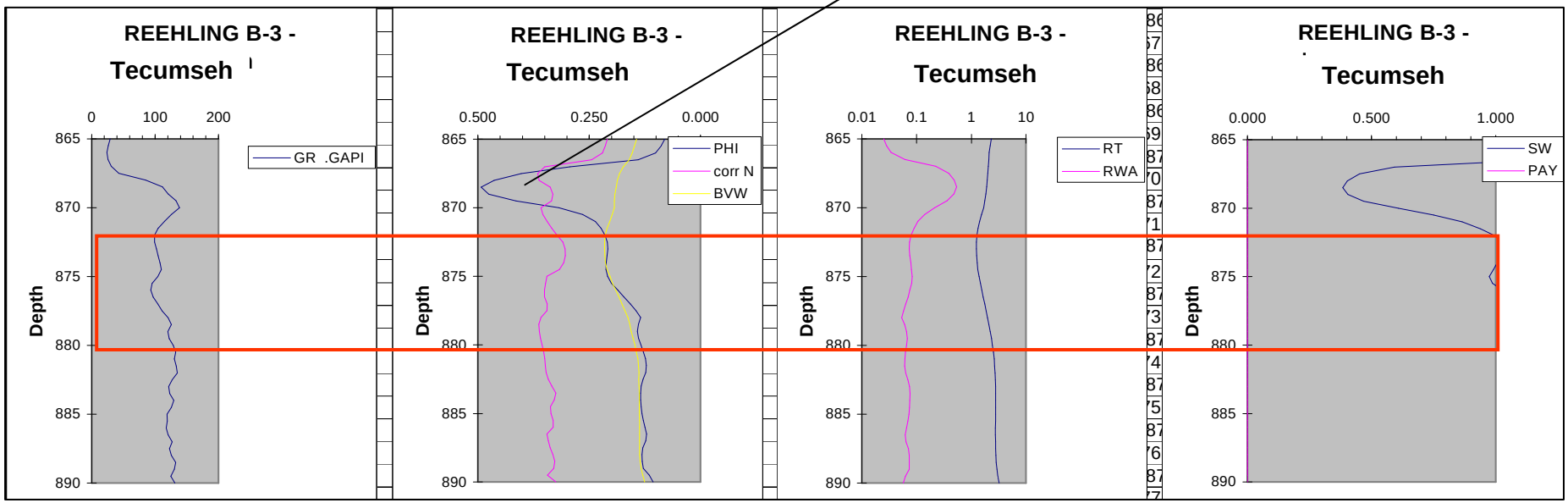
Log analysis of White Cloud sand in Reehling B1 well.



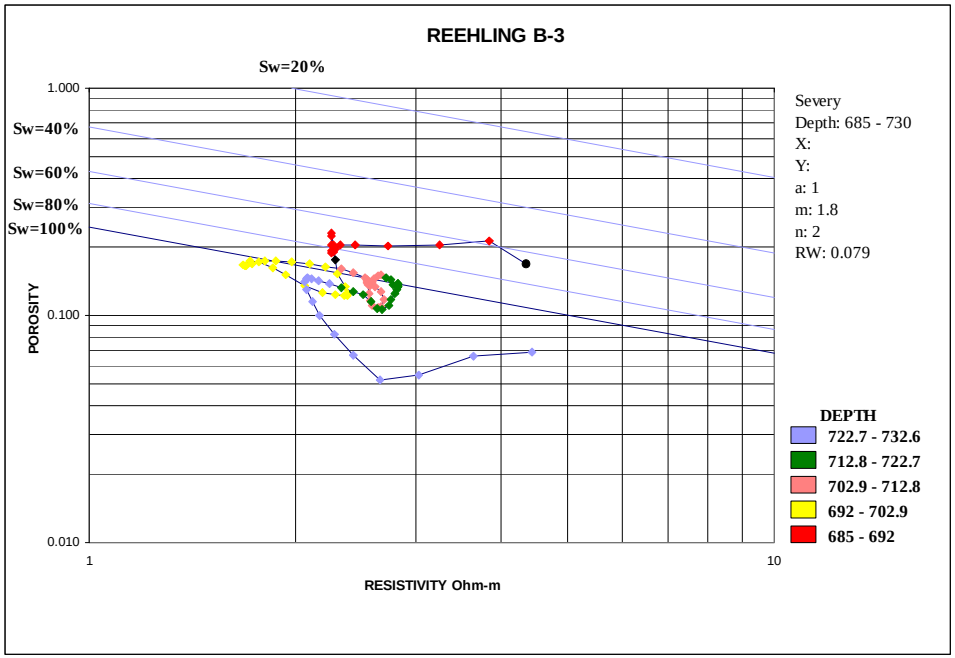
Reehling B-3
Tecumseh (872-880 ft)

- Washout at shale accounting for high porosity on top of sand
- High GR (~100 API), and overlap of BVW and density porosity
- **Expected to be wet**

Density log reading high (~50%) at washout across shale see caliper log

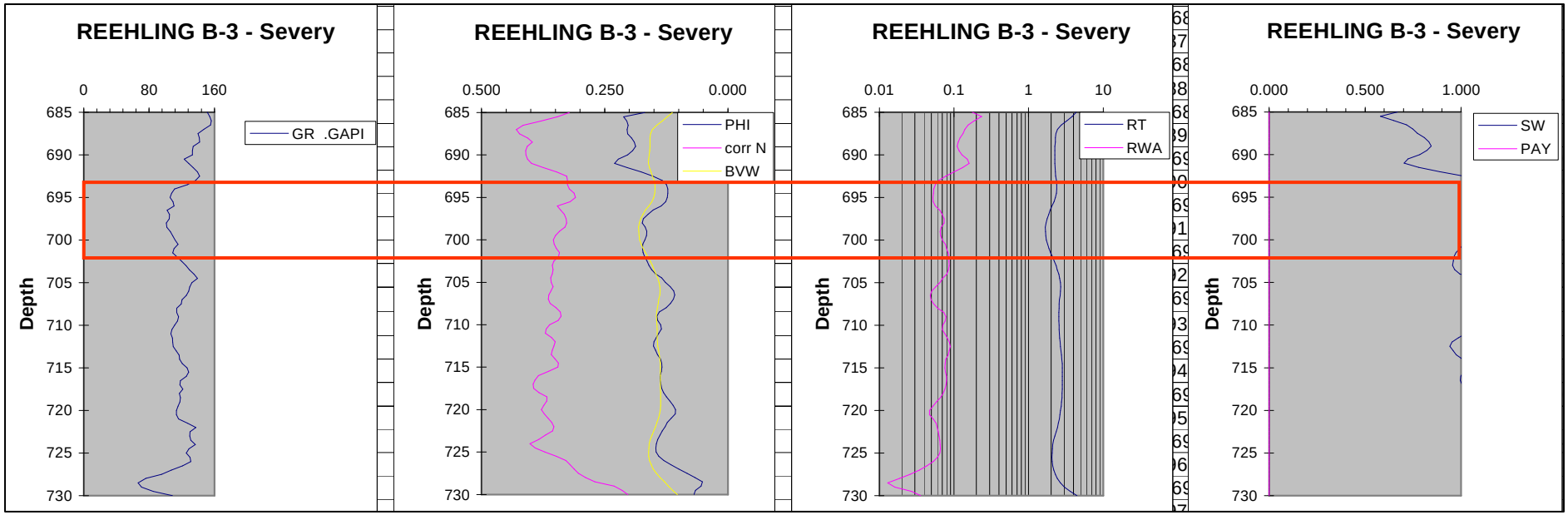


Log analysis of Tecumseh sand in Reehling B3 well.



Reehling B-3
Severy (692-702 ft)

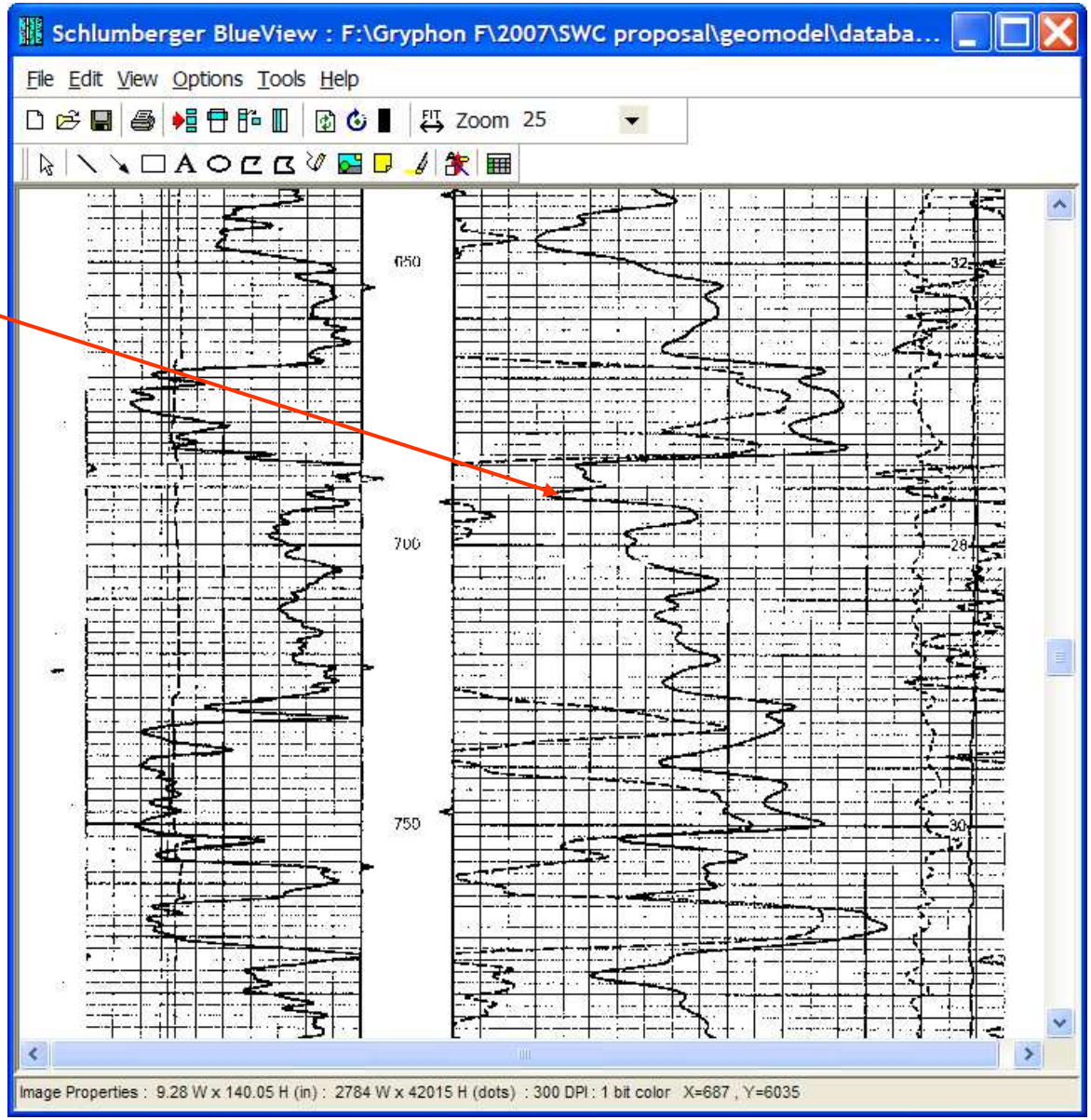
- Overlying coal (690-692 ft) possibly - high porosity combines with slightly lower GR
- Sand - overlap between BVW and density porosity
- **Expected to be wet**



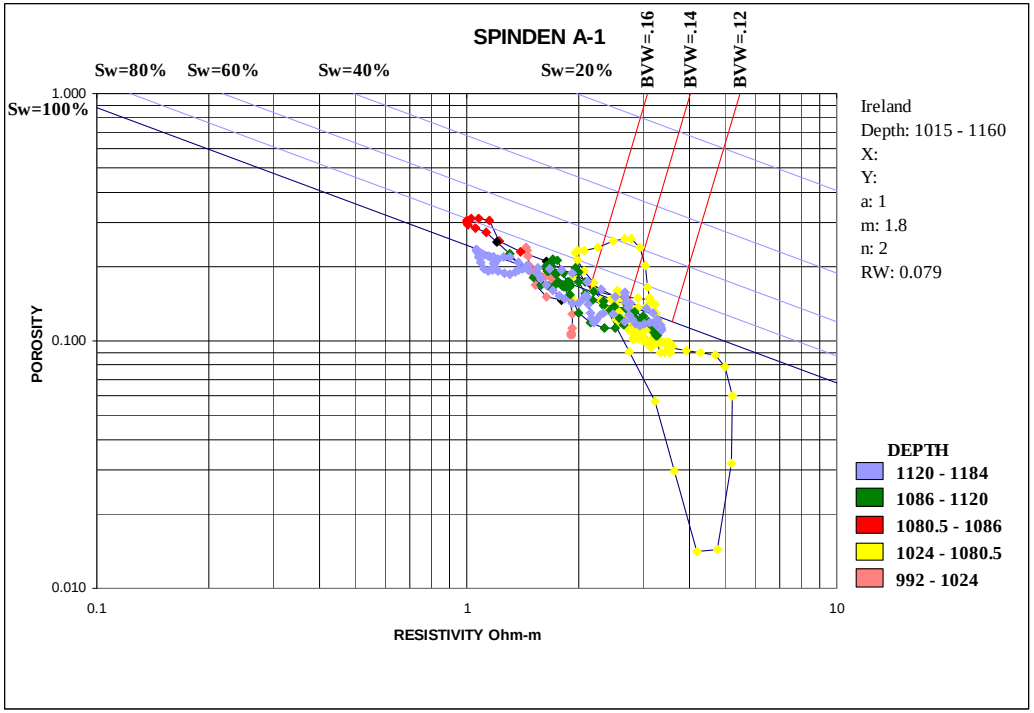
Log analysis of Severy sand in Reehling B3 well.

Reehling B-3

• Coal overlying Severy sand

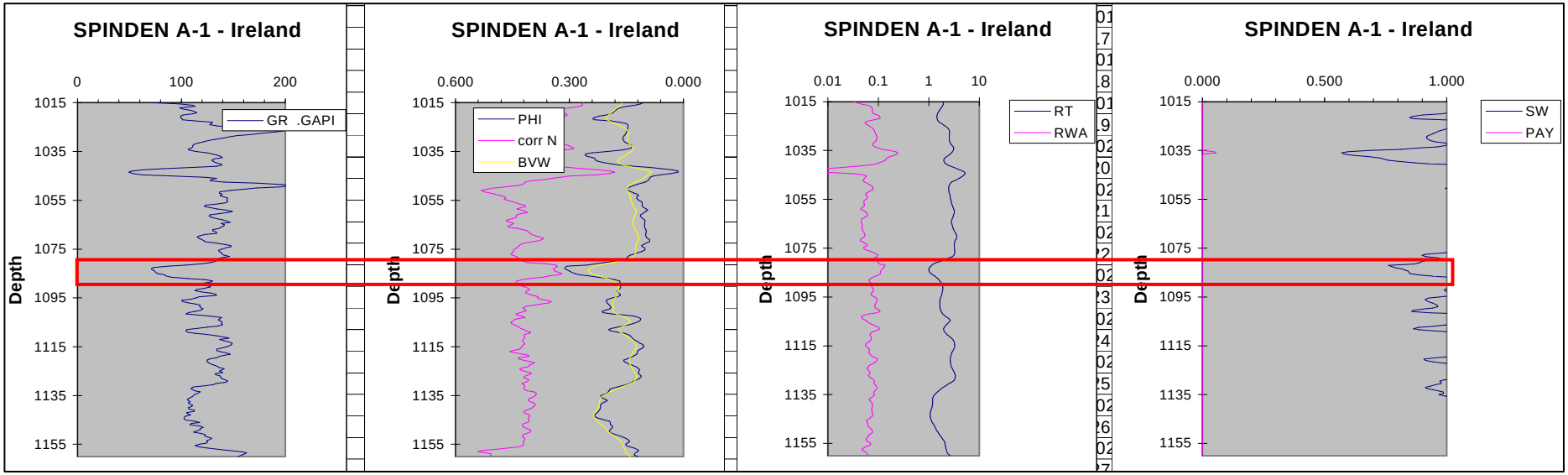


Log showing location of coal bed atop the Severy sand in Reehling B3 well.

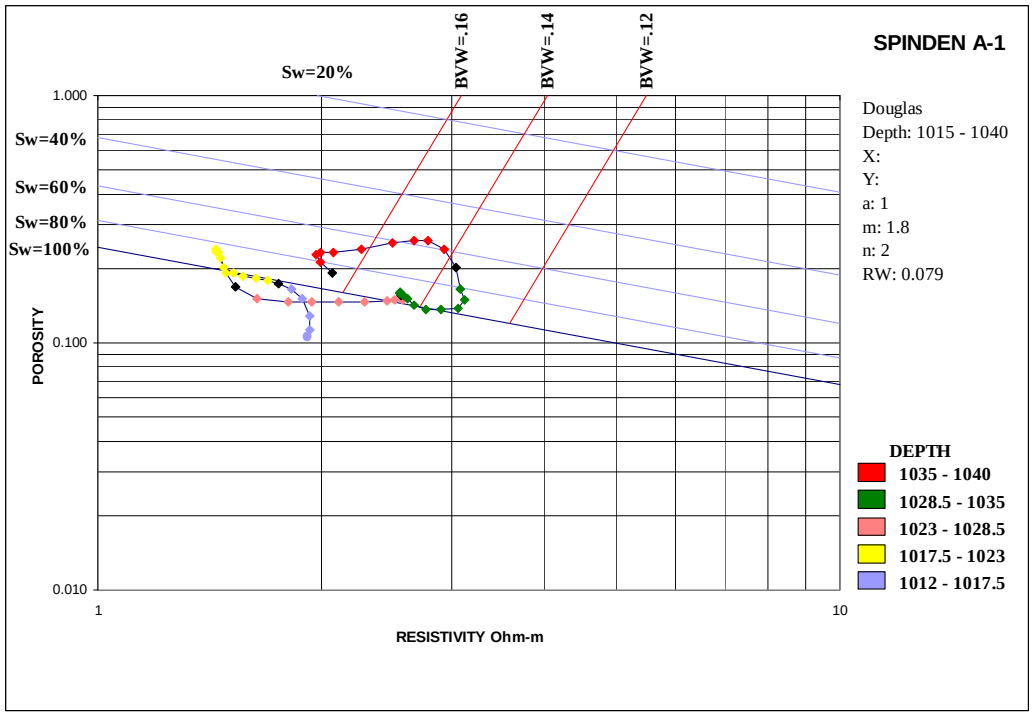


Spinden A-1
Ireland (1080-1086 ft)

- Separation between density porosity and BVW
- GR < 100, Sw~80%, BVW high
- **Poor prospect – some gas in transition**

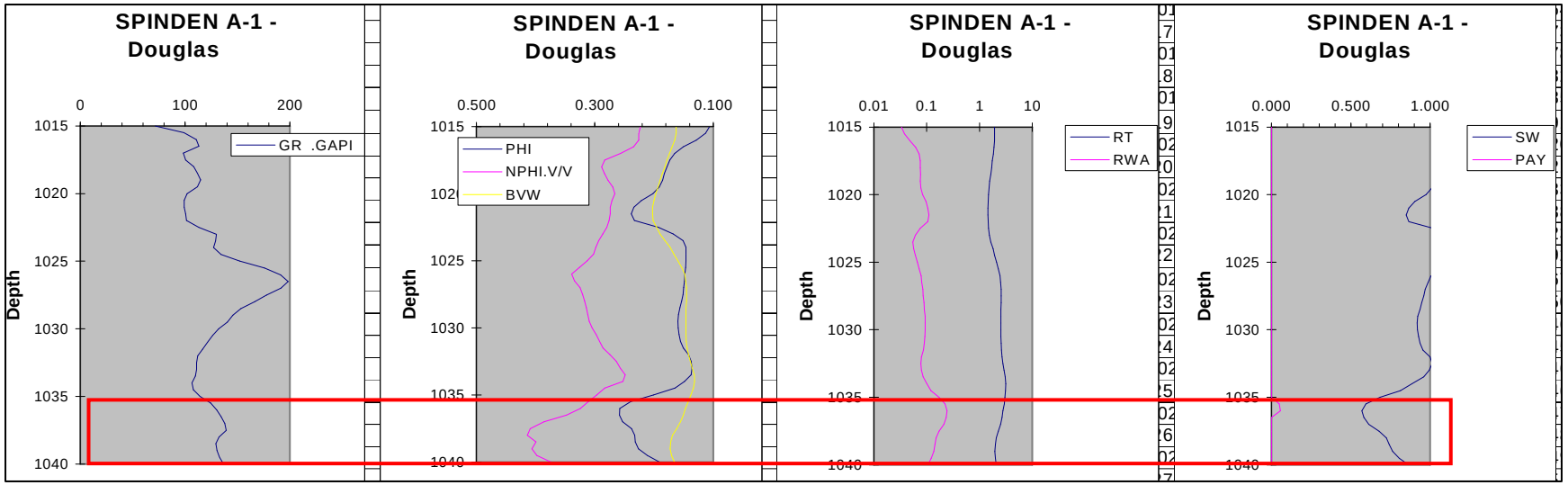


Log analysis of Ireland sand in Spinden A1 well.

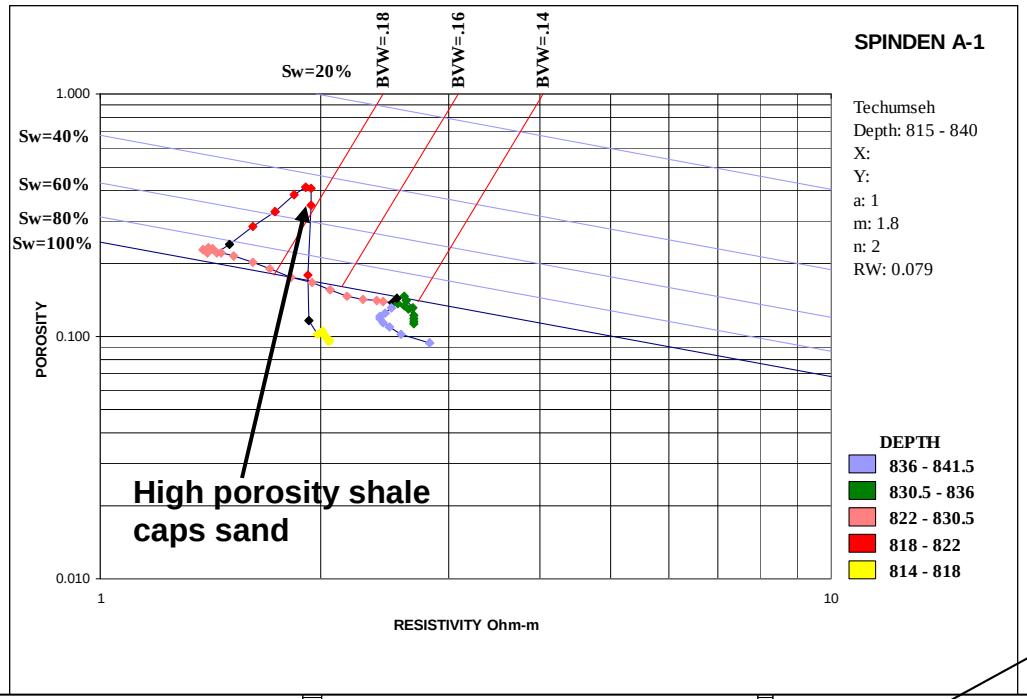


Spinden A-1
Douglas (1035-40)

- High GR (> 100 API), separation between desnity porosity and BVW
- Increasing Sw at the base indicate possible transition
- **Probably some gas** where Sw < 60%.
- GR cut-off needs to be tested.



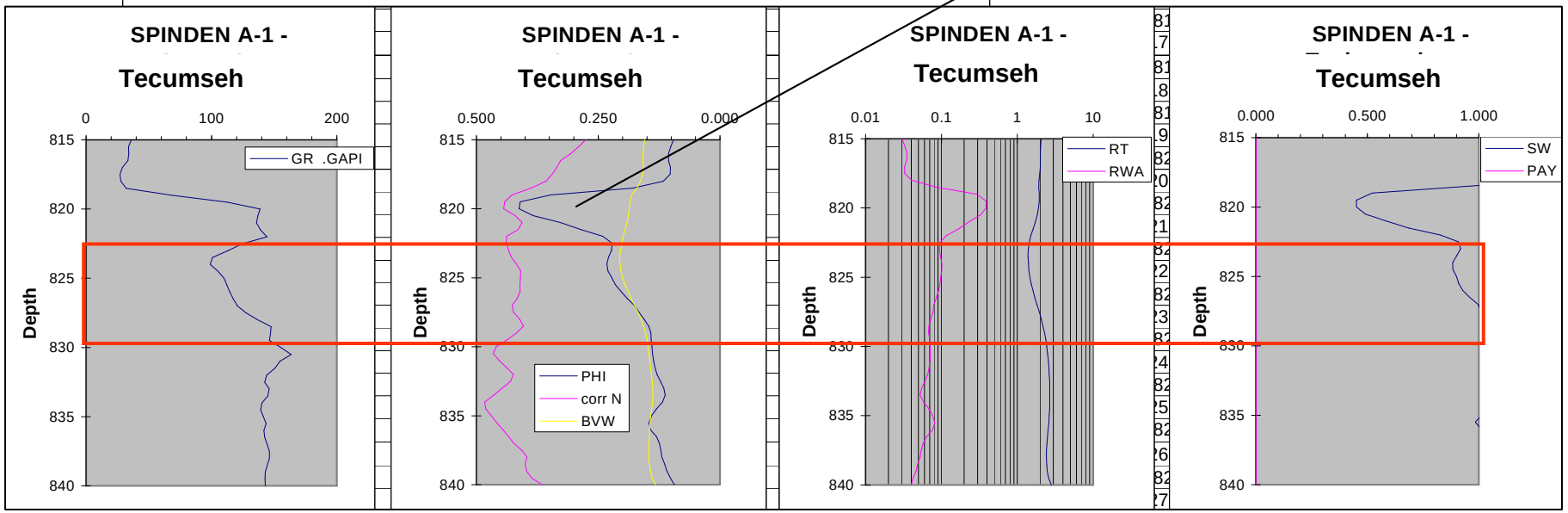
Log analysis of Douglas sand in Spinden A1 well.



Spinden A-1
Tecumseh (822-30 ft)

- Capping shale on top of sand.
- Density porosity and BVW overlap in sand, and high GR (> 100 API)
- **Sand expected to be wet**

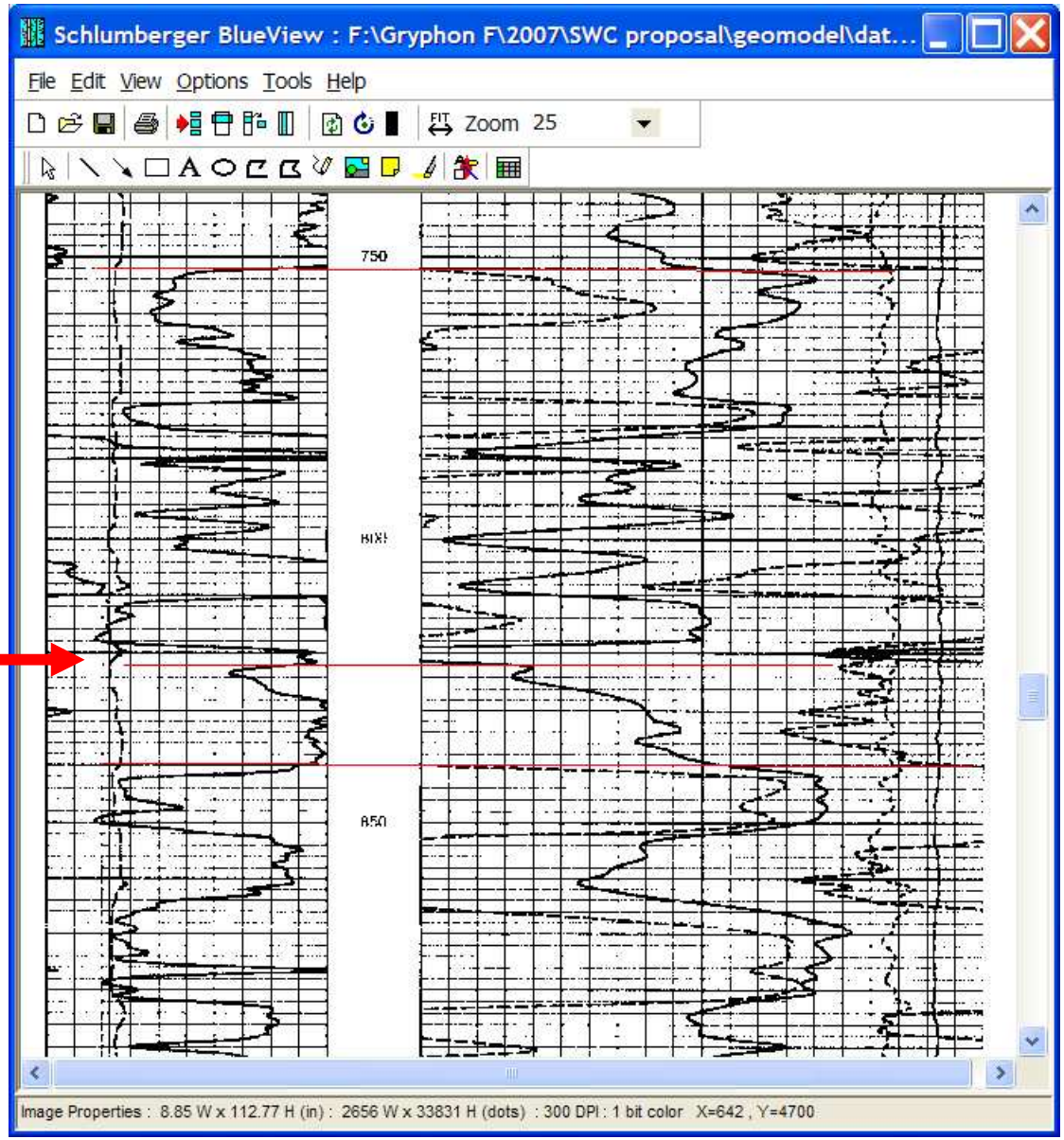
Capping shale – not a wash out effect



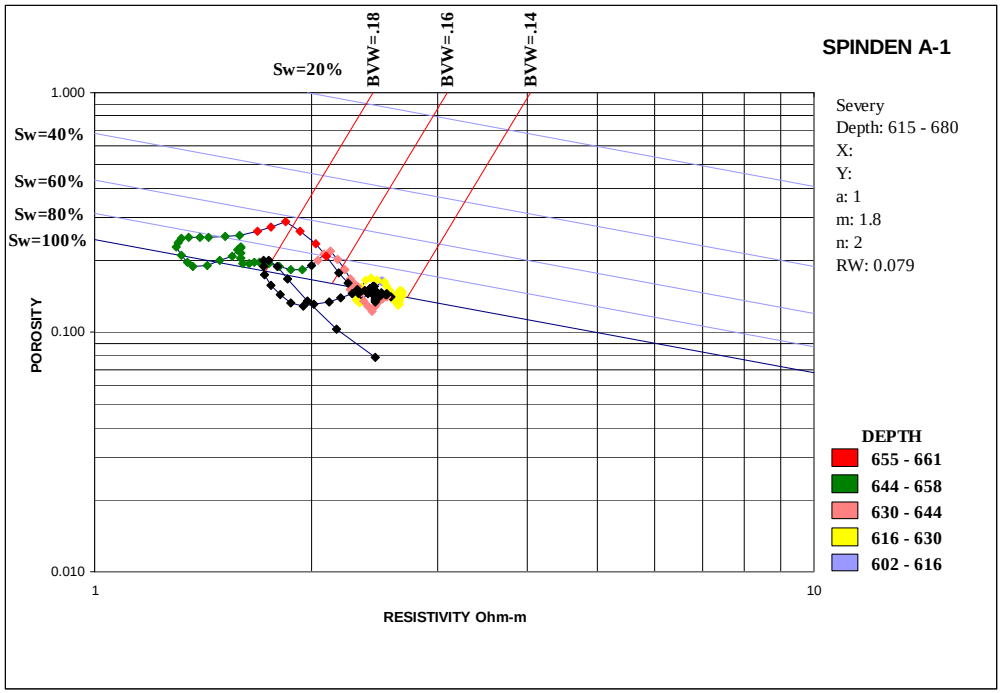
Log analysis of Tecumseh sand in Spinden A1 well.

Spinden A-1

Shale caps Tecumseh sand. The high porosity marking the shale is not due to hole washout

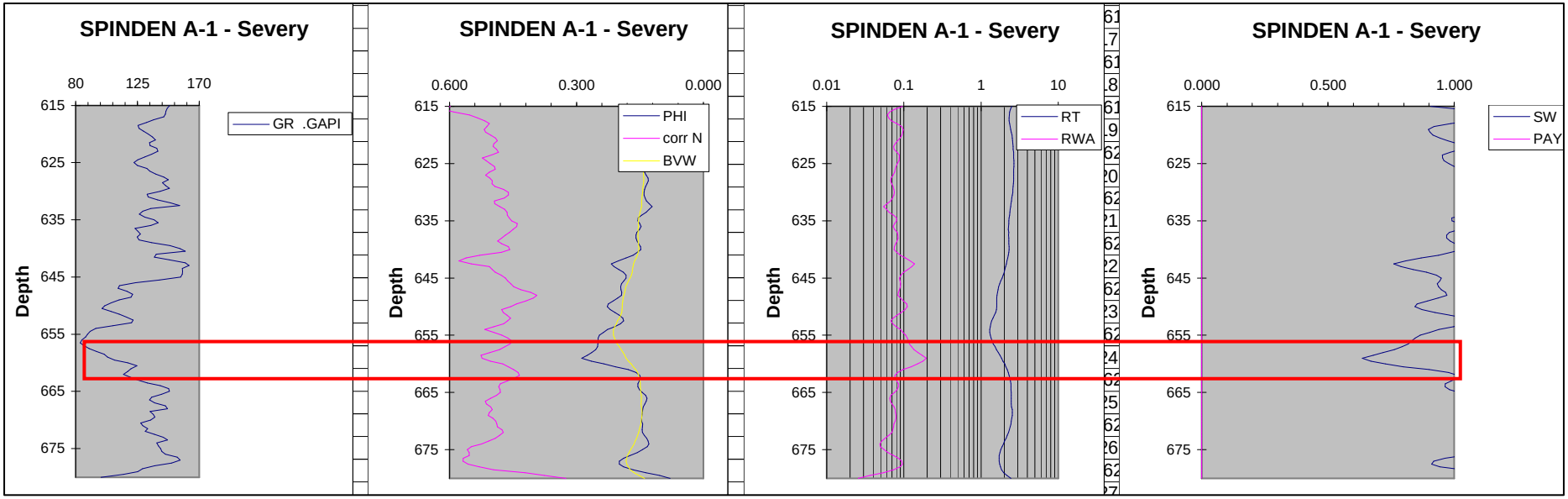


Log showing the location of the shale bed capping the Tecumseh sand in Spinden A1 well.

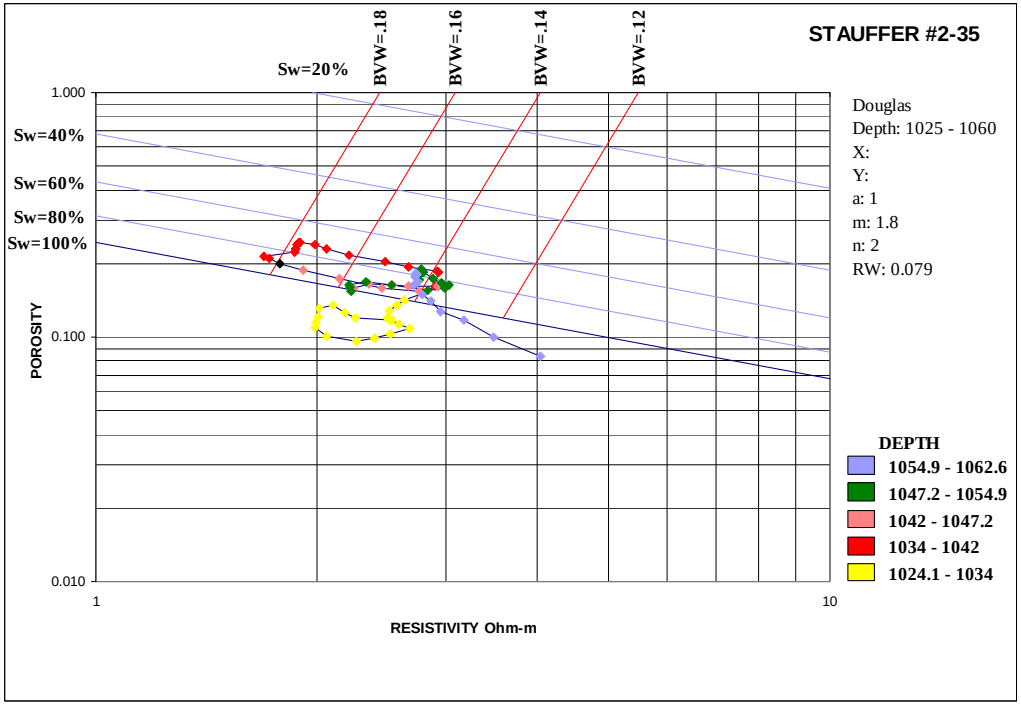


Spinden A-1
Severy (655-61 ft)

- Cleaner sand (low GR) with high BVW (>0.16) indicating finer pores
- Seperation between density porosity and BVW
- Intermediate Sw (between 60 and 70%) suggests
- **Gas in transition**

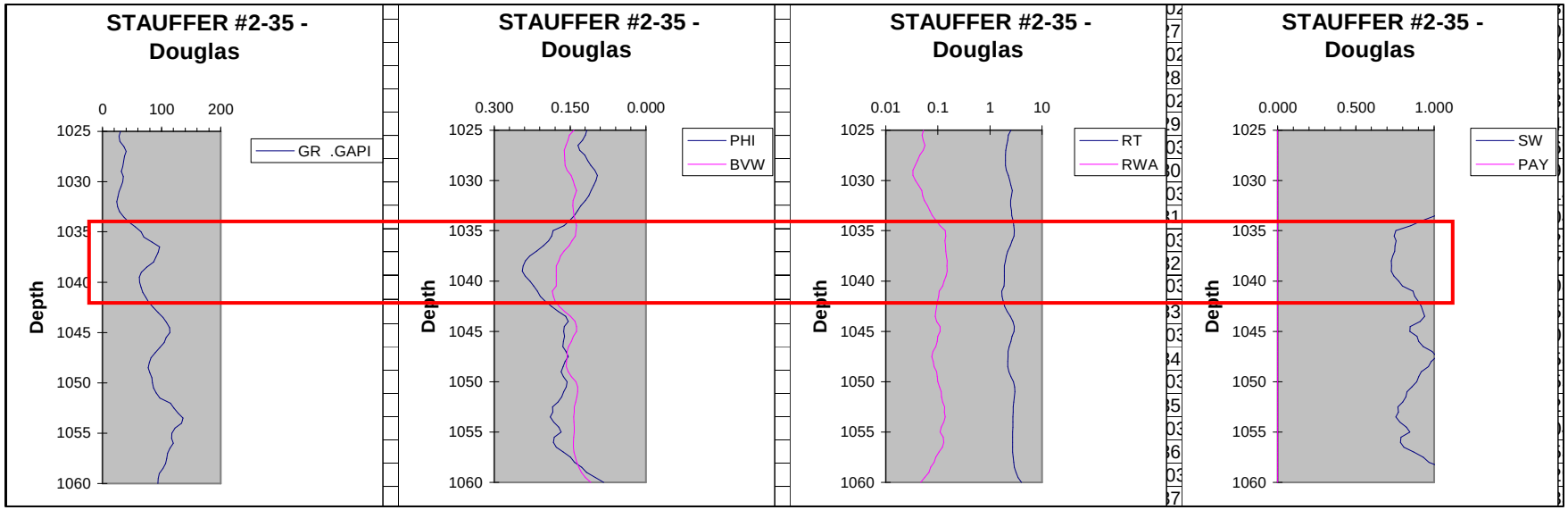


Log analysis of Severy sand in Spinden A1 well.

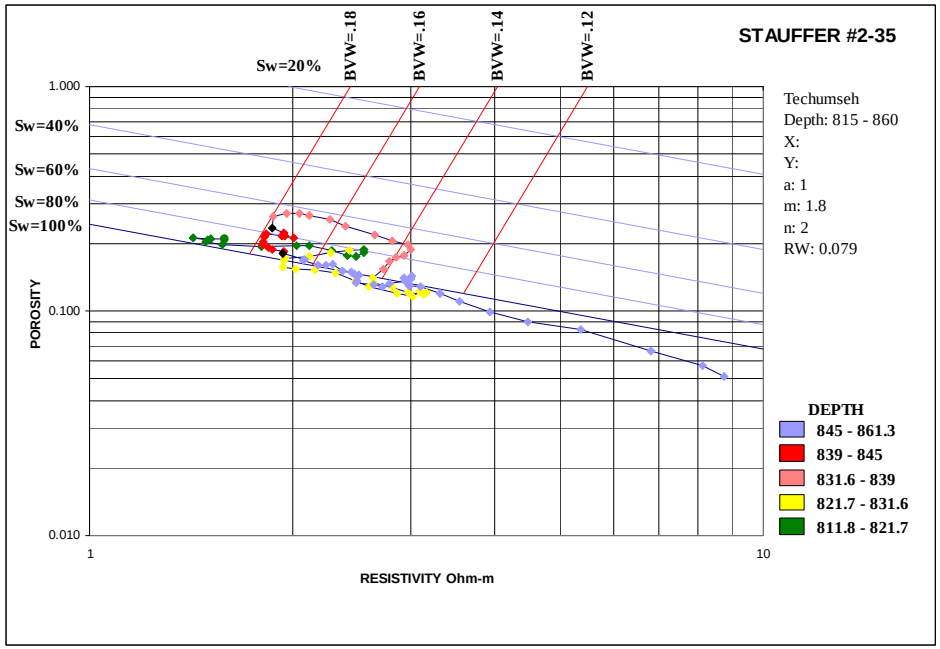


Stauffer 2-35
Douglas (1034-42 ft)

- Gas confirmed during drilling
- GR < 100 API, seperation between density porosity and BVW
- Sw > 70% and increases with depth
- **Probably some gas in transitional**
- Recommend further testing



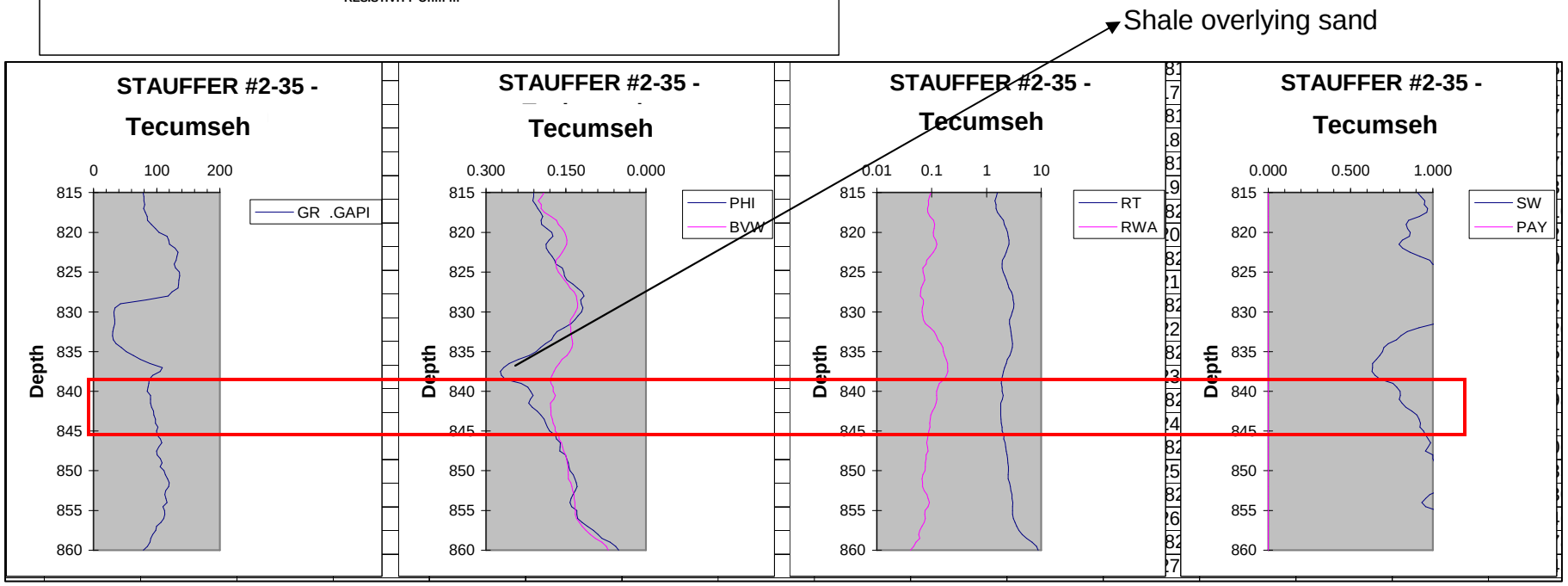
Log analysis of Douglas sand in Stauffer 2-35 well.



Stauffer 2-35

Tecumseh (839-45 ft)

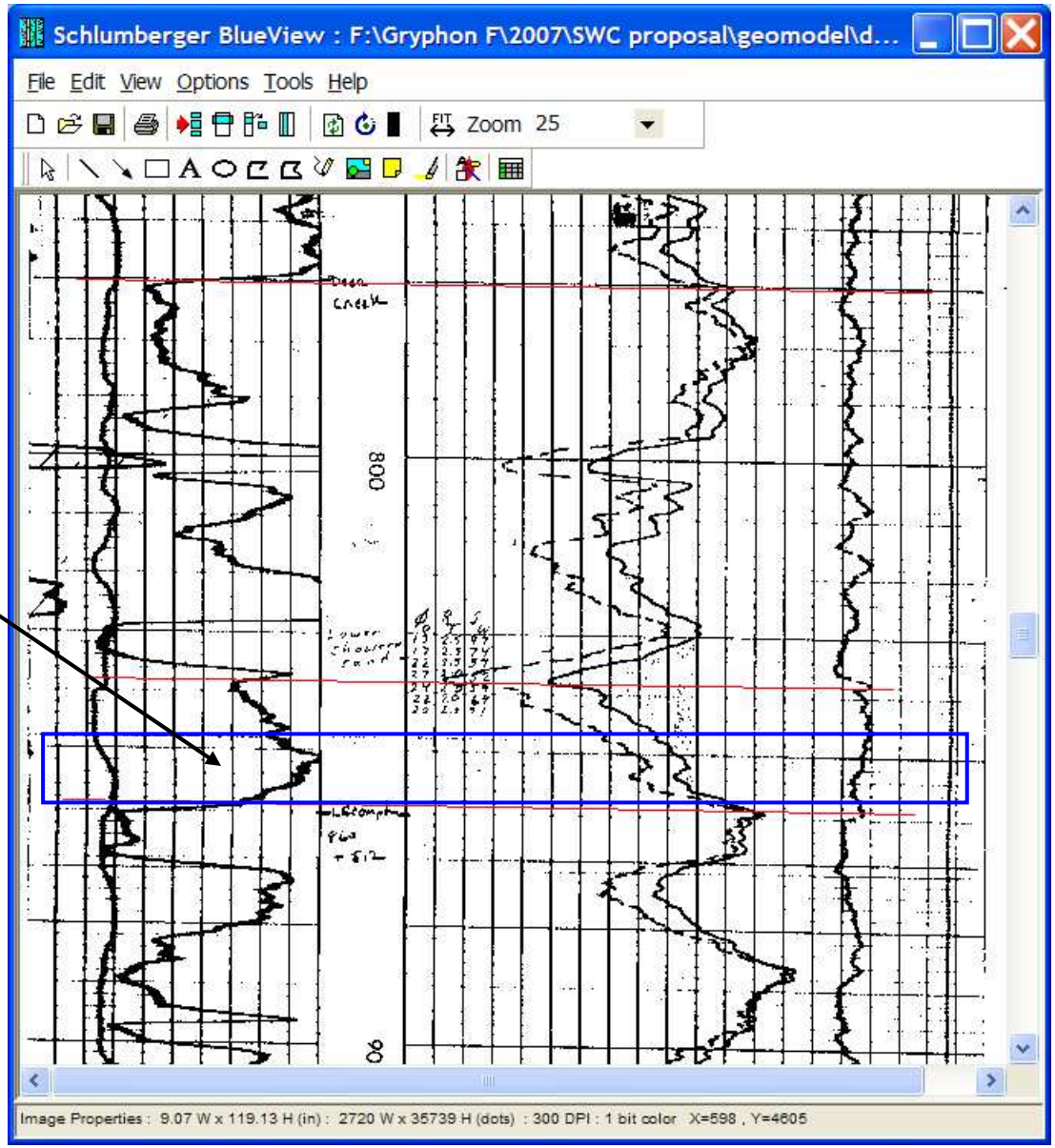
- Little separation between density porosity and BVW
- Sw increases with depth and exceeds 80%
- **Sand expected to be wet**



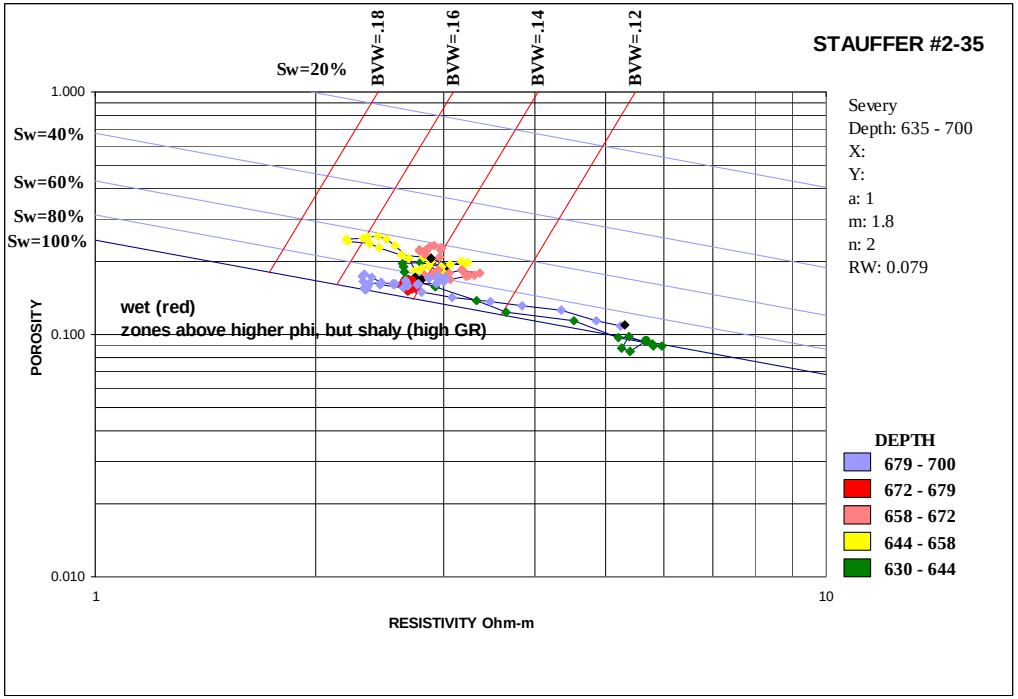
Log analysis of Tecumseh sand in Stauffer 2-35 well.

Stauffer 2-35

Shale bed overlies the Tecumseh sand

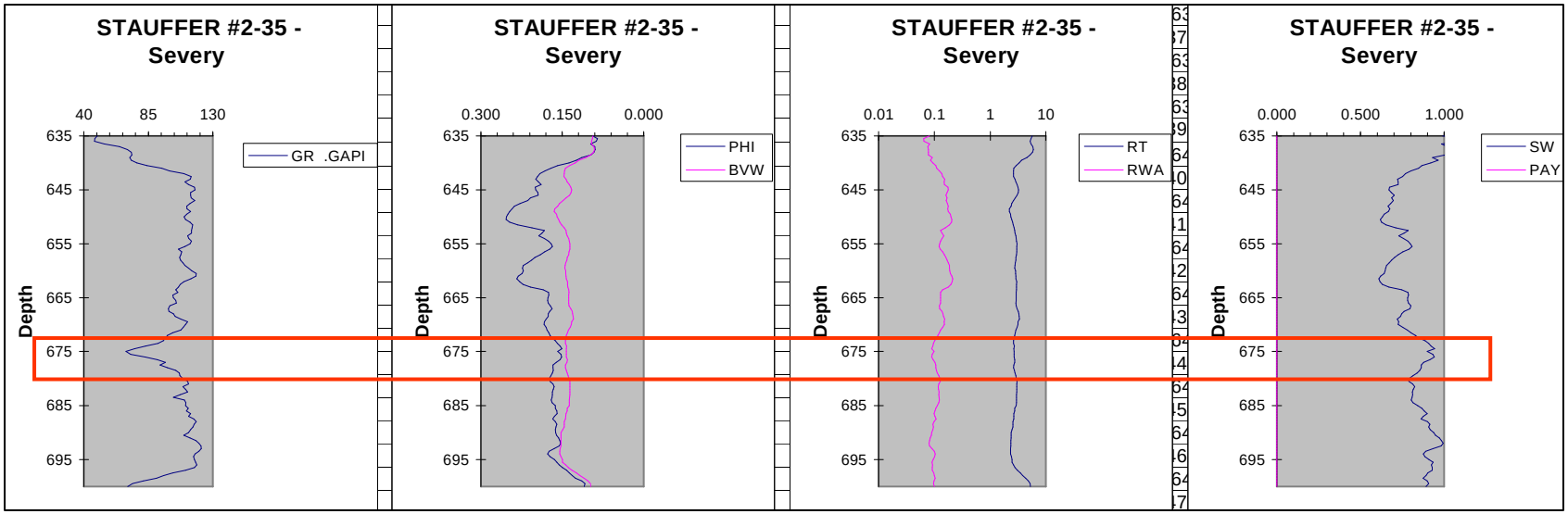


Log showing location of shale bed overlying Tecumseh sand in Stauffer 2-35 well.

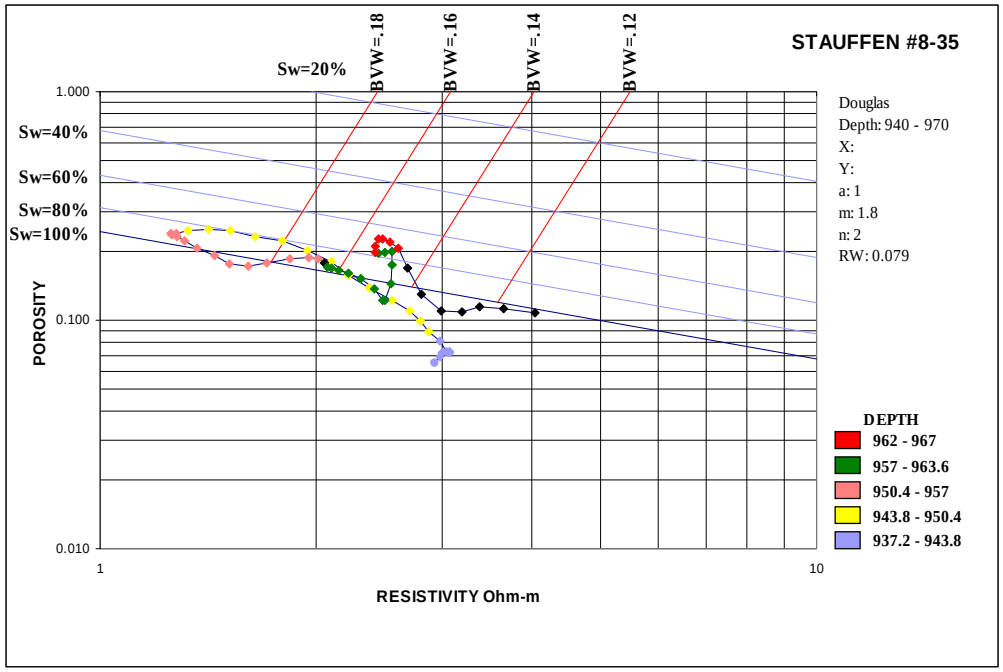


Stauffer 2-35
Severy (672-679 ft)

- Overlap of BVW and density porosity
- Sw > 80%)
- Slight cleaning of sand upward
- **Sand expected to be wet**

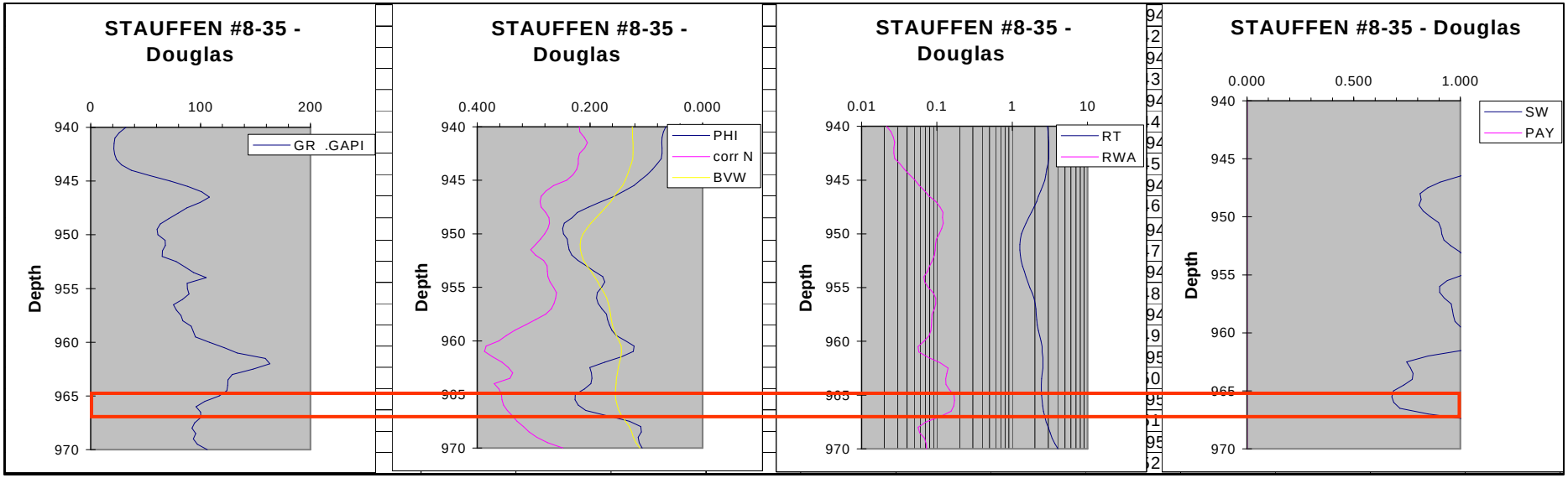


Log analysis of Severy sand in Stauffer 2-35 well.



Stauffer 8-35
Douglas (965-967 ft)

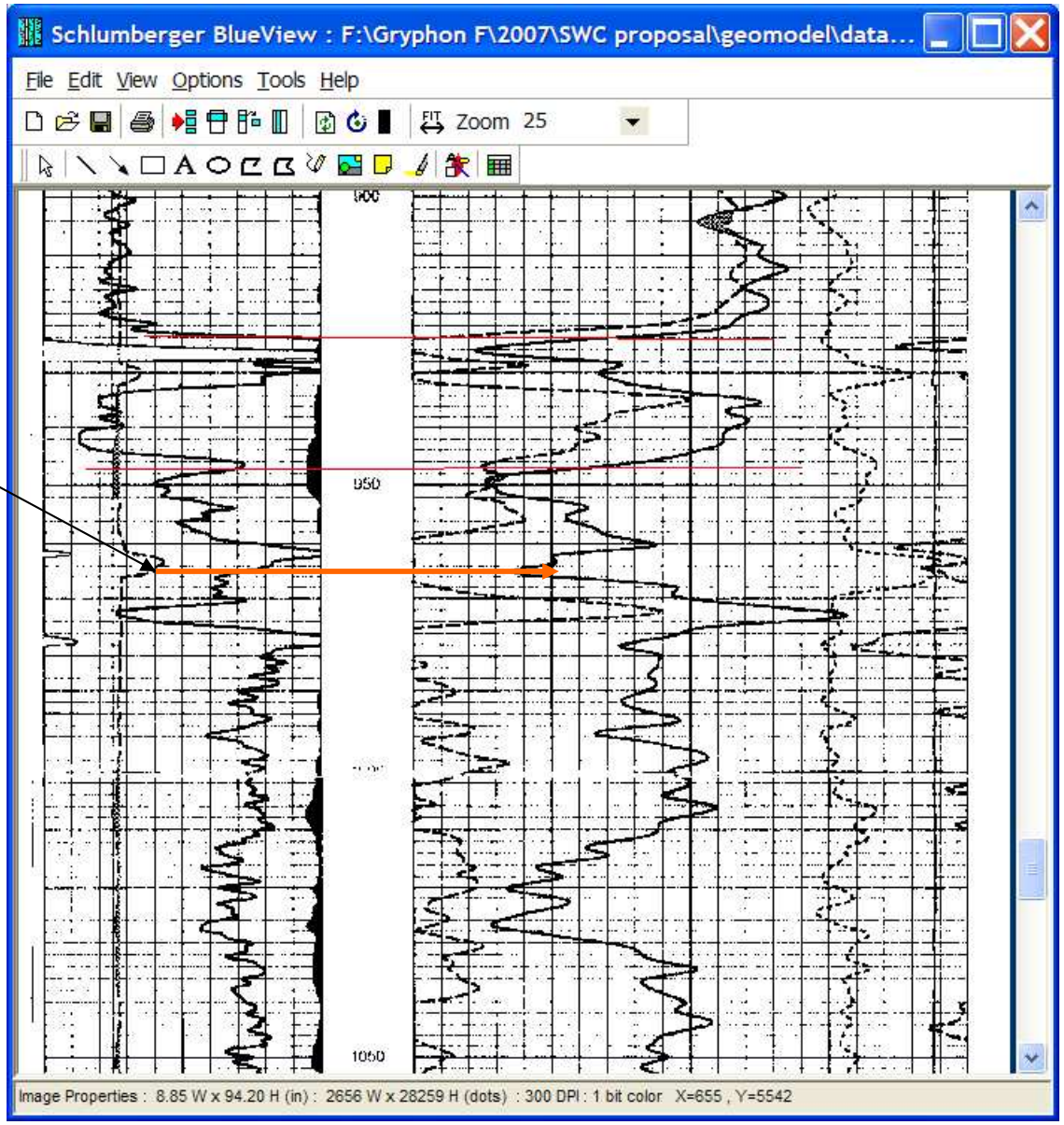
- Shale washout on top of sand (962-964 ft)
- Sand below shale - BVW cluster around 0.15, separation between density porosity and BVW
- Sw < 80%
- **Thin zone with some transitional gas**.
- Zone needs to be tested to see if water is mobile.



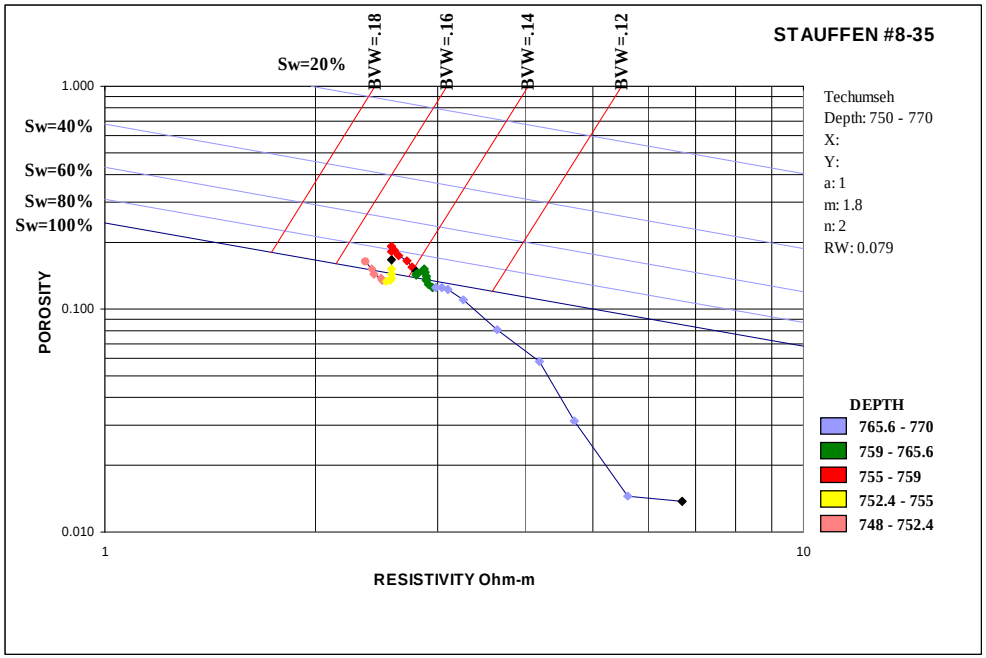
Log analysis of Douglas sand in Stauffer 8-35 well.

Stauffer 8-35
Douglas

• Washout at top in overlying shale

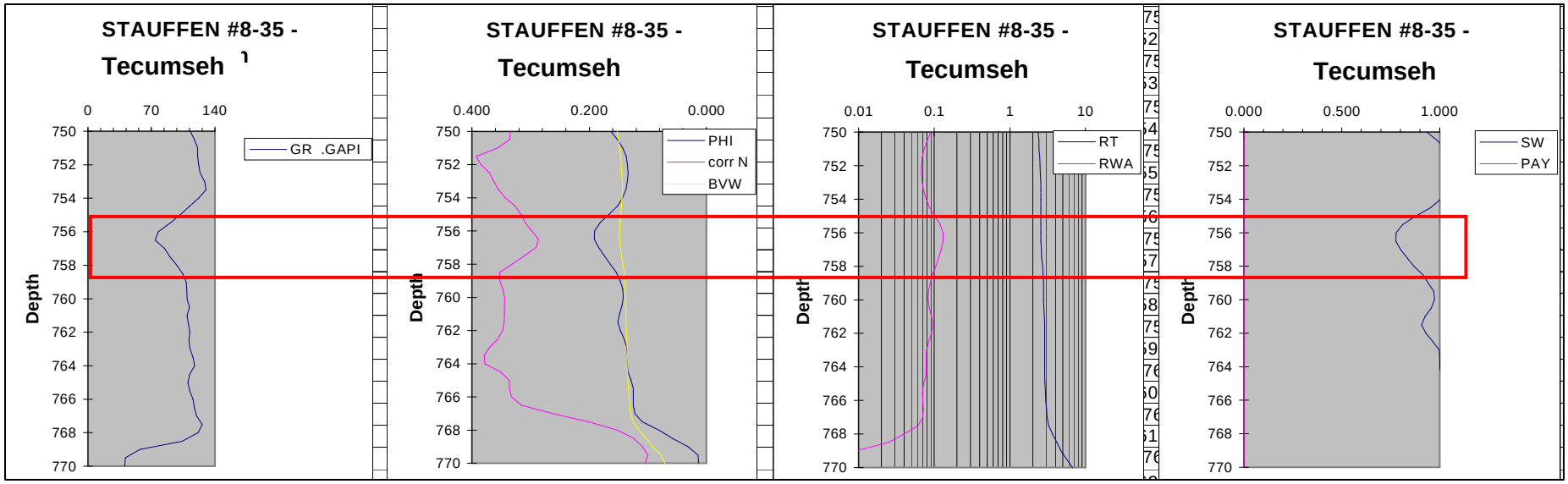


Log showing shale that was washed out. Shale overlies the Severy sand in Stauffer 2-35 well.

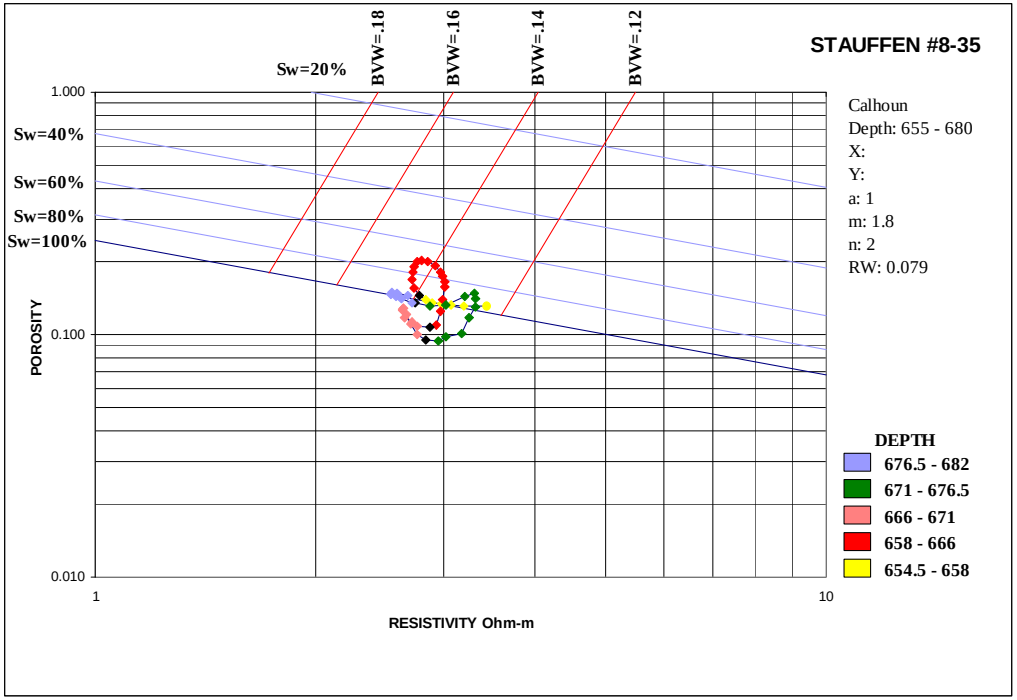


Stauffer 8-35
Tecumseh (755-759 ft)

- Small clustering at moderate BVW (0.15) – test to check for mobile water
- Decrease in GR upwards may be indicative of coarsening
- Top of sand - Separation between density porosity and BVW
- Sw > 80%
- Bottom of sand - Sw increases downwards
- **Poor prospect - gas in transition zone**



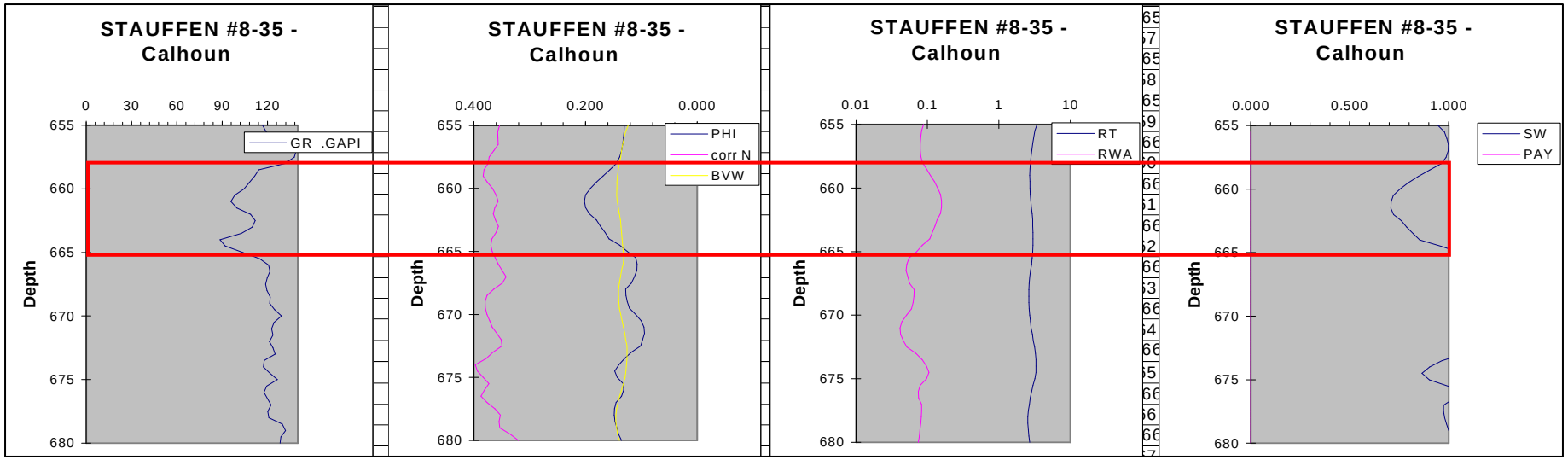
Log analysis of Tecumseh sand in Stauffer 8-35 well.



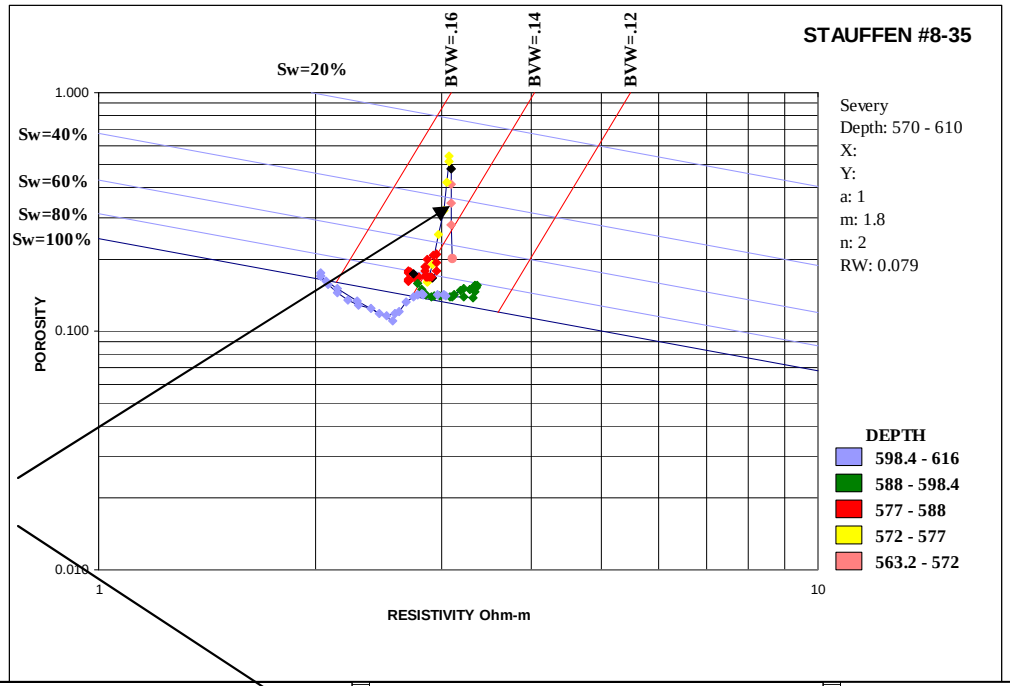
Stauffer 8-35

Calhoun (658-65 ft)

- Top of sand – low GR and seperation between density porosity and BVW, BVW around 0.14
- Base of sand - Sw increases with depth – indicative of transition
- **Probably gas in transition**



Log analysis of Calhoun sand in Stauffer 8-35 well.

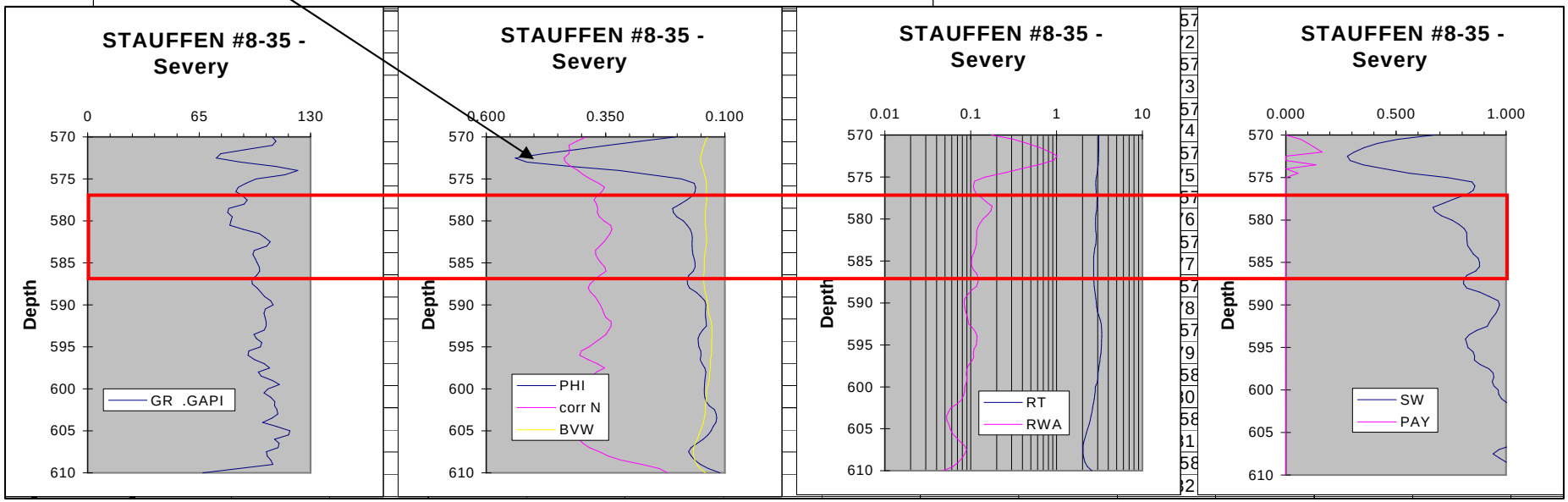


Coal

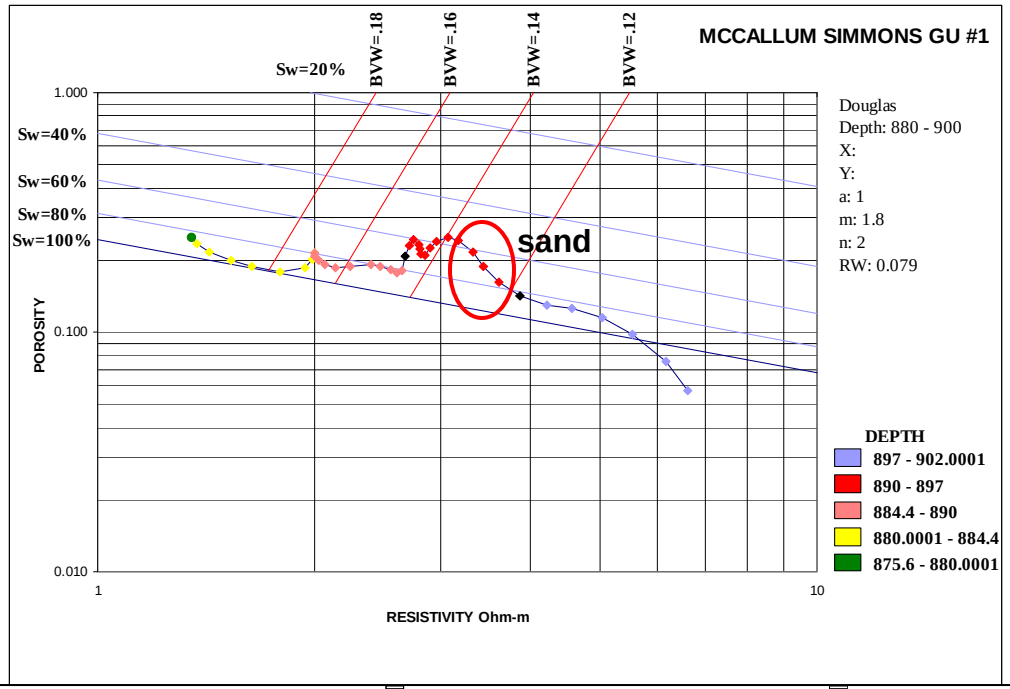
Stauffer 8-35

Severy (577-588 ft)

- Clustered BVW ~0.14
- Coal on top of sand (high porosity, moderate GR)
- GR indicates cleaning upward in sand. No gas effect visible. Porosity low.
- Slight separation between density porosity and BVW, Sw < 80%
- **Probable gas**



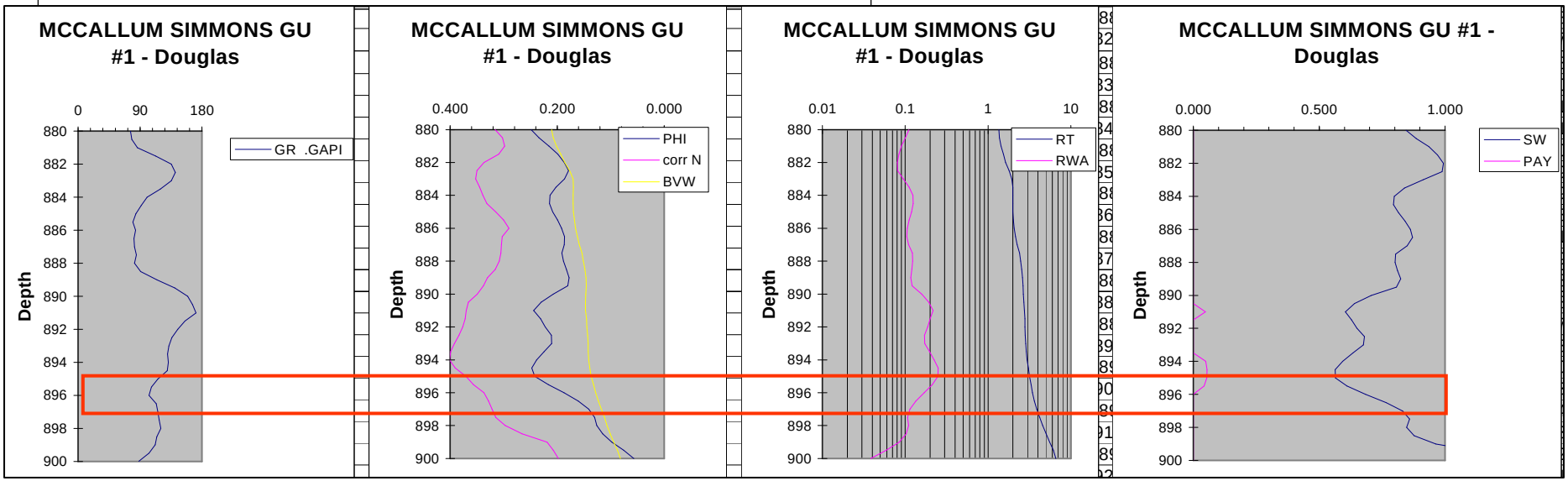
Log analysis of Severy sand in Stauffer 8-35 well.



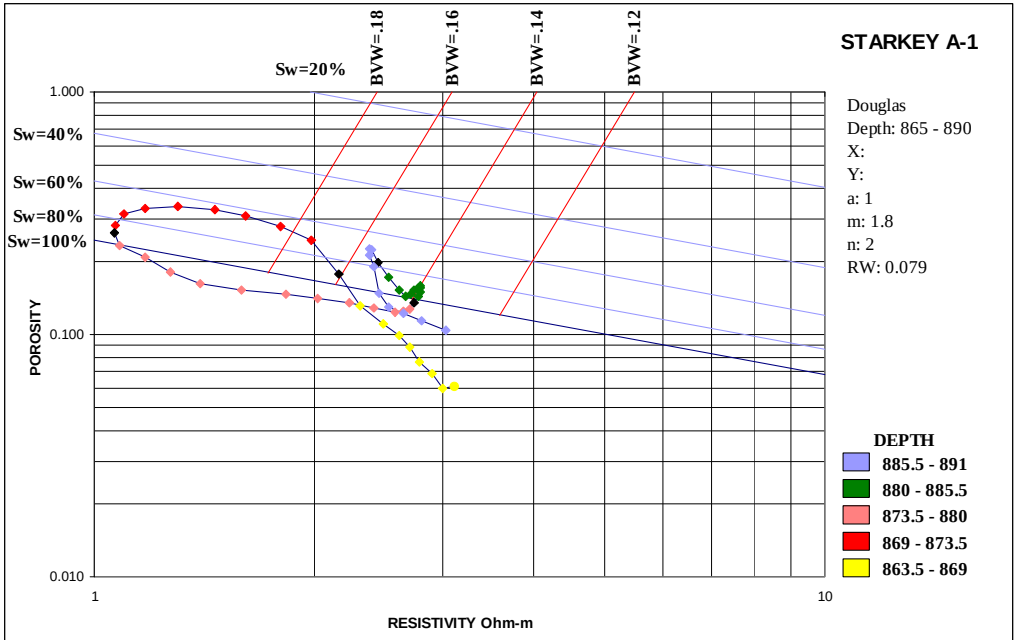
McCallum Simmons GU #1

Douglas (895-897 ft)

- Washout above sand in shale bed (891-895 ft)
- BVW < 0.14 in sand with separation between density porosity and BVW
- Sw < 80% in sand
- **Probably gas in transition**



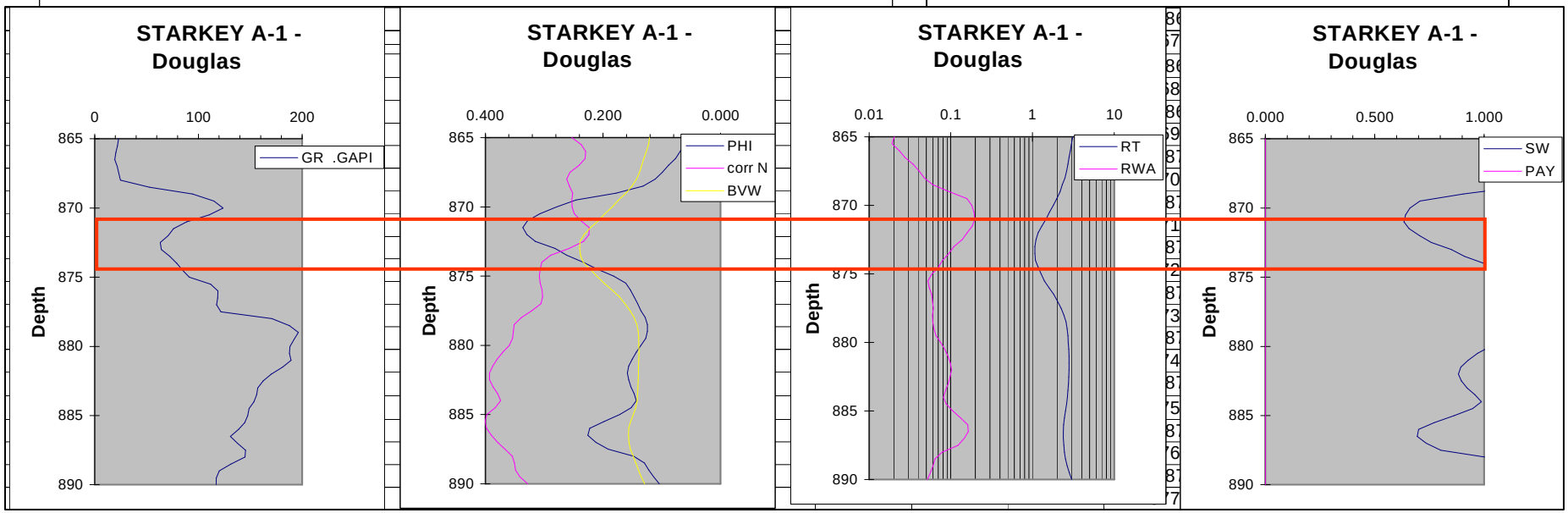
Log analysis of Douglas sand in McCallum Simmons GU 1 well.



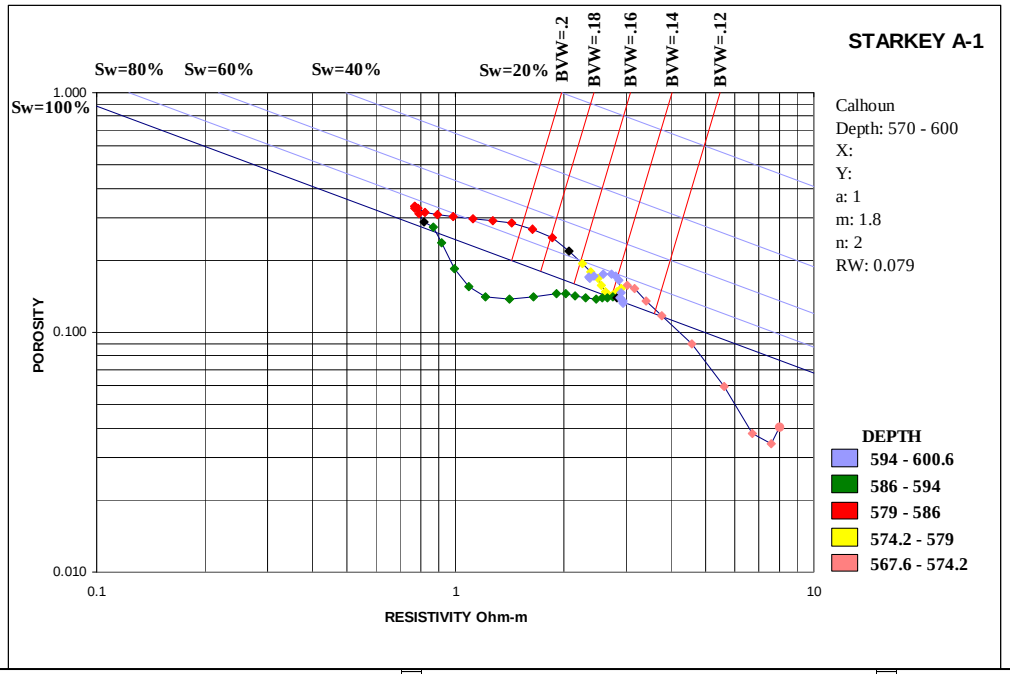
Starkey A-1

Douglas (871-874 ft)

- Gas effect on neutron porosity, separation between density porosity and BVW. No washout.
- But high BVW (>0.18) suggesting fine pores and probable lower perm
- Coarsening upward package indicated by decreasing BVW. GR < 100 API.
- **May produce gas.**



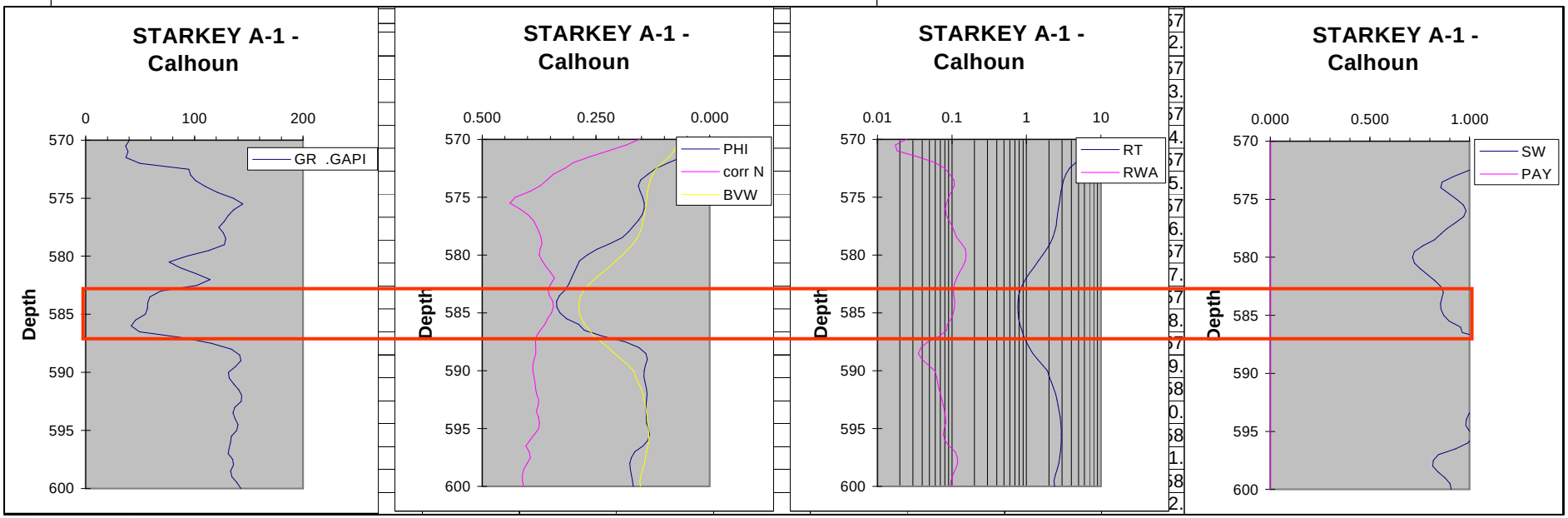
Log analysis of Douglas sand in Starkey A1 well.



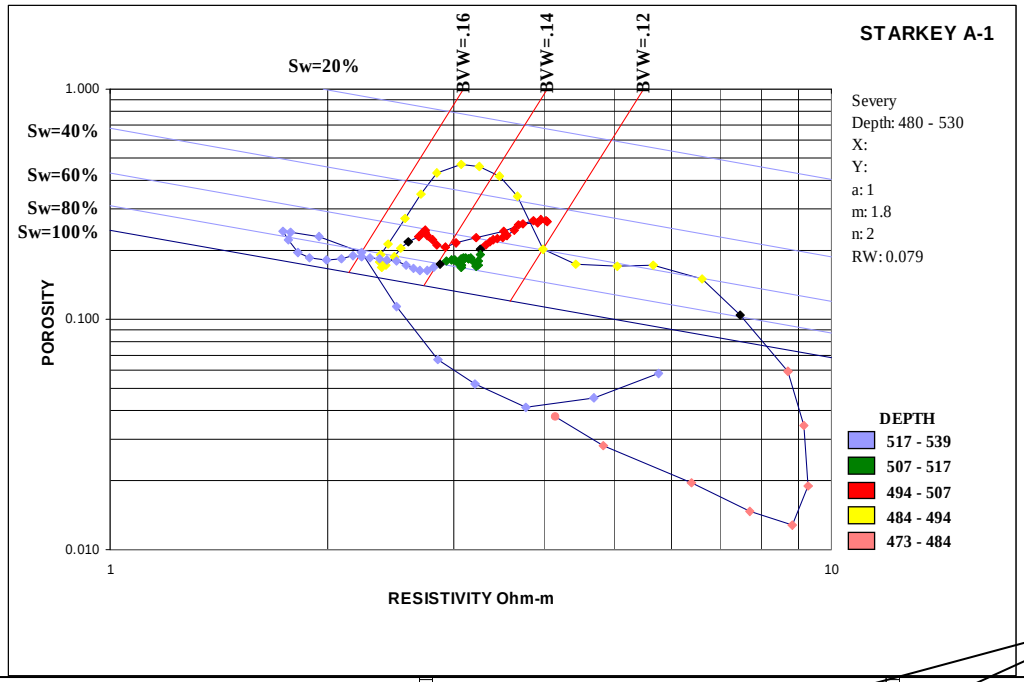
Starkey A-1

Calhoun (583-86 ft)

- Slight gas effect on neutron porosity
- high BVW (>0.2) suggest fine pores
- high Sw (+ 80%) suggests transition. Also Sw increases with depth.
- **Gas in transition**



Log analysis of Calhoun sand in Starkey A1 well.

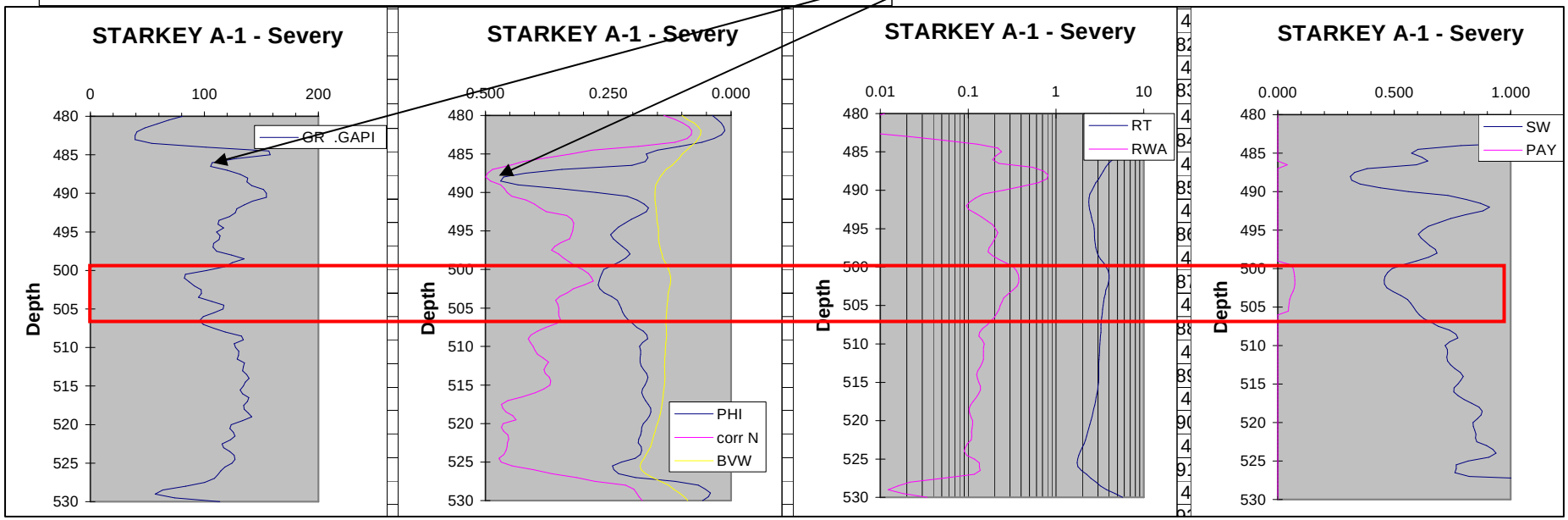


Starkey A-1

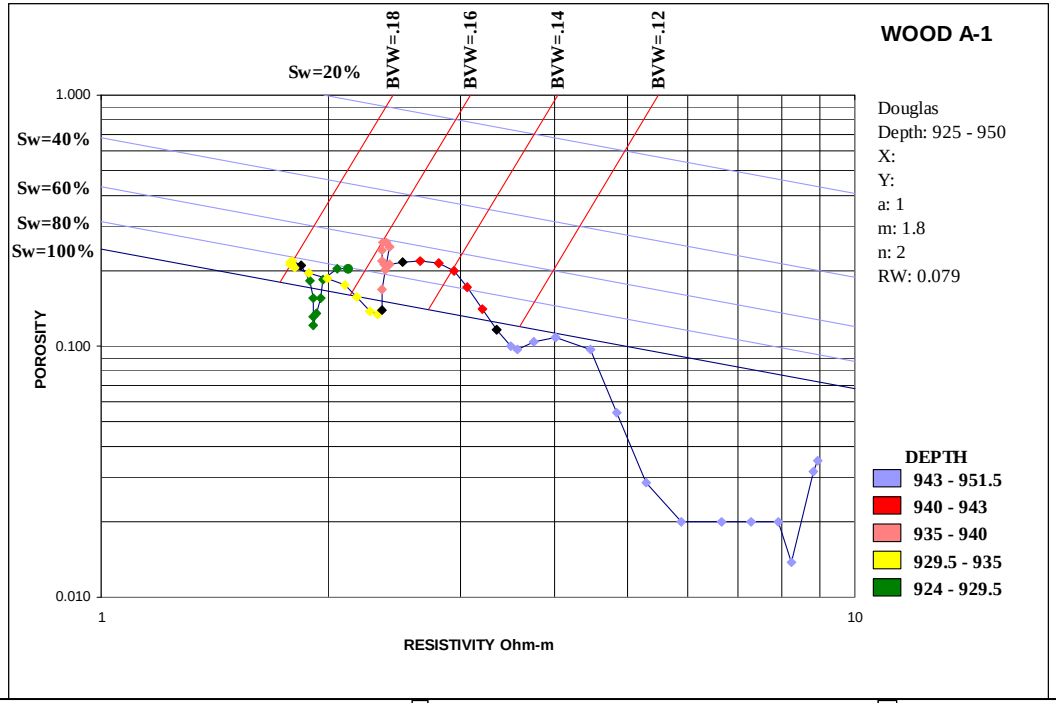
Severy (500-506 ft)

- Slight gas effect on neutron porosity
- Low BVW (~0.12) suggest larger pores. Sw increases with depth. Much of sand at Sw < 60%.
- A (3 ft) coal bed is suspected to overly the sand.
- **GAS zone**

Indicative of Coal



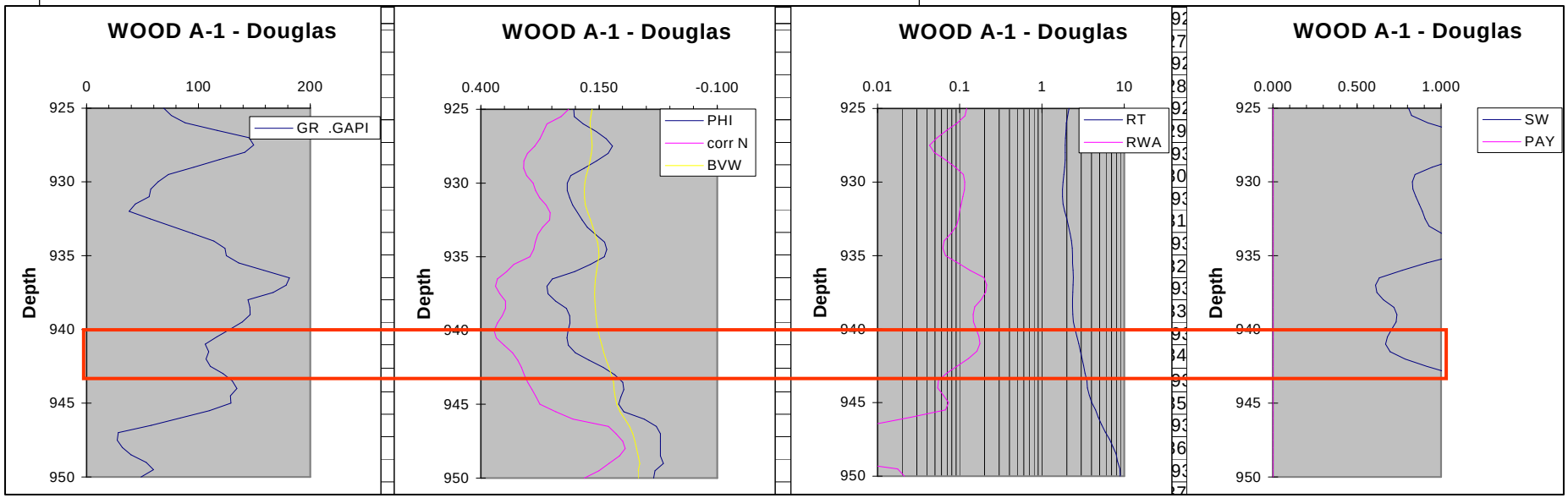
Log analysis of Severy sand in Starkey A1 well.



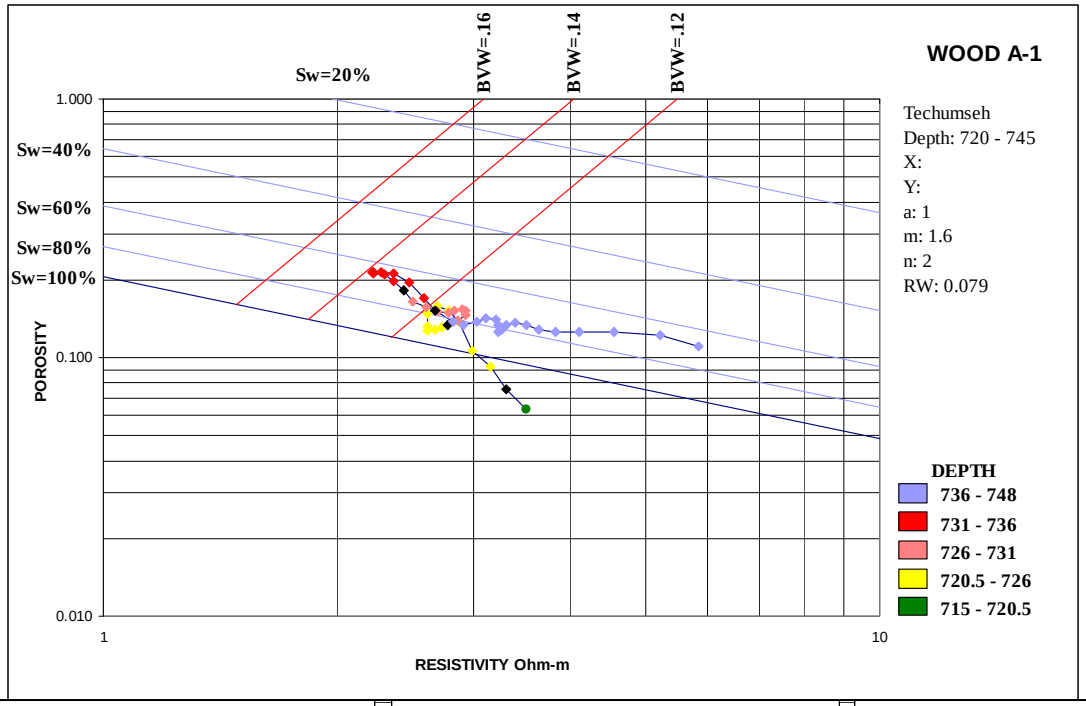
Wood A-1

Douglas (940-943 ft)

- No gas effect on neutron porosity. Separation between density porosity and BVW.
- Quite shaly (GR> 100 API), but BVW less than 0.155
- Sw < 80% and increases with depth
- **Possible gas in transition**



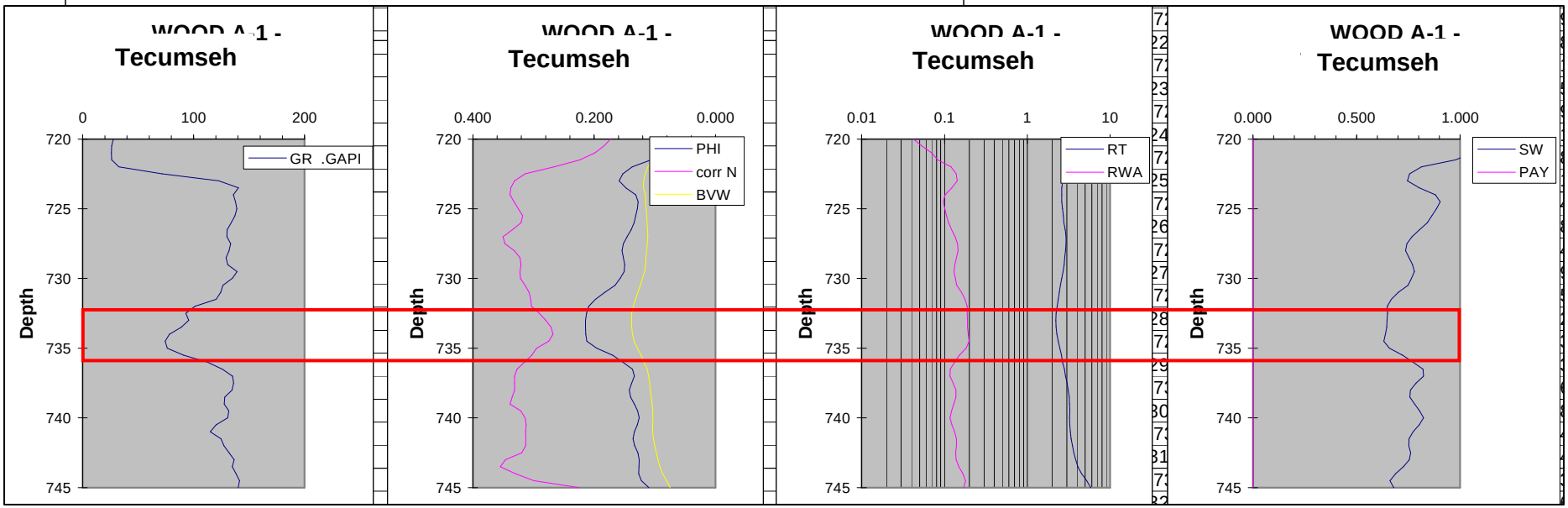
Log analysis of Douglas sand in Wood A1 well.



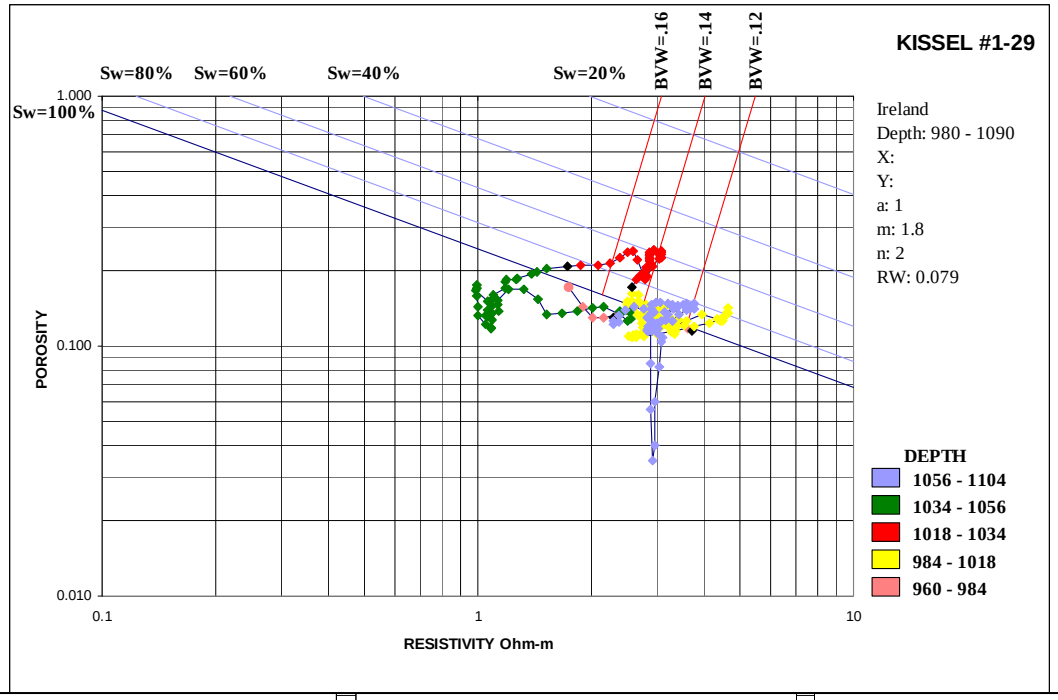
Wood A-1

Tecumseh (732-736 ft)

- Slight gas effect on neutron log.
- GR < 100 API with moderate porosity and BVW cluster around 0.0135
- Sw < 80%. No transition visible
- **Possibly gas**



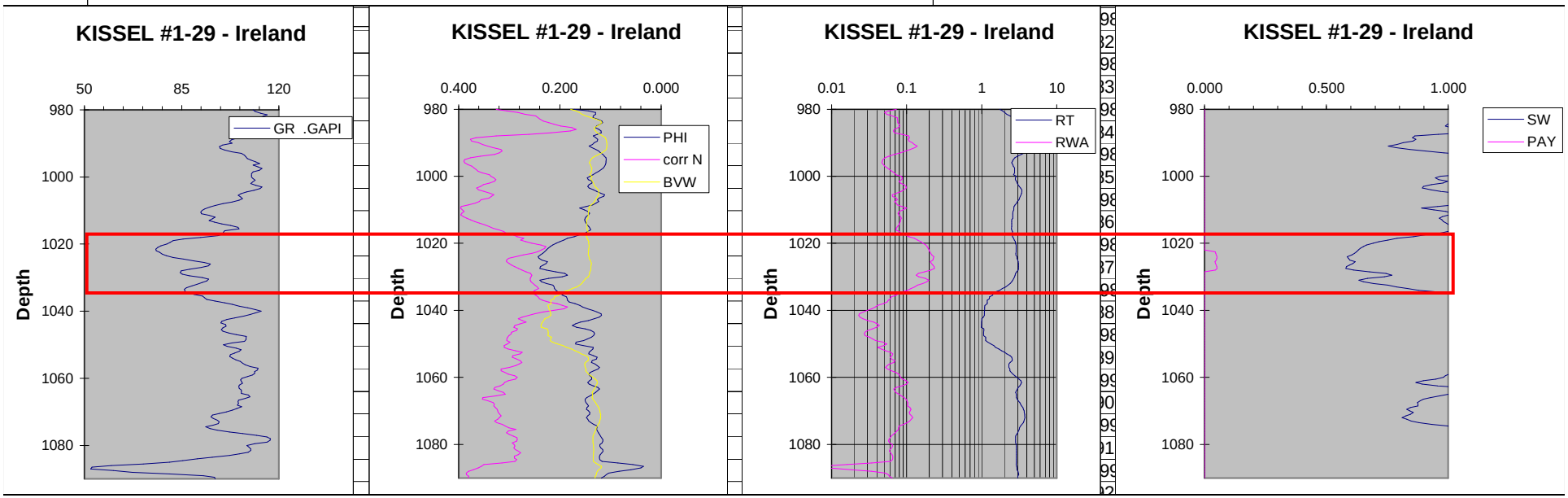
Log analysis of Tecumseh sand in Wood A1 well.



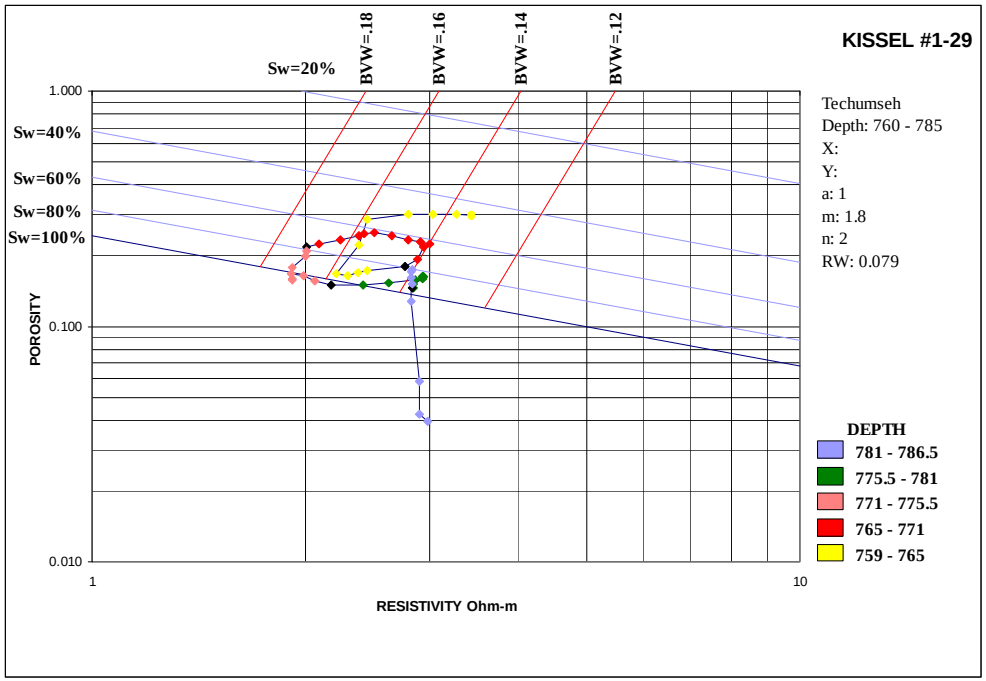
Kissel 1-29

Ireland (1020-1037 ft)

- Gas effect visible on neutron porosity log, separation between density porosity and BVW
- Low GR (< 100 API) and BVW cluster around 0.14
- 60% > Sw > 80%
- **Possibly Gas**



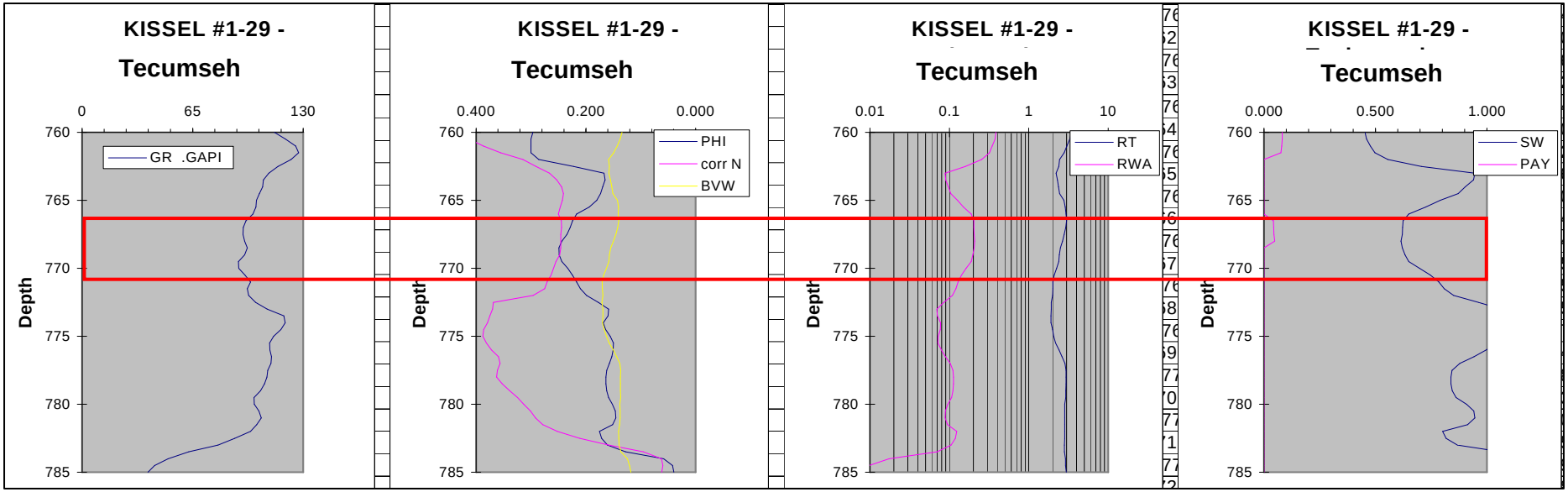
Log analysis of Ireland sand in Kissel 1-29 well.



Kissel 1-29

Tecumseh (766-771 ft)

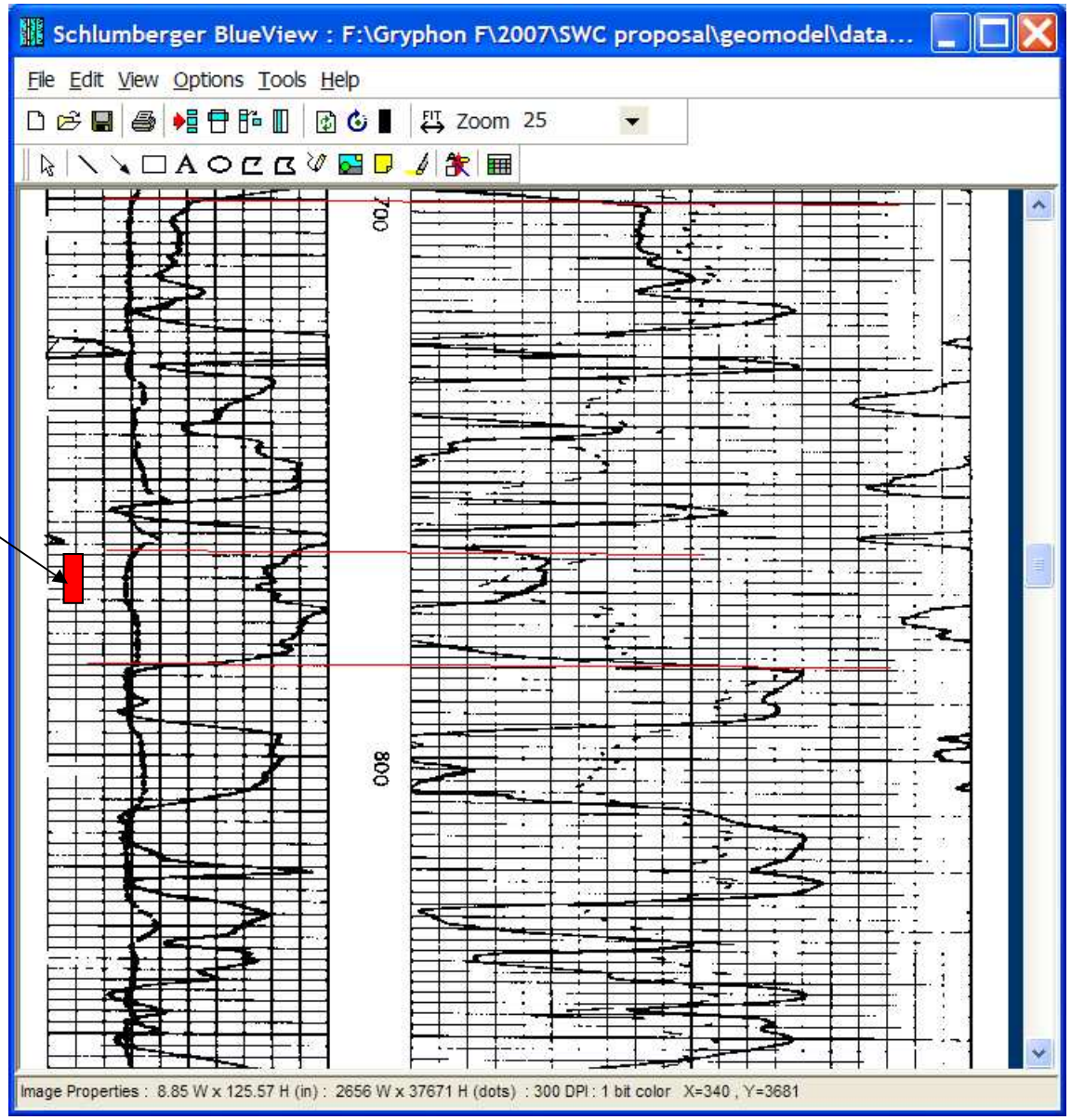
- Gas effect on neutron porosity, separation between density porosity and BVW
- BVW < 0.16 with some clustering around 0.14. Sw close to 60%
- Possible mudcake build up over this interval indicating higher permeability
- **Possibly gas**



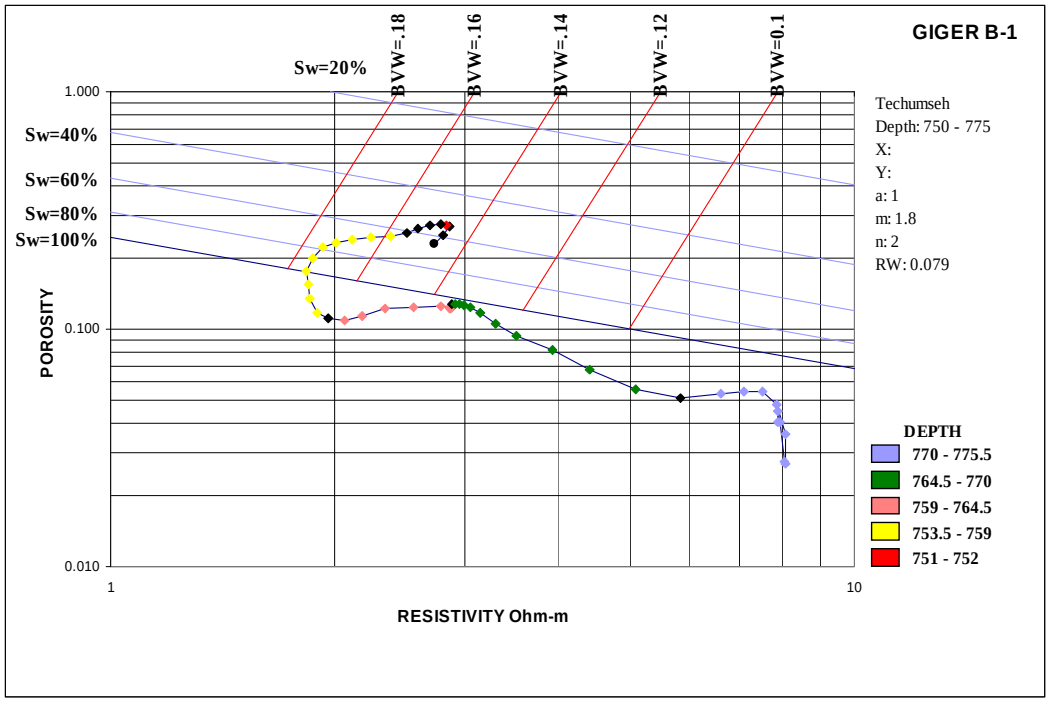
Log analysis of Tecumseh sand in Kissel 1-29 well.

Kissel 1-29

- Mudcake buildup 762-772 ft.



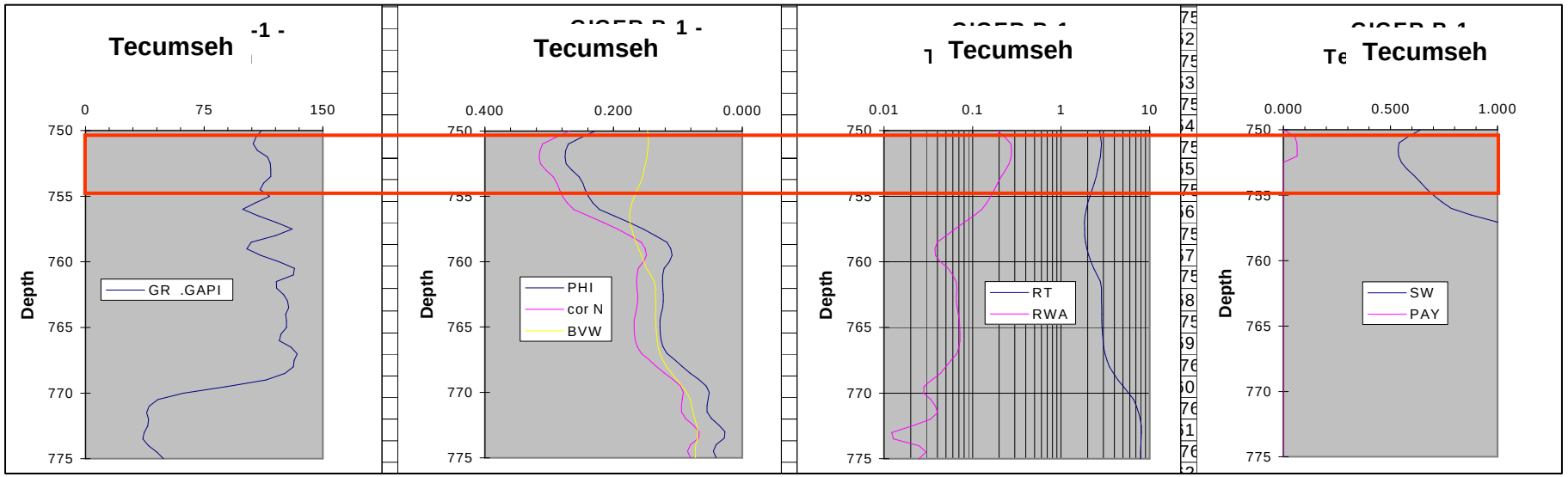
Log showing mud cake buildup over the Tecumseh sand in Kissel 1-29 well.



Giger B-1

Tecumseh (750-755 ft)

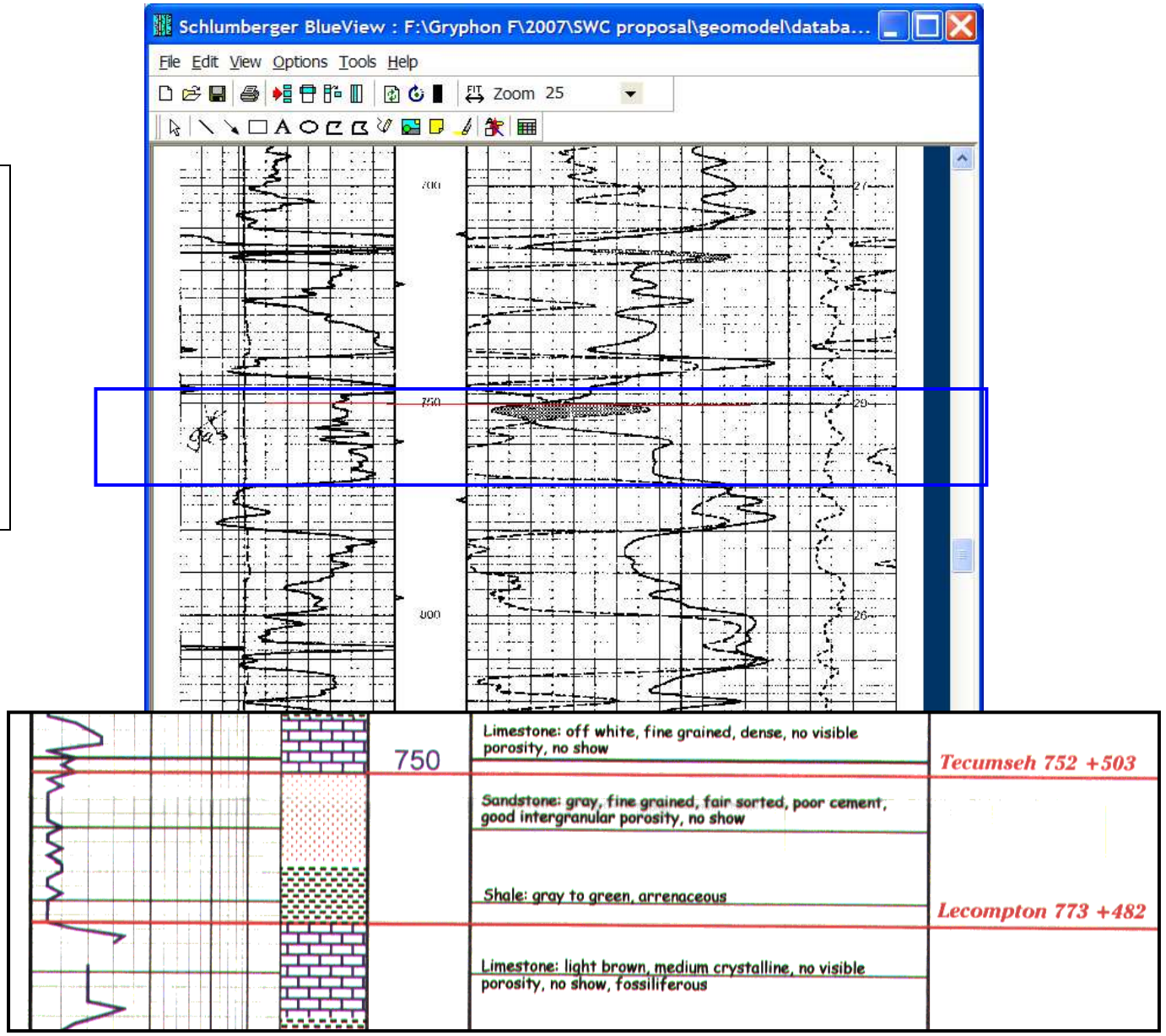
- Gas effect on neutron porosity, separation between density porosity and BVW
- BVW clusters around 0.15, moderately high density porosity (28%), Sw ~ 60% or less
- GR high
- **Possibly gas bearing. No show during drilling.**



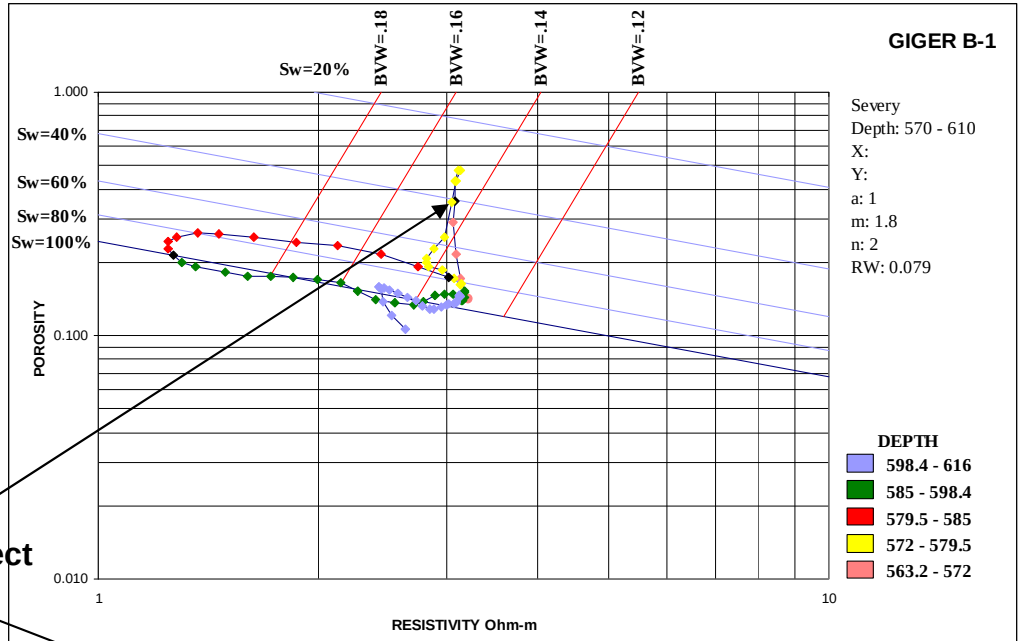
Log analysis of Tecumseh sand in Giger B1 well.

Giger B-1

- Samples indicate fine grain porous sandstone in spite of high gamma ray;
- No gas show during drilling.



Log showing high GR over sand interval while geo report indicates fine grained sand from the same interval.

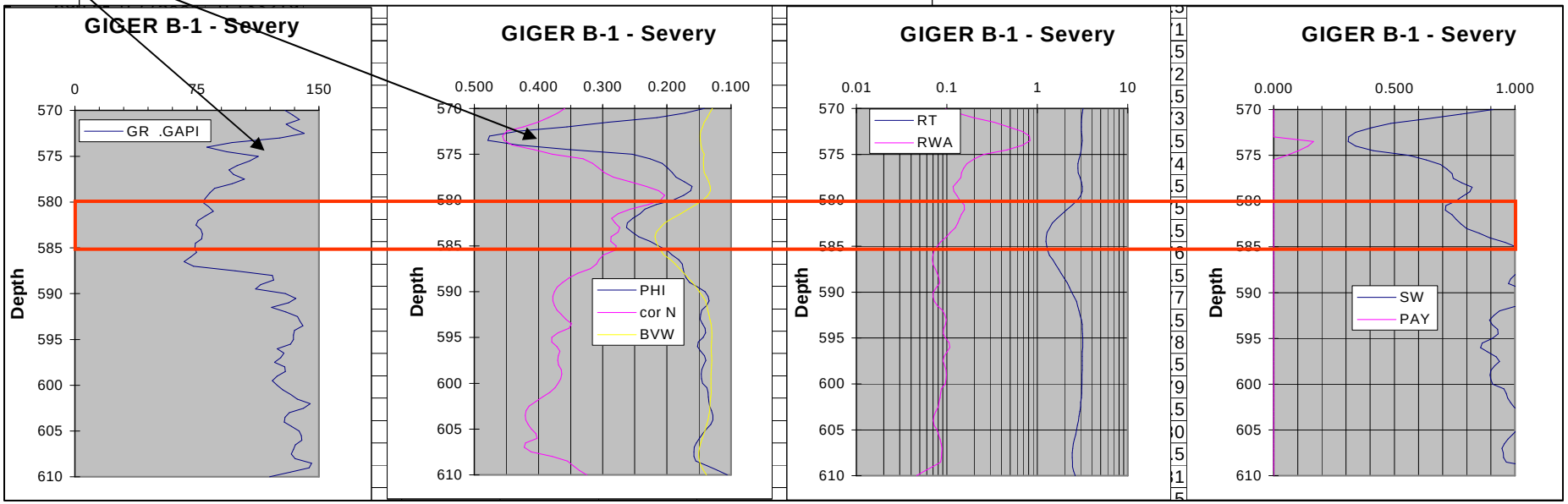


Suspect Coal

Giger B-1

Severy (580-585 ft)

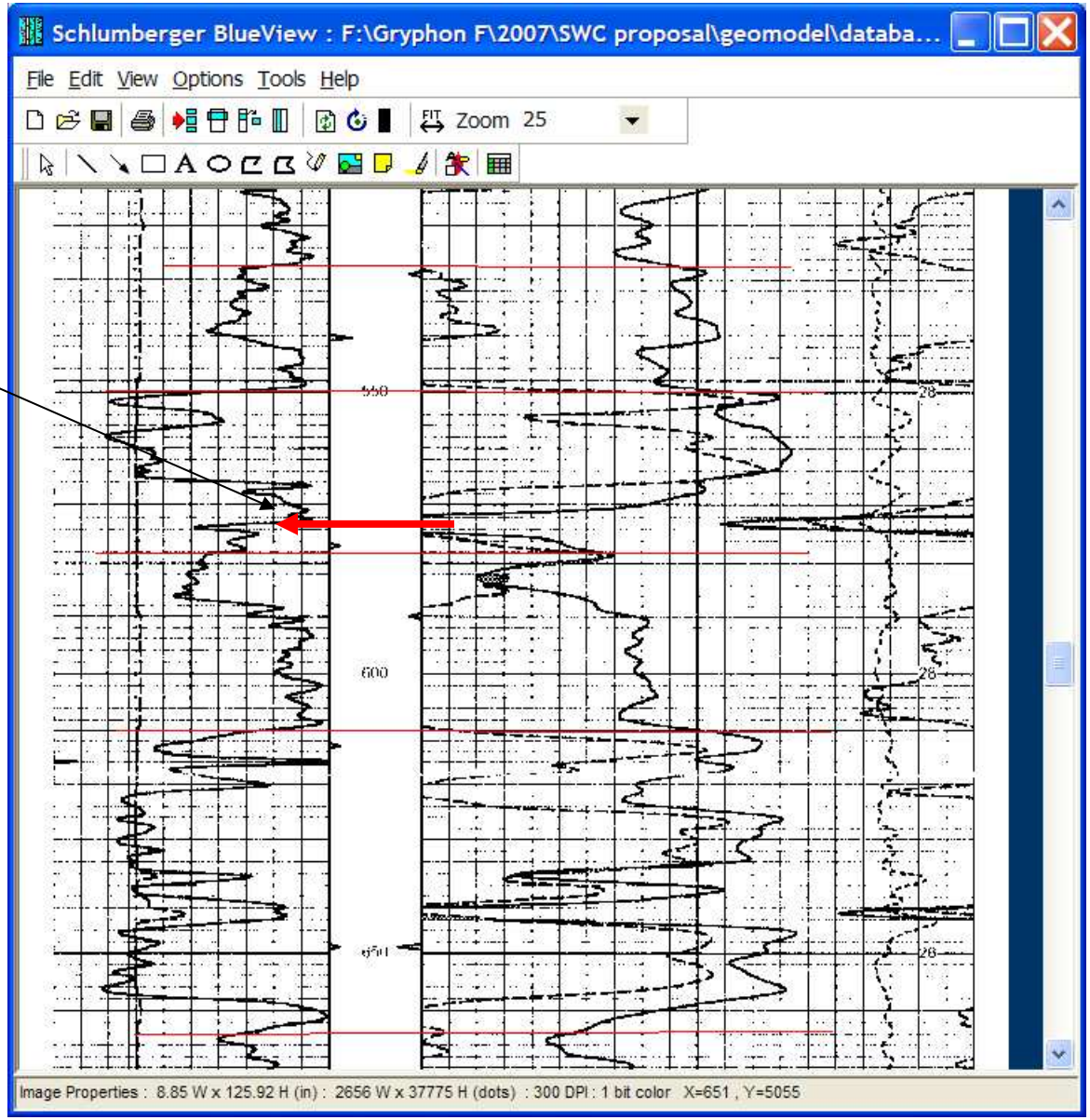
- Gas effect on neutron porosity, slight separation between density porosity and BVW
- Increasing BVW and Sw with depth
- Moderate porosity, and relativity low GR (< 100 API), Sw + 70%
- Possible coal bed (2 ft) above sand
- **Possible gas zone in transition**



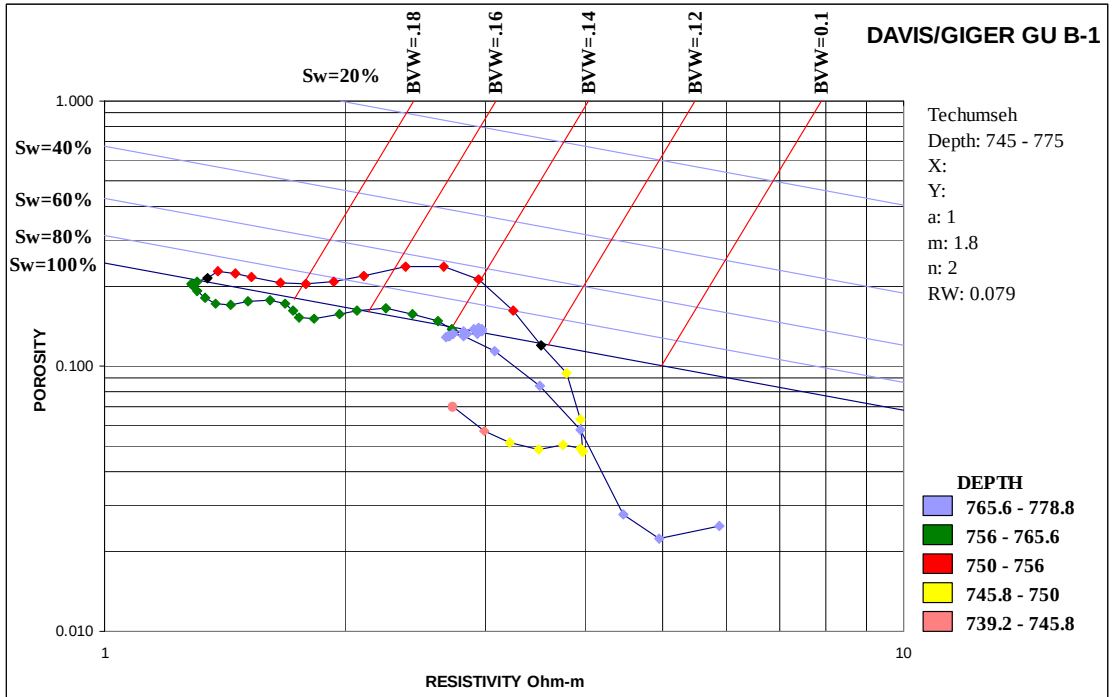
Log analysis of Severy sand in Giger B1 well.

Giger B-1, Severy

- **Possible coal bed**



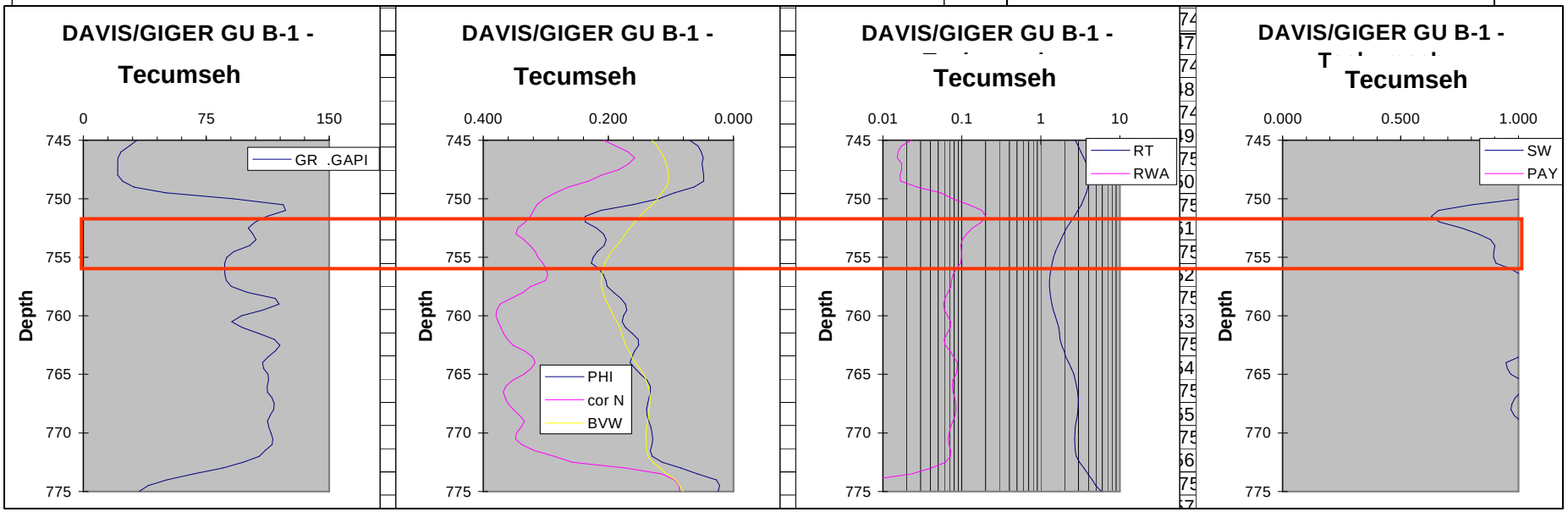
Log showing presence of possible coal bed in Giger B1 well.



Davis/Giger GU B-1

Tecumseh (752-756 ft)

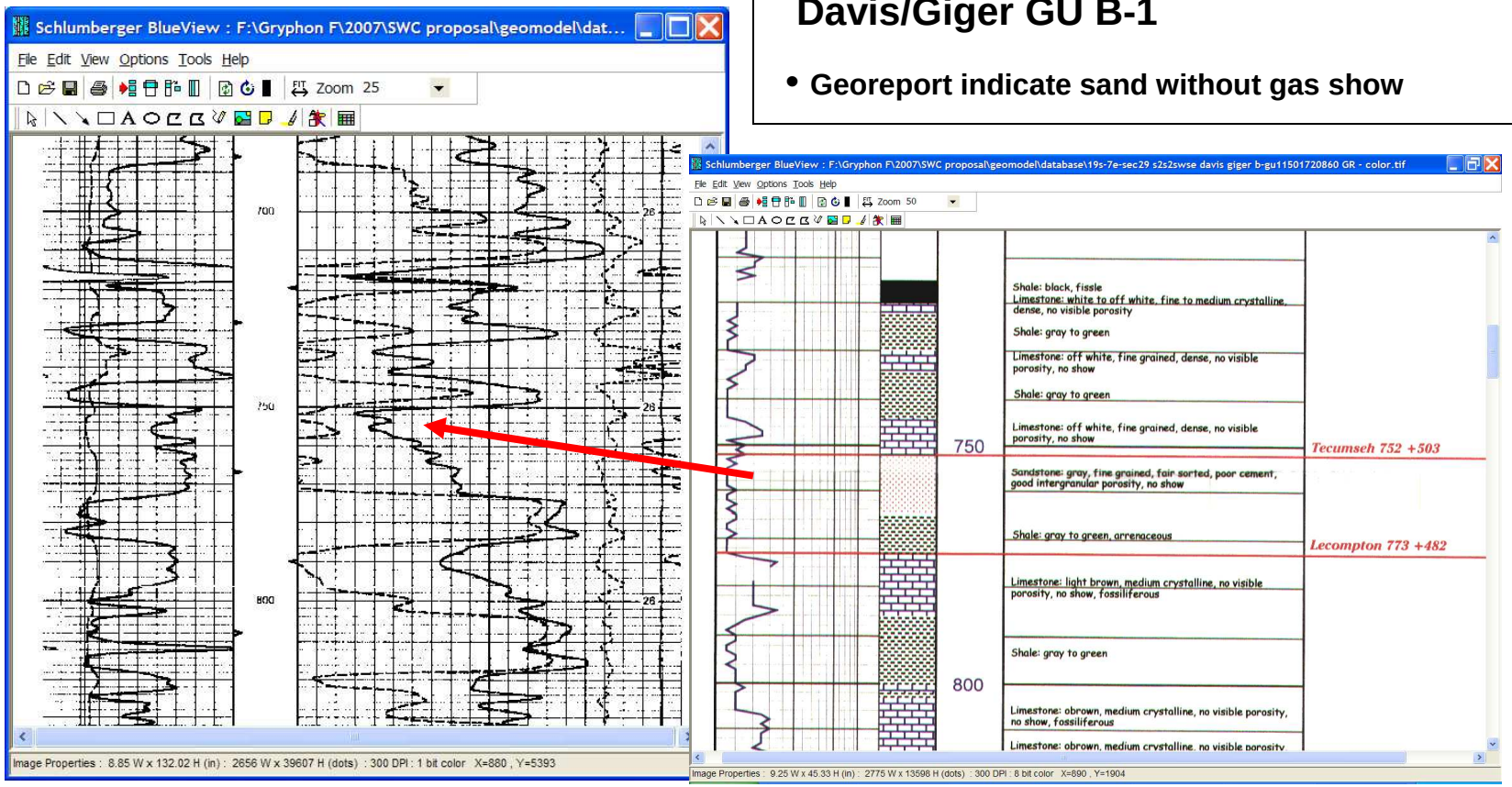
- No gas effect, separation between density porosity and BVW
- Increasing Sw and BVW with depth. Upper sand Sw < 80% and BVW < 0.16.
- **Some chance of gas in transition. No show during drilling.**



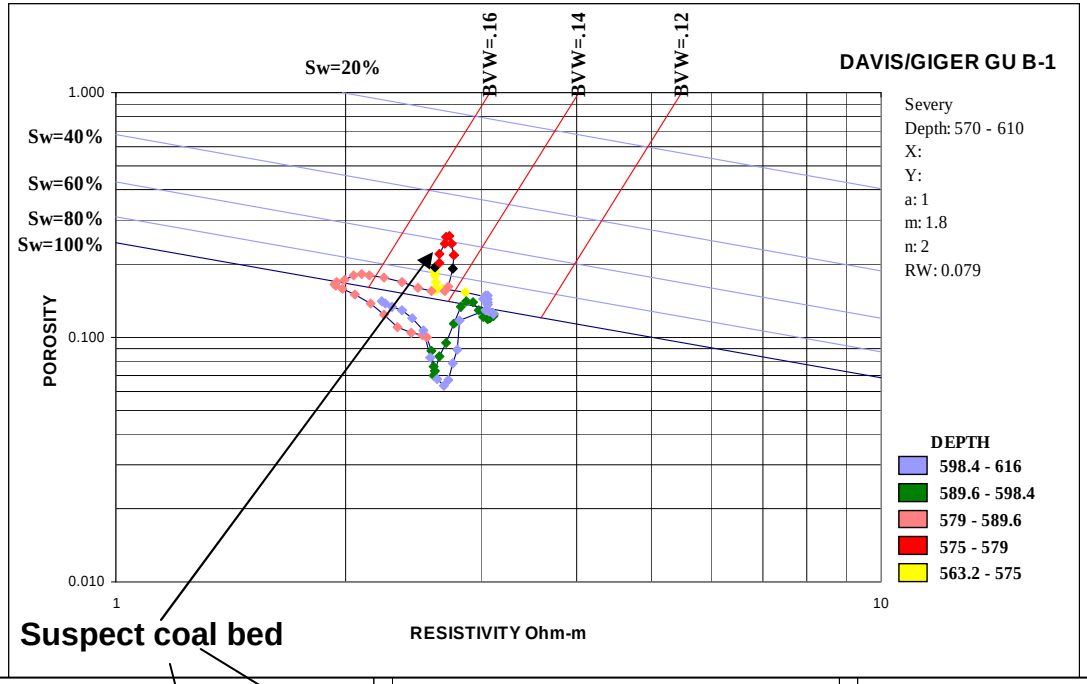
Log analysis of Tecumseh sand in Davis-Giger GU B1 well.

Davis/Giger GU B-1

- Georeport indicate sand without gas show



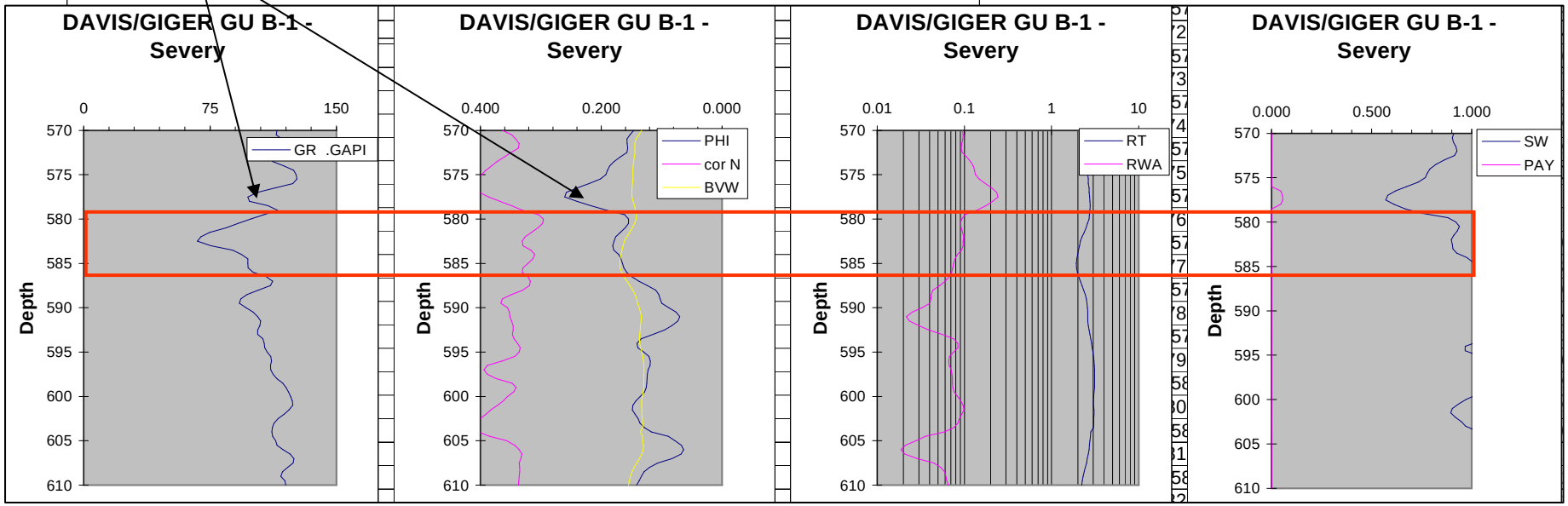
Geo report indicates no gas shows during drilling of Tecumseh in Davis/Giger GU B1 well.



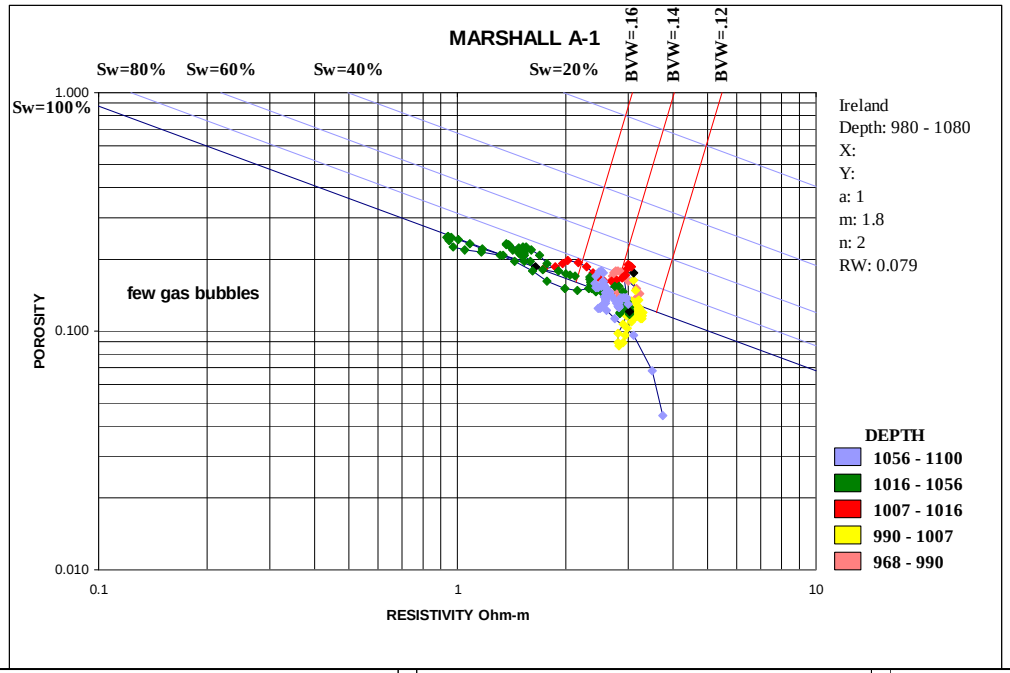
Davis/Giger GU B-1

Severy (579-586 ft)

- Suspect coal to overly the sand
- Little separation between density porosity and BVW
- Sw +90%
- **Wet sand**



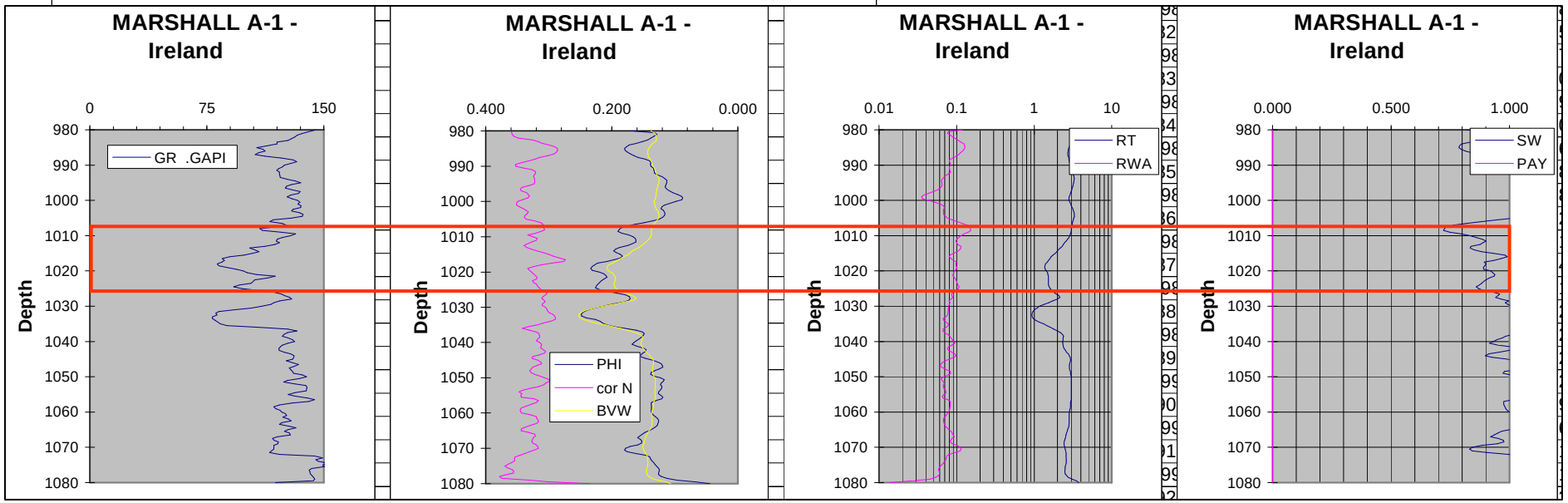
Log analysis of Severy sand in Davis-Giger GU B1 well.



Marshall A1

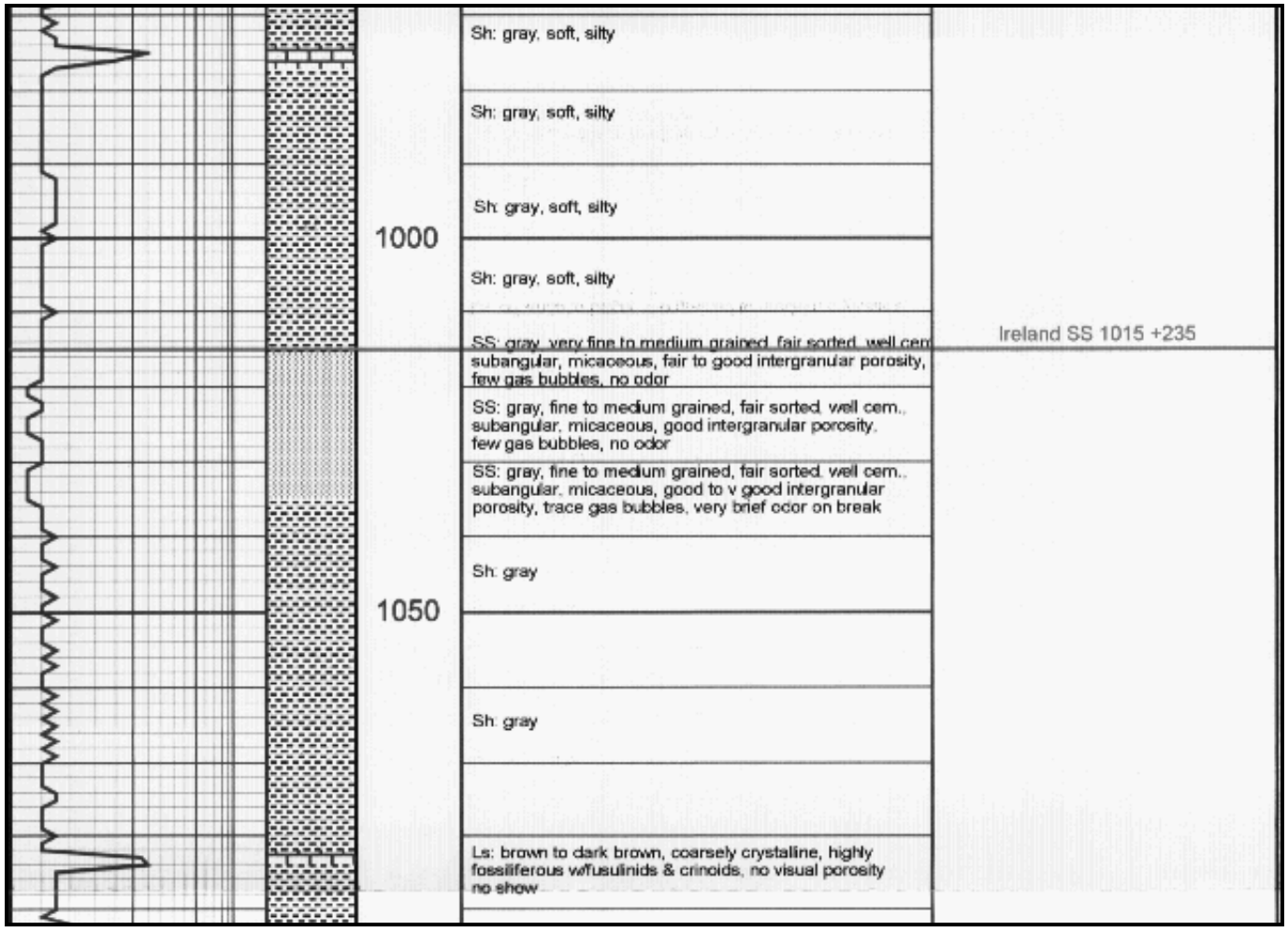
Ireland (1007-1026 ft)

- Minor separation between density porosity and BVW
- High GR (+100 API) due to micacious sand (georeport)
- Some gas show (bubbles) observed (georeport)
- Sw + 90%
- **Wet Sand**

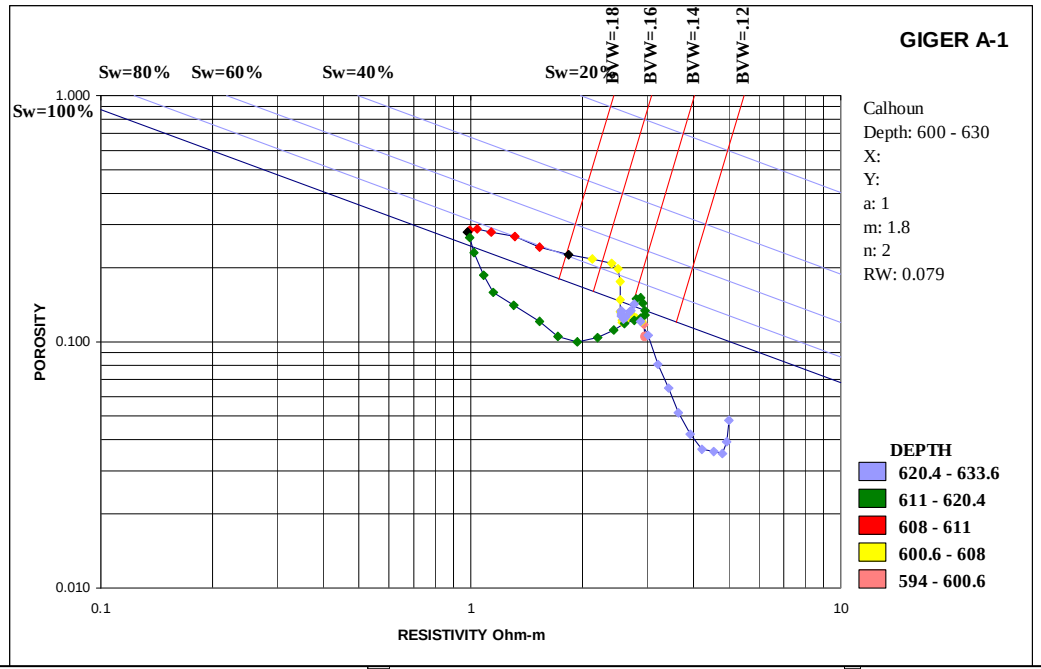


Log analysis of Ireland sand in Marshall A1 well.

Marshall A-1



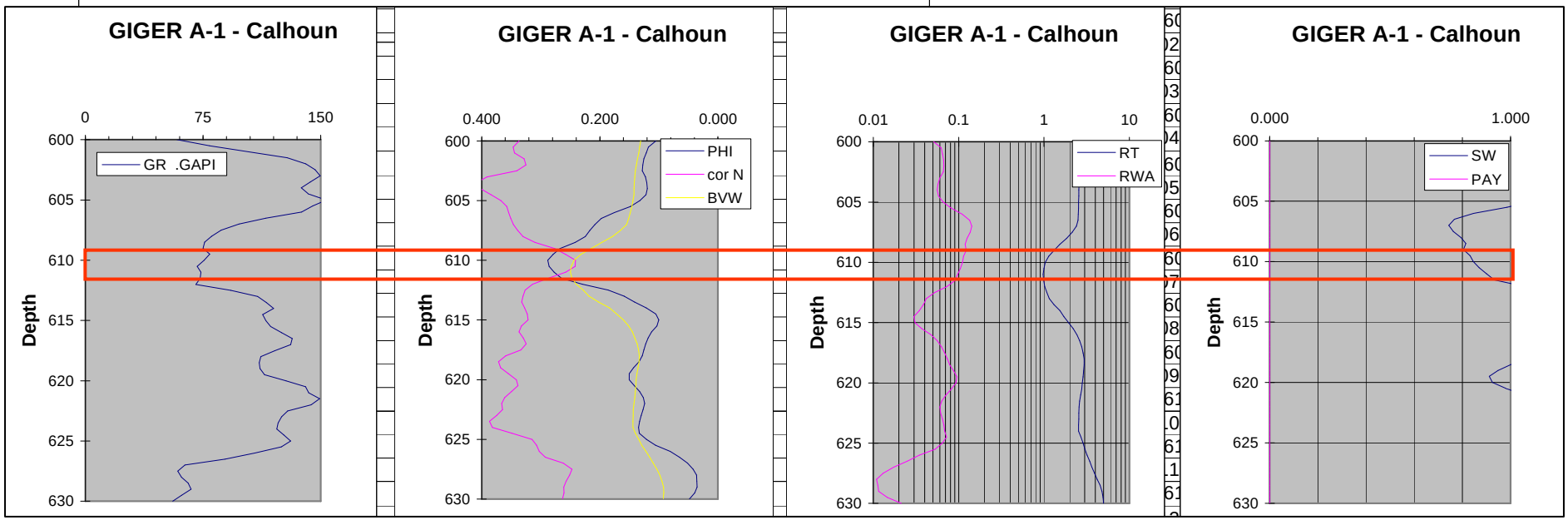
Geo report showing mention of micacious sand and gas bubbles during drilling of Ireland in Marshall A1 well.



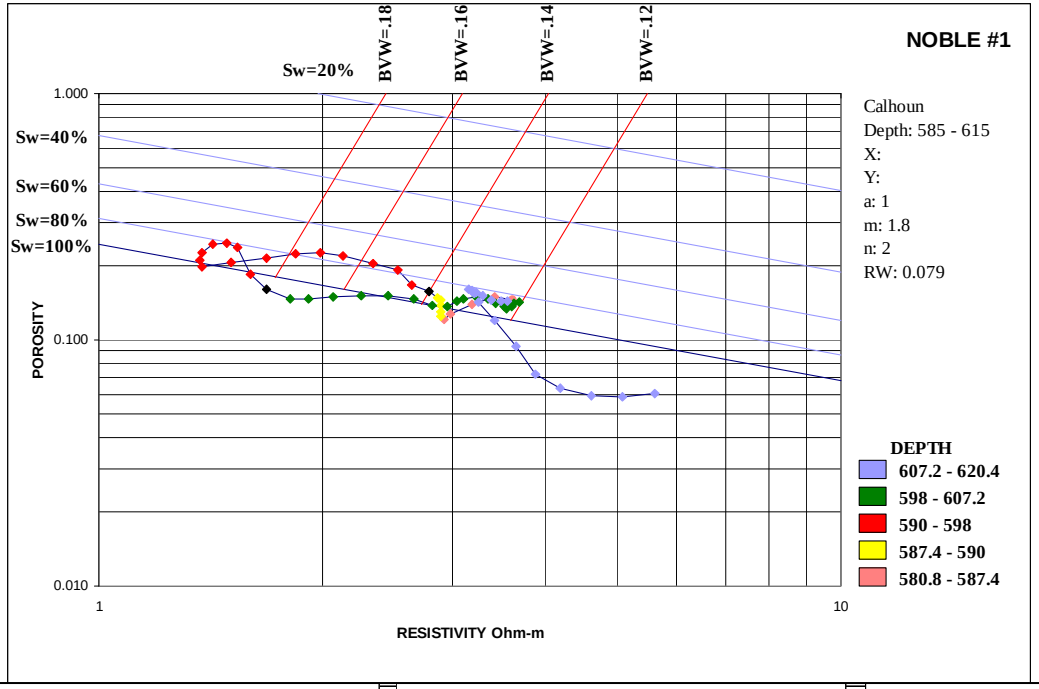
Giger A-1

Calhoun (608-611 ft)

- Gas effect on neutron porosity, separation between density porosity and BVW
- Sw~80% and BVW +0.18
- GR~75 API
- **Probable gas in transition**



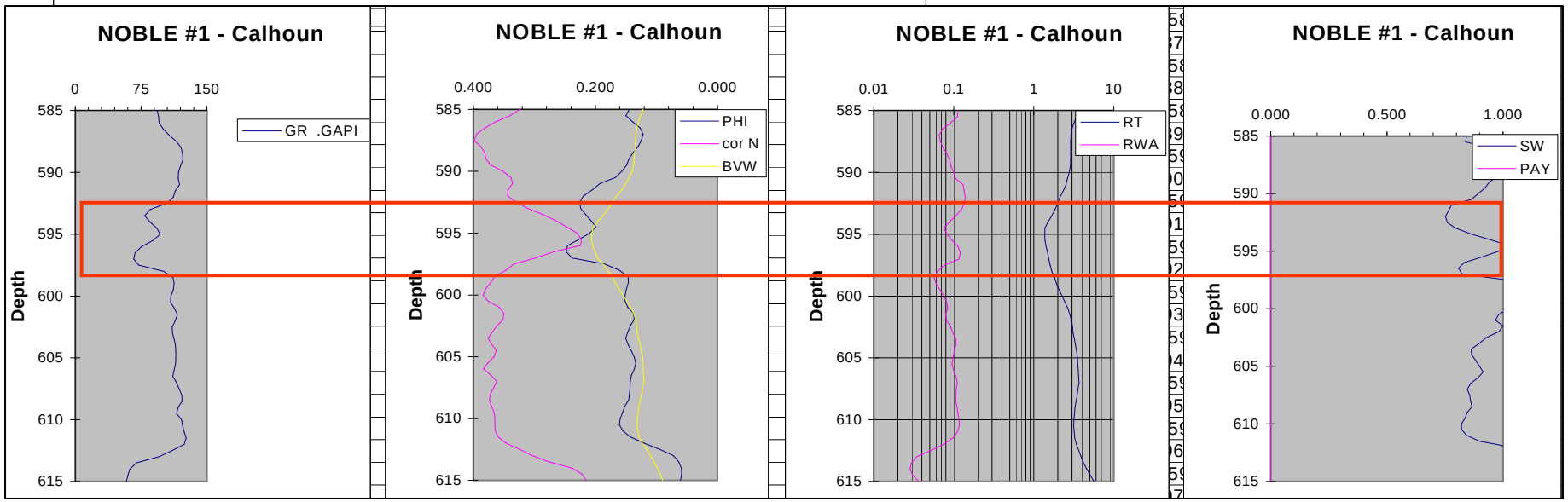
Log analysis of Calhoun sand in Giger A1 well.



Noble #1

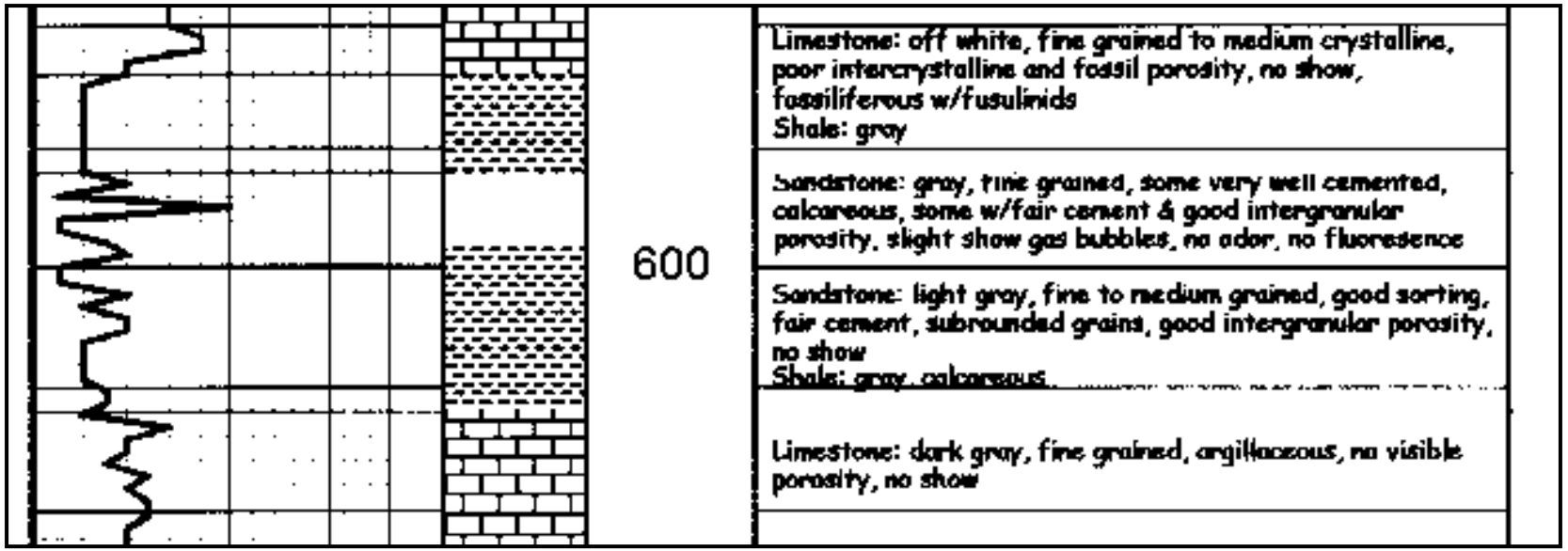
Calhoun (593-598 ft)

- Gas effect on neutron porosity, some separation between density porosity and BVW
- High Sw +80% and increasing with depth. BVW +0.14 and increases with depth. Slight gas bubbles on drilling
- **Gas in transition**

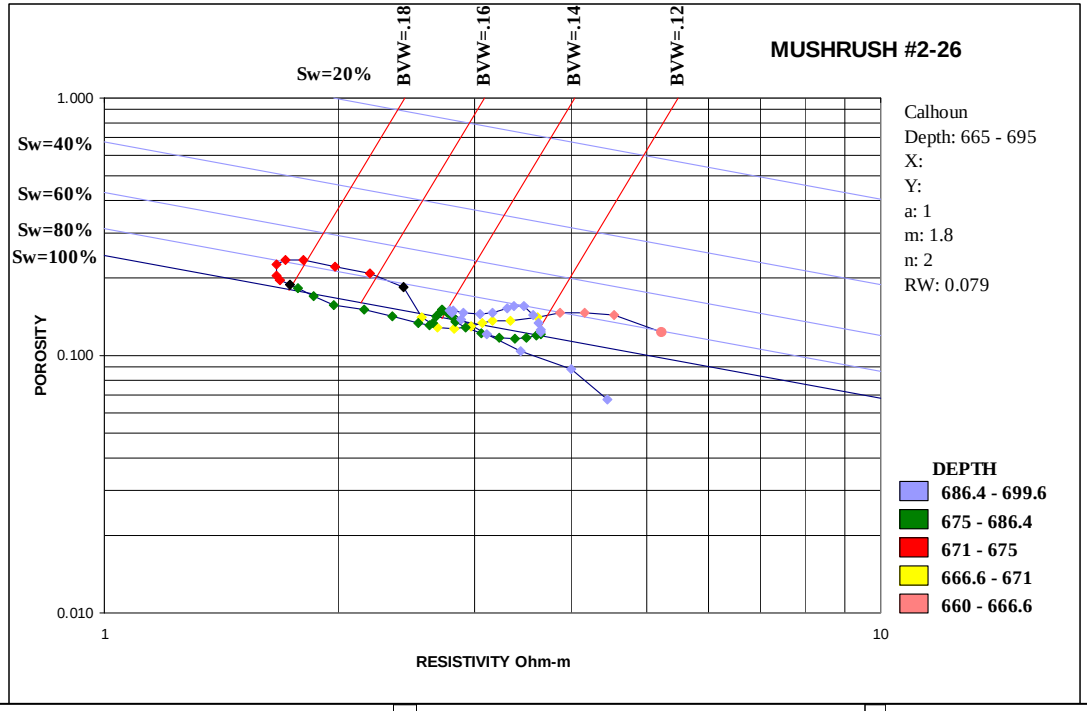


Log analysis of Calhoun sand in Noble 1 well.

Noble #1



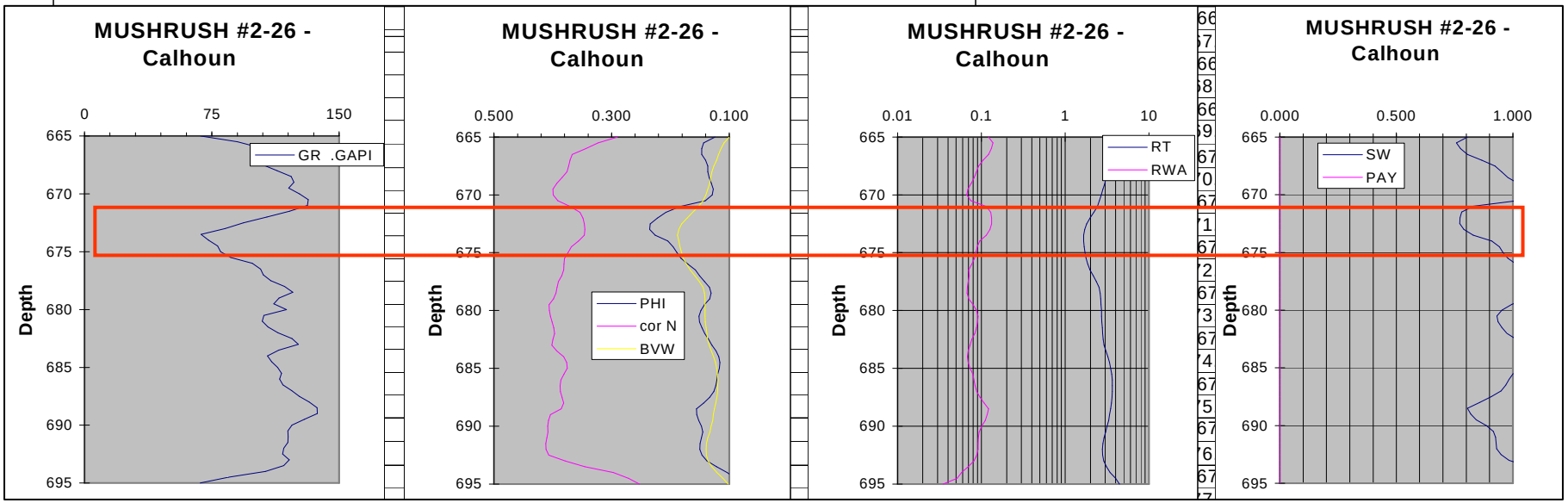
Geo report showing observation of gas bubbles during drilling of Calhoun sand in Noble 1 well.



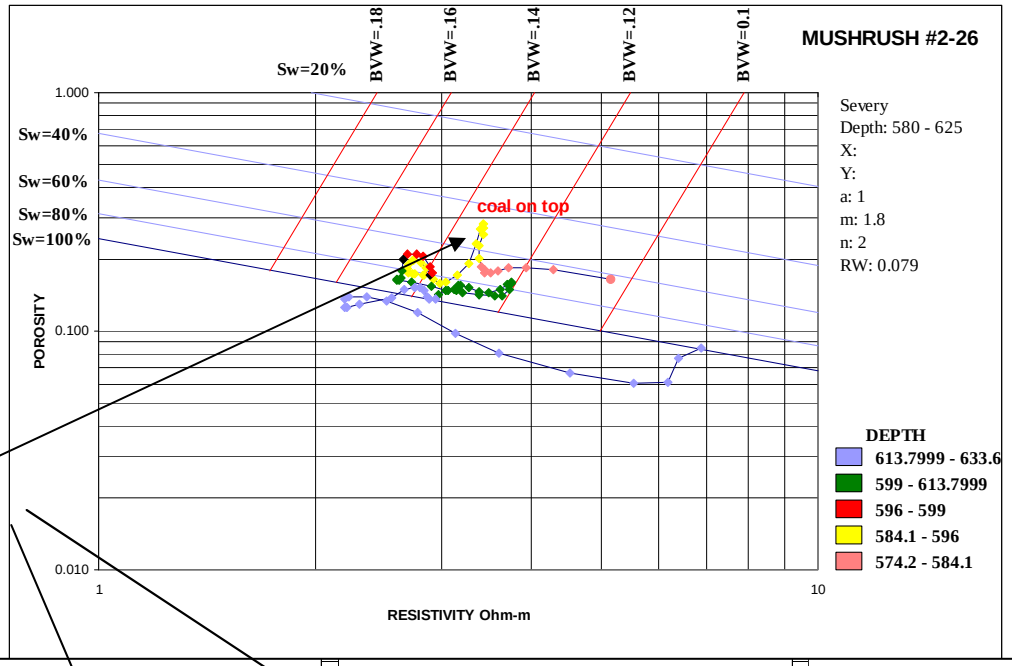
Mushrush 2-26

Calhoun (671-675 ft)

- Appearance of gas effect on neutron log, slight separation between density log and BVW
- , Sw +80%, BVW >0.16
- **Poor prospect - gas in transition**



Log analysis of Calhoun sand in Mushrush 2-26 well.

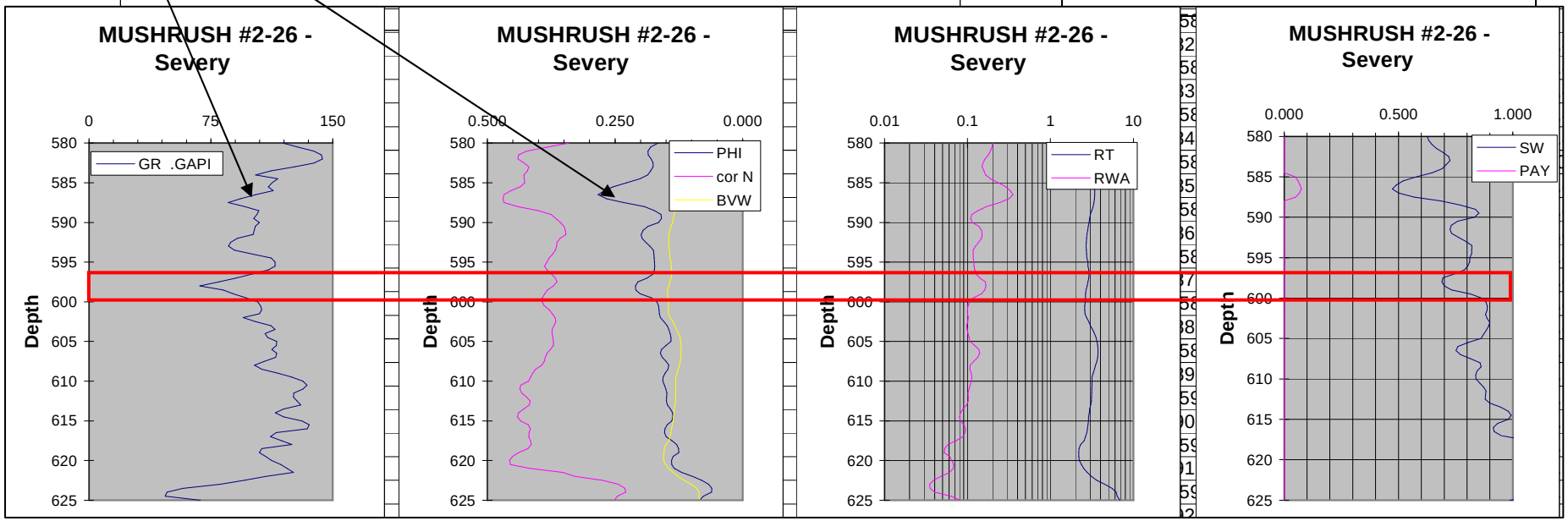


Suspect Coal bed

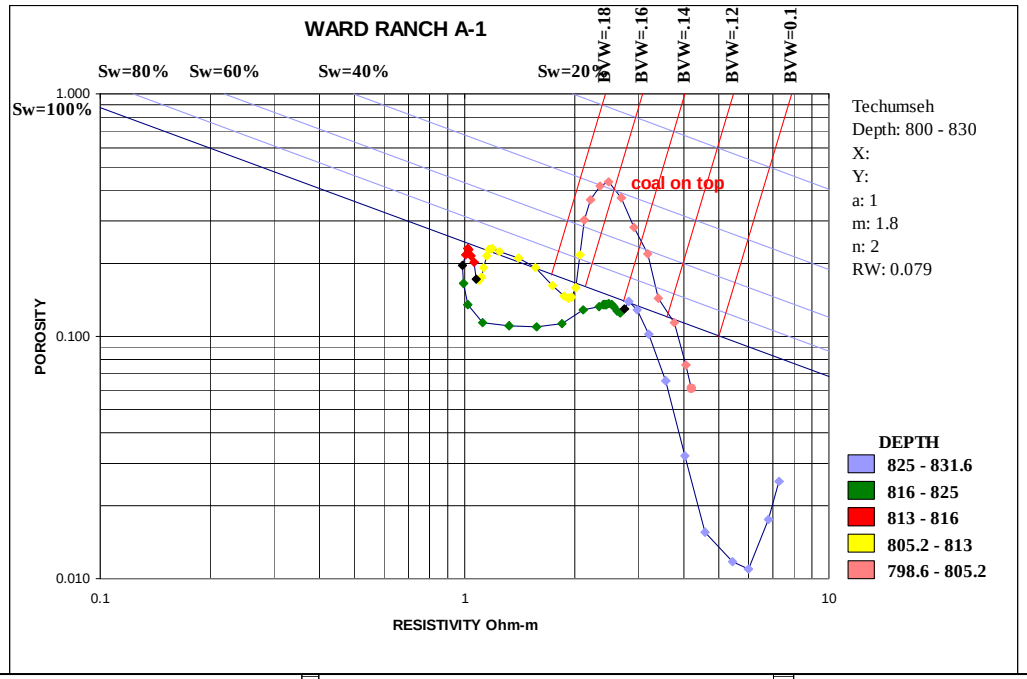
Mushrush 2-26

Severy (596-599 ft)

- Thin gas sand, BVW cluster ~014, Sw 70%
- Appearance of a gas effect on the neutron log, separation between density log and BVW
- **Gas in transition**
- Thin coal on top



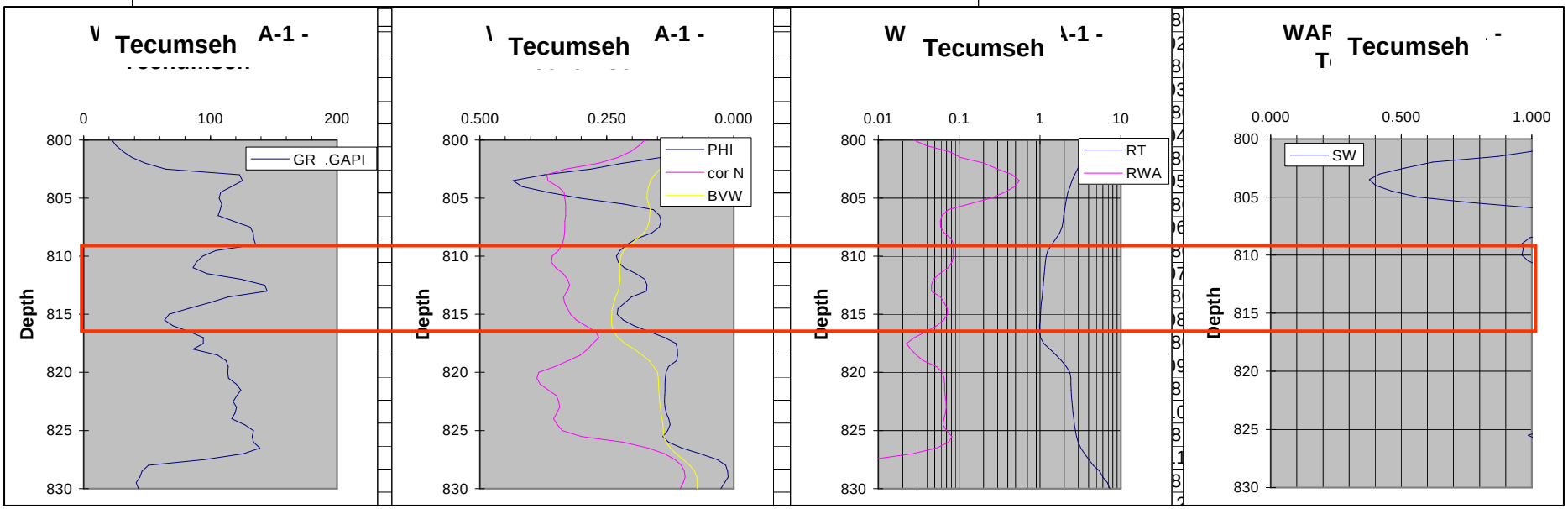
Log analysis of Severy sand in Mushrush 2-26 well.



Ward Ranch A-1

Tecumseh (808-816 ft)

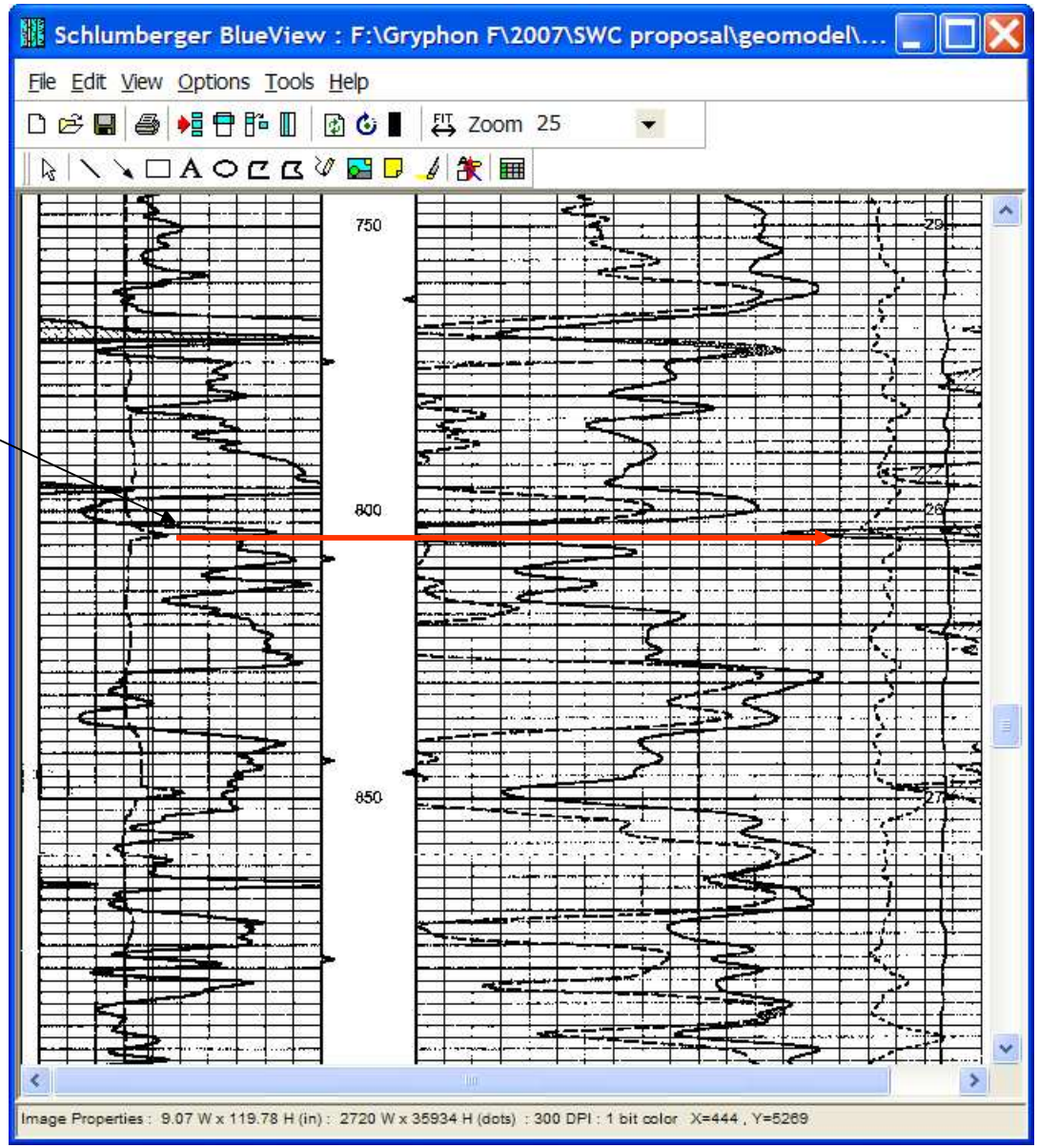
- Washout 802-806 ft – so shale (and not coal) overlies the sand
- BVW > density porosity
- **Wet sand**



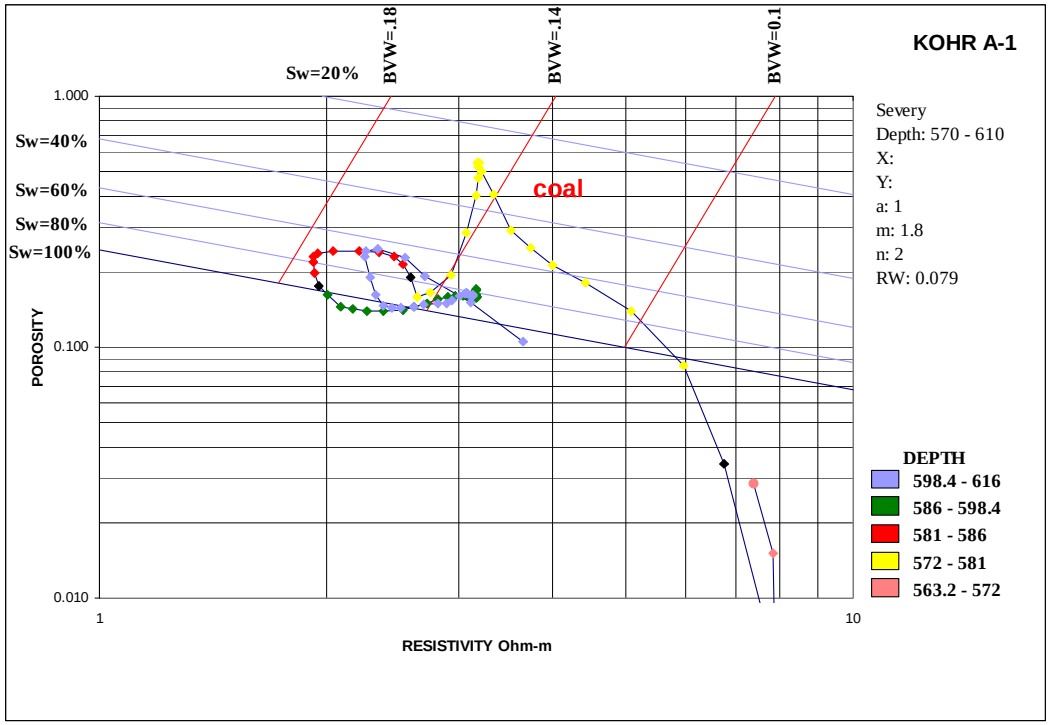
Log analysis of Tecumseh sand in Ward Ranch A1 well.

Ward Ranch A-1

• Wash out coincides with high porosity – suggestive of shale bed rather than coal.



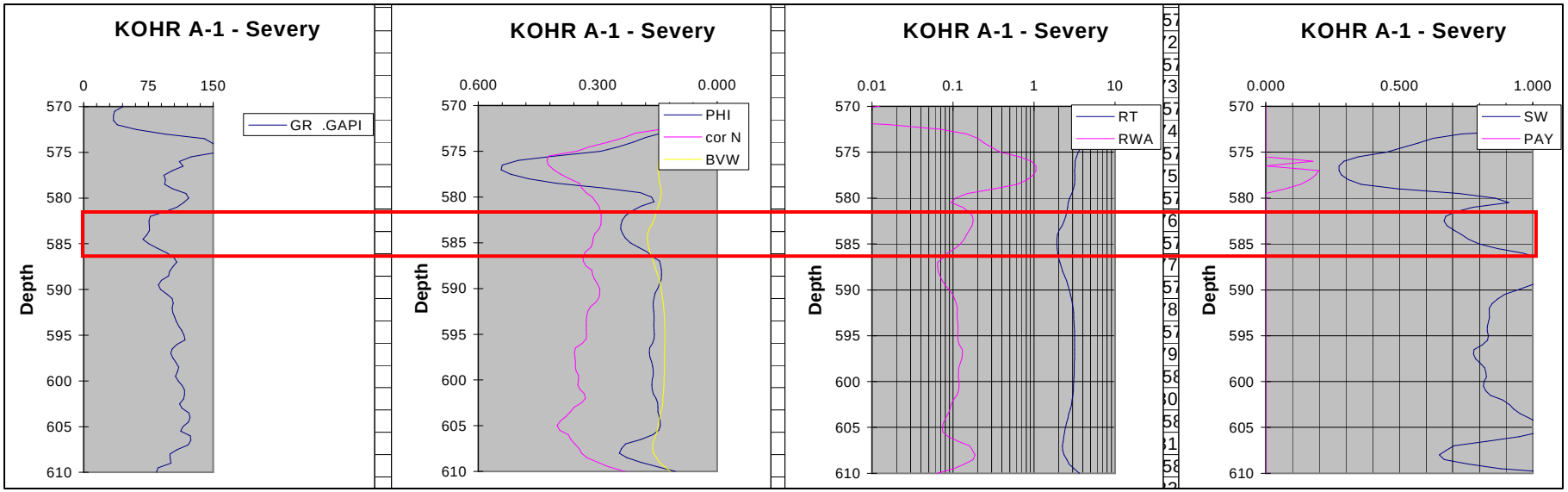
Log showing washout coincident with porosity high implying presence of shale overlying the Tecumseh sand in Ward Ranch A1 well.



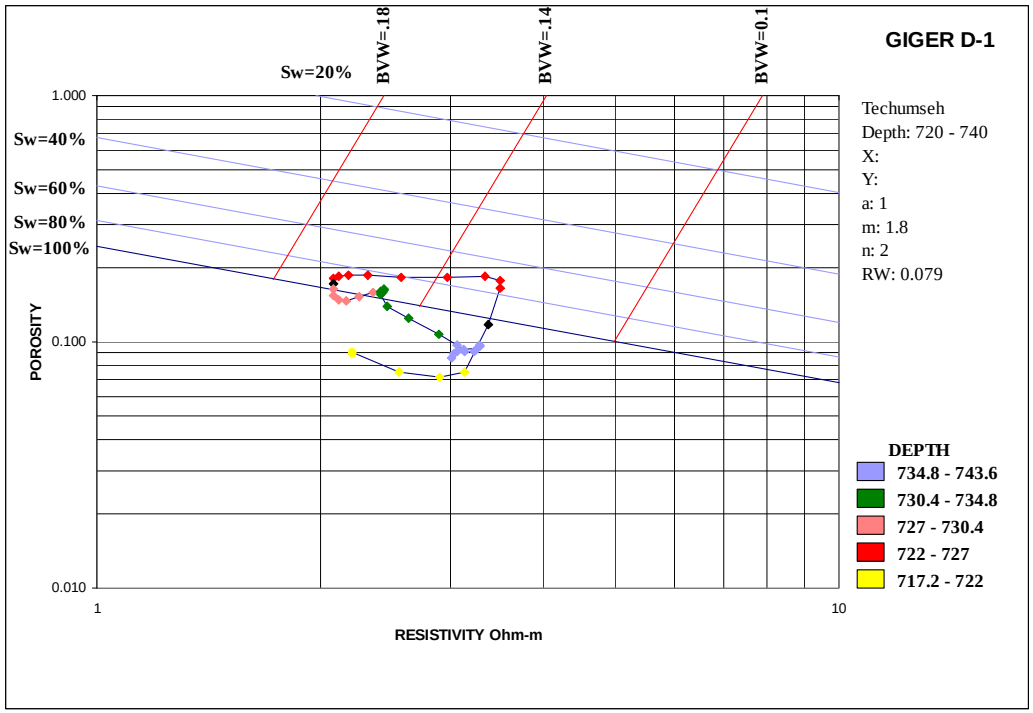
Kohr A-1

Severy (582-86 ft)

- Coal overlying sand
- Gas effect on neutron porosity, separation between density porosity and BVW
- Sw < 80% and increases with depth like BVW (> 0.145)
- **Probably gas in transition**



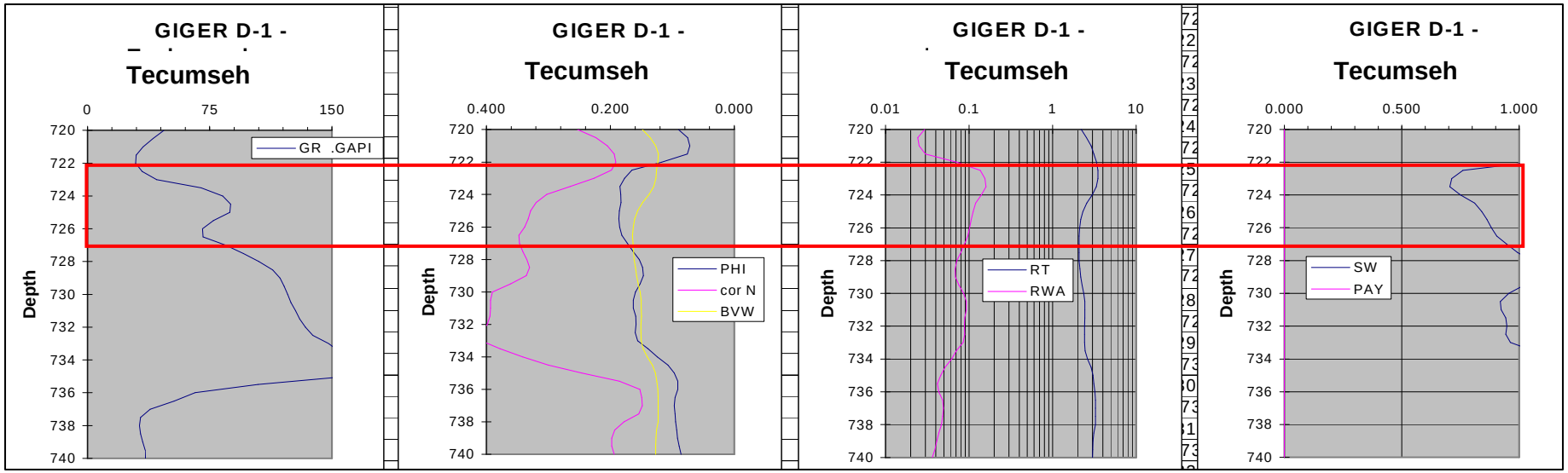
Log analysis of Severy sand in Kohr A1 well.



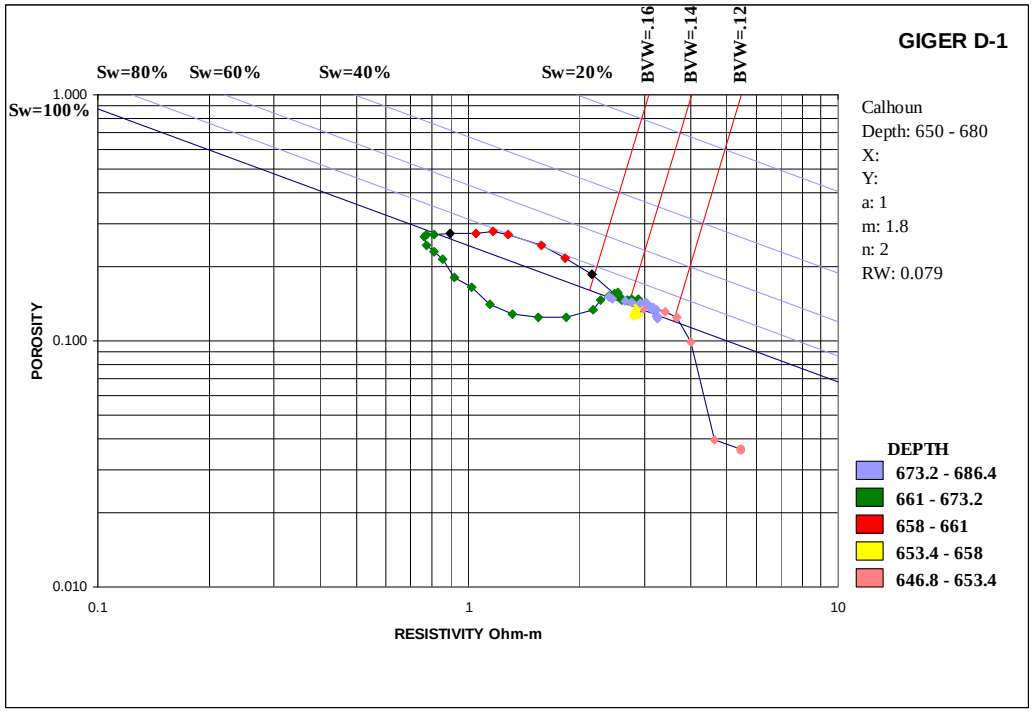
Giger D-1

Tecumseh (722-727 ft)

- BVW and Sw increase with depth
- Separation between density porosity and BVW
- **Poor prospect - gas in transition**



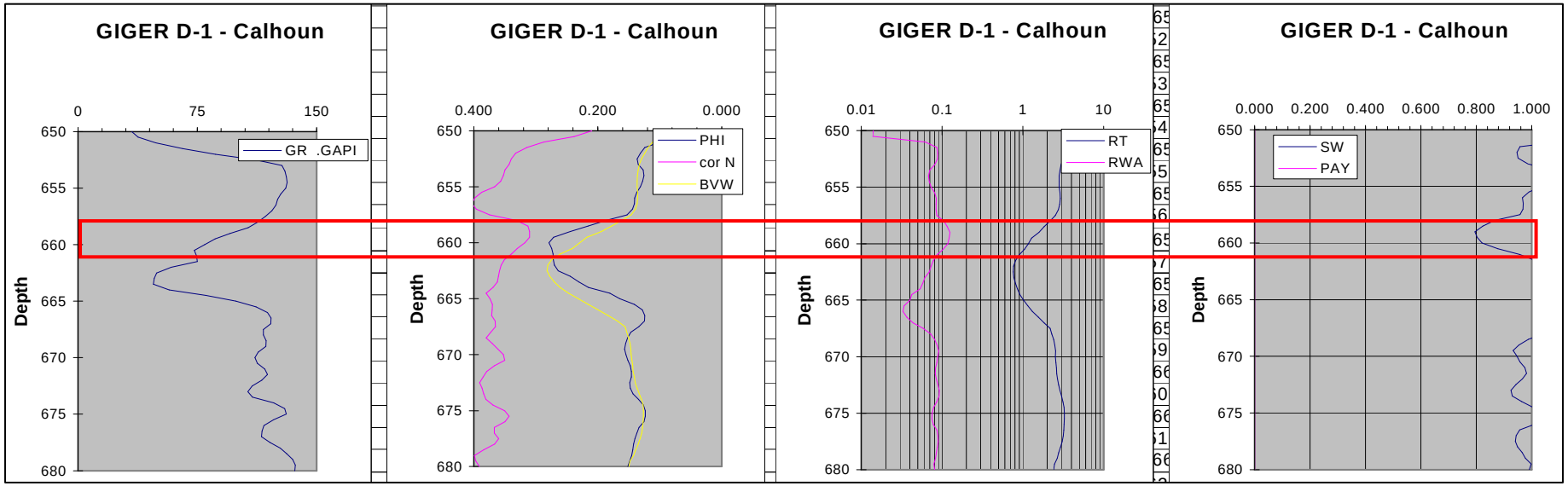
Log analysis of Tecumseh sand in Giger D1 well.



Giger D-1

Calhoun (658-661 ft)

- Gas effect on neutron density, some separation between density porosity and BVW
- Sw > 80% and increases with depth. BVW + 0.16
- **Poor prospect - Gas in transition**,



Log analysis of Calhoun sand in Giger D1 well.

CONCLUSIONS

- **Wireline logs from 26 wells in and around the Elmdale field were analyzed to determine the gas production potential of several sand bodies such as Ireland, Douglas, Tecumseh, Calhoun, Severy, and White Cloud. Gas production potential was identified in these sands at several wells.**
  - **Current log analysis indicates that each of the sand bodies show gas production potential at a limited number of wells, and that none of the sands have a pervasive gas production potential over the study area.**
  - **Additional production testing needs to be carried out at select wells to validate and refine the log analysis.**

- **Regional analyses of low-BTU data was initiated using 54 gas samples and the following trends observed:**
  - **In general, the shallower zones tend to produce low-BTU gas.**
  - **Hydrocarbon-wetness increases with age and depth of the producing zone.**
  - **Nitrogen-to-helium ratios are unaffected by the age of the pay zone.**
  - **Given the limited data set available, the deeper formations appear to display a greater compositional range hydrocarbon and non-hydrocarbon gases.**