Subsurface Techniques in Stratigraphic Analysis: The Berea Sandstone in the Williams Oil Field, Bay and Midland Co., MI; Log Correlation; Stratigraphic Cross Sections; Structure, Lithology and Facies Mapping

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Introduction

The purpose of this lab is to use computer spatial technology software (Geoplus Petra) to interpret petrophysical wire line log data and use these data for stratigraphic maps and cross sections. Using these displays you will try to make some sense of the facies and distribution of reservoir rock types in the Williams oil field of Bay and Midland Co. Michigan. You will build on the insight you have developed this semester on the Berea Sandstone in the Midwest.

Materials; Paper/analogue approach (see ***Berea lab PDF*** folder)

1. A small scale map of the Larkin-Williams oil field in Bay and Midland Co showing the distribution of wells and the nature of production.
2. Displays of all 14 wells in 5 display (8.5" x 11") panels for reference.
3. Field well location map with cross sections A-A' and B-B' indicated (see below)
4. A "log map" with small reference gamma-ray logs from the 14 wells that you will work with.
5. Four large scale base maps of the 14 study wells in the Williams portion of the field
6. Two log cross sections, north-south: A-A' and east-west: B-B' for the stratigraphic cross section/correlation section exercise

Materials, Digital Approach (see ***Berea Lab Digital*** folder)

You must have access to Geoplus Petra (*http://www.geoplus.com/html/download.html* , for demo download). The software is also available for network installation to academic institutions for a nominal fee (~$500). This is an incredible bargain for academics willing to invest some time to learning the software.

1. Bay and Midland County section and quarter-quarter section shape files
2. CSV (comma delimited ASCII text) files including the project master data base: ***berea_project.csv***
3. Williams field shape files, extracted from Michigan Department of Environmental Quality, Geological Survey Division (MDEQ-GSD) data bases showing existing logs in the field (*larkin_williams_logs.shp*) and available raster logs (from the author upon request, ~ 92Mb, zipped) in Bay county (*bay_wlliams_logs.shp*) from which digital logs were created.
4. LAS (digital well log) files for 16 wells in the field
5. Michigan state county and township shape files (from the Michigan Department of Spatial Technology, MI Geographic Data Library)
6. ASCII text files (*.txt) of digital log data from the field area

Exercise; Paper/analogue approach

1. Construct a table with the following information (refer to the log displays)

Well Name	Berea SS top (log)	KB	Berea SS top (subsea)	Sand A (upper, thickness)	Sand B (lower, thickness)

2. Label one copy of your base map with the subsea depth to the top of the Berea Sandstone. Draw a structure contour map (depth to a surface) of the top Berea. Use a yellow pencil or highlighter.
3. Note trends in gamma-ray response on the displays of the 14 wells with pure sand and pure shale cut off lines as in the previous exercise. Interpret and label grain size, CUS, FUS, Irregular Sequence (IS) trends. Use sweeping lines to the left for CUS, sweeping lines to the right for FUS, and vertical wiggly lines for IS.
4. Transfer your sweeping and wiggly lines to the two cross sections and try to correlate distinctive small scale successions. You may want to make photocopies of the cross sections to experiment with your correlations.
5. Using your insight from the previous lab AND the addition cores laid out in the lab, try to pick the most prospective (possible oil reservoir intervals) in each well in the two cross sections. Mark the perforation points with bright red dots.
6. Use one copy each of the base map to plot the stratigraphic thickness of the A sand (blue contour lines) and B sand (red contour lines; from the table you created) and construct isopach/isolith maps. These are thickness contour (rather than depth to) maps.
7. Make a brief statement on the possible depositional environment for the Berea in the Williams field on the basis of the information you have. This includes regional information, core data, vertical sequence trends, geometry, and scale.

Exercise; Digital approach

1. Using Petra, create a project from the *berea_project.csv* file.
2. Import petrophysical well log data (LAS batch is the easiest, ASCII txt file is the hardest, ASCII CSV files are better but slow).
3. Use Petra's Thematic Mapper module to import MI county and township shape files as overlays into the Berea project. Keep these in one (new) layer file.
4. Use Petra's Thematic Mapper module to import Bay and Midland county section shape files as layers in the Berea project. Keep these in one (new) layer file.
5. Use Petra's Thematic Mapper module to import Bay and Midland county quarter-quarter section shape files as layers in the Berea project. Keep these in one (new) layer file.
6. Create a map of the oil field using the mapping module. Fiddle with the formatting of the land grid files in the *Overlays* pull down menu, *Preferences and Layers*
7. In the *wells* pull down menu, chose *highlight wells*, *by data criteria* and *logs data*, identify those wells with *any curves at all*.
8. Create well to well cross sections in the mapping module from the *Cross Section* pull down or *Cross Section Icon*.
9. Use the *Logs* pull down (or *select logs and scales* icon) to set up log display. This will take some fiddling. Go through each *select logs and scales* tab and set up the log display to configure scales, style (including *cutoffs*), tracks (*widths* and *track label ht*).
10. Create formation tops in the *Correlation tool bar* (make sure that this tool bar is available through *Tops* pull down, *correlation tool bar*) for top Berea SST, top Transgressive sand, Base Transgressive Sand, Top "B" Sand, Base "B" Sand, Top "A" Sand, Base "A" Sand.
11. You can create both structural and stratigraphic cross sections.
12. Return to Mapping module and select wells for gridding from *Wells*, *Select Wells by Data*, *Select Wells by Tops*
13. Gridding is a complex business, we will just use defaults to create a structure contour grid ("depth to" grid) from the top Berea Sandstone Fm top; *Contours* pull down, *Create Grid*. The defaults set you up to create the grid and save the file.
14. Display the grid just created using *Contours* pull down, *Display Contours*
15. I have provided isopach data (on the basis of "tops picks") in the zones area of the Main Module. This should normally be done by the investigator. This data ("thickness" rather than "depth to") is available for the logged wells only. In Mapping Module you must *Select Wells*, from the *Wells* pull down to select wells by data criteria (as before).
16. Create isopach Grids as above from *Zone Data* area
17. Display Isopach Grid Contour maps.
18. Pick the most appropriate perforation points in each of the logged wells in the project.
19. Try to explain the depositional setting and the stratal geometry of the "A" and "B" Sands in terms of a depositional model

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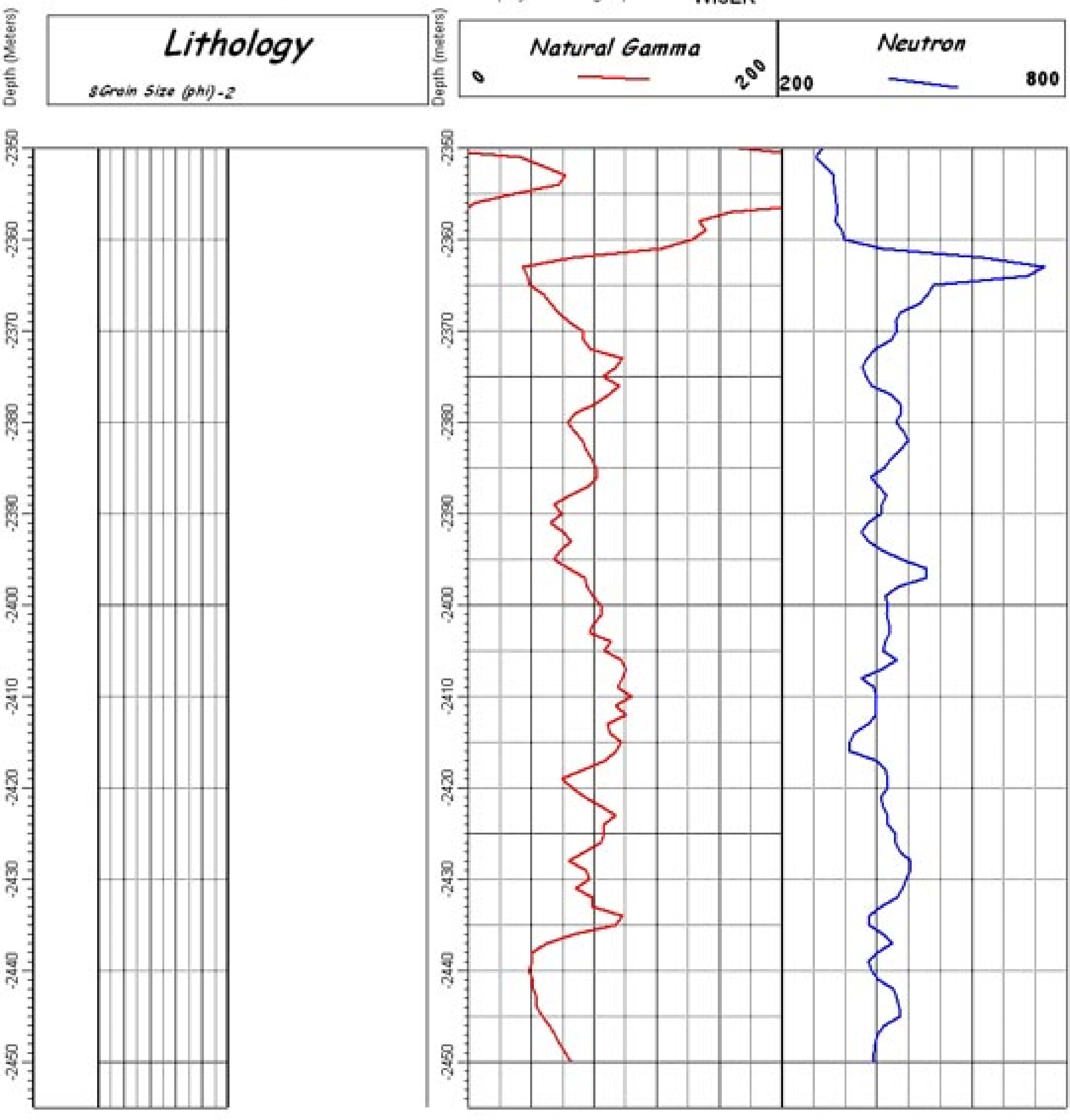
Log ID: **Wiser - Retzloff 1-31 (21017357180000)**

Total Depth:	-2201 TO -2487	Elevation (Ground Surface):	NA
Location:	6-14N-3E BAY, CO. MI	Drilling Date:	1980
Latitude:	43N	Drilled By:	WIXEY
Longitude:	80W	Lithology Logged By:	NA
Hole Diameter:	NA	Geophysical Log Operator:	WISER



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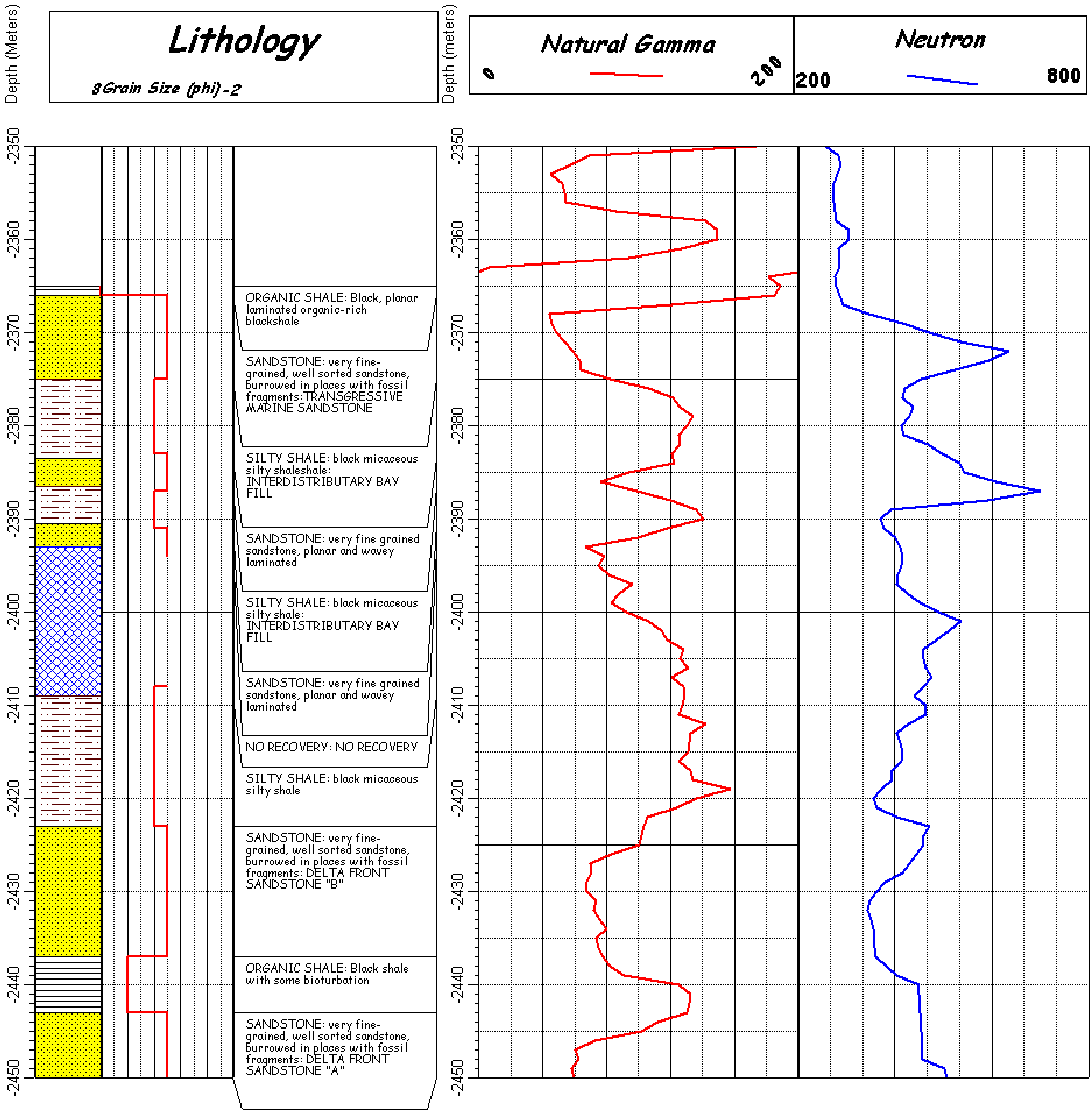
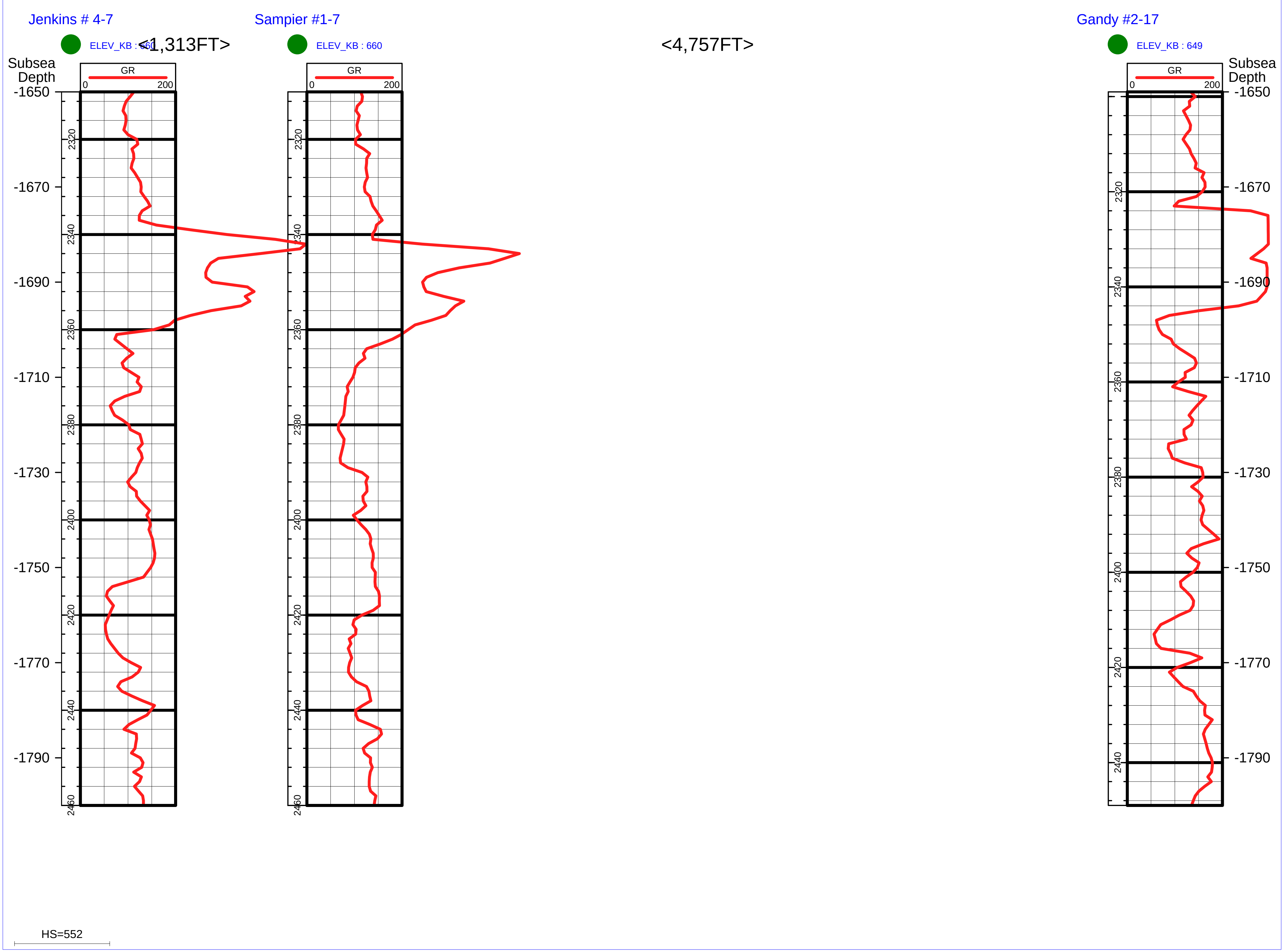
Log ID: **Wiser - Retzloff 2-31 (21017357180000)**

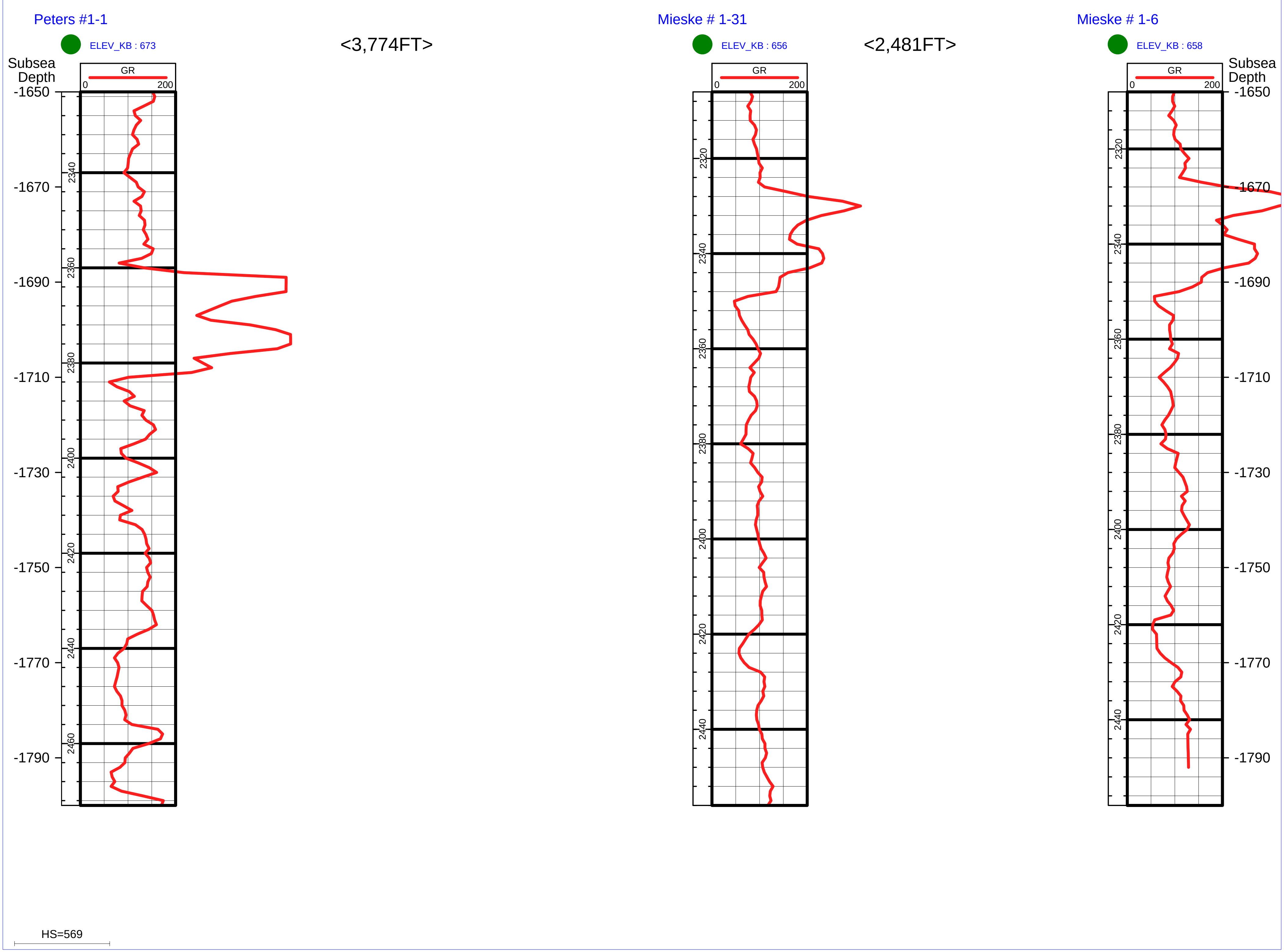
Total Depth:	-2201 TO -2487	Elevation (Ground Surface):	ELEVATION
Location:	6-14N-3E BAY, CO. MI	Drilling Date:	1980
Latitude:	43N	Drilled By:	AKIN WIXEY
Longitude:	80W	Lithology Logged By:	BALTHAZAR
Hole Diameter:	VARIABLE	Geophysical Log Operator:	WISER



Berea log correlation & mapping Section 1



Berea log correlation & mapping Section 2



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Berea log correlation & mapping Section 3

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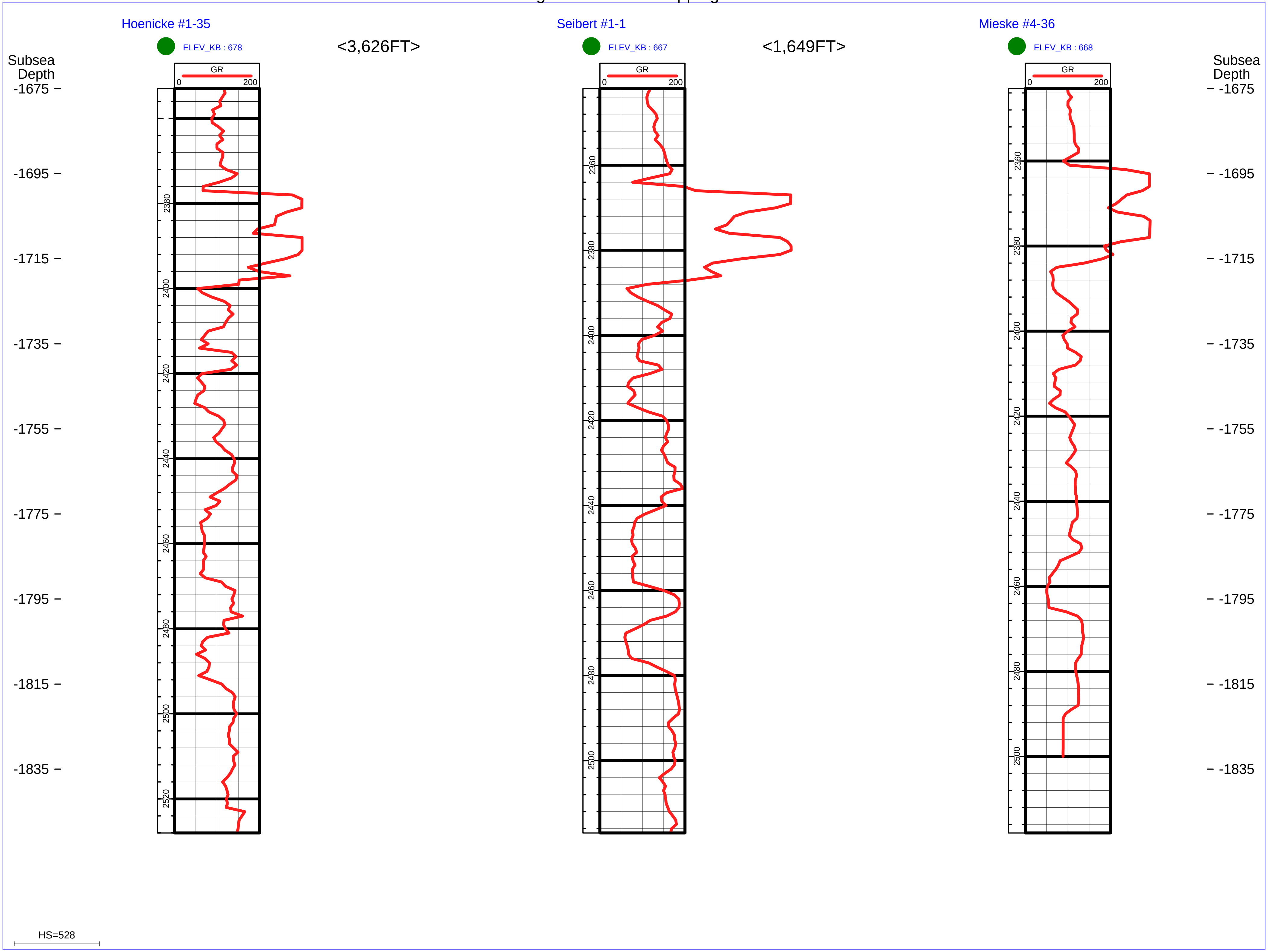
Berea log correlation & mapping Section 4



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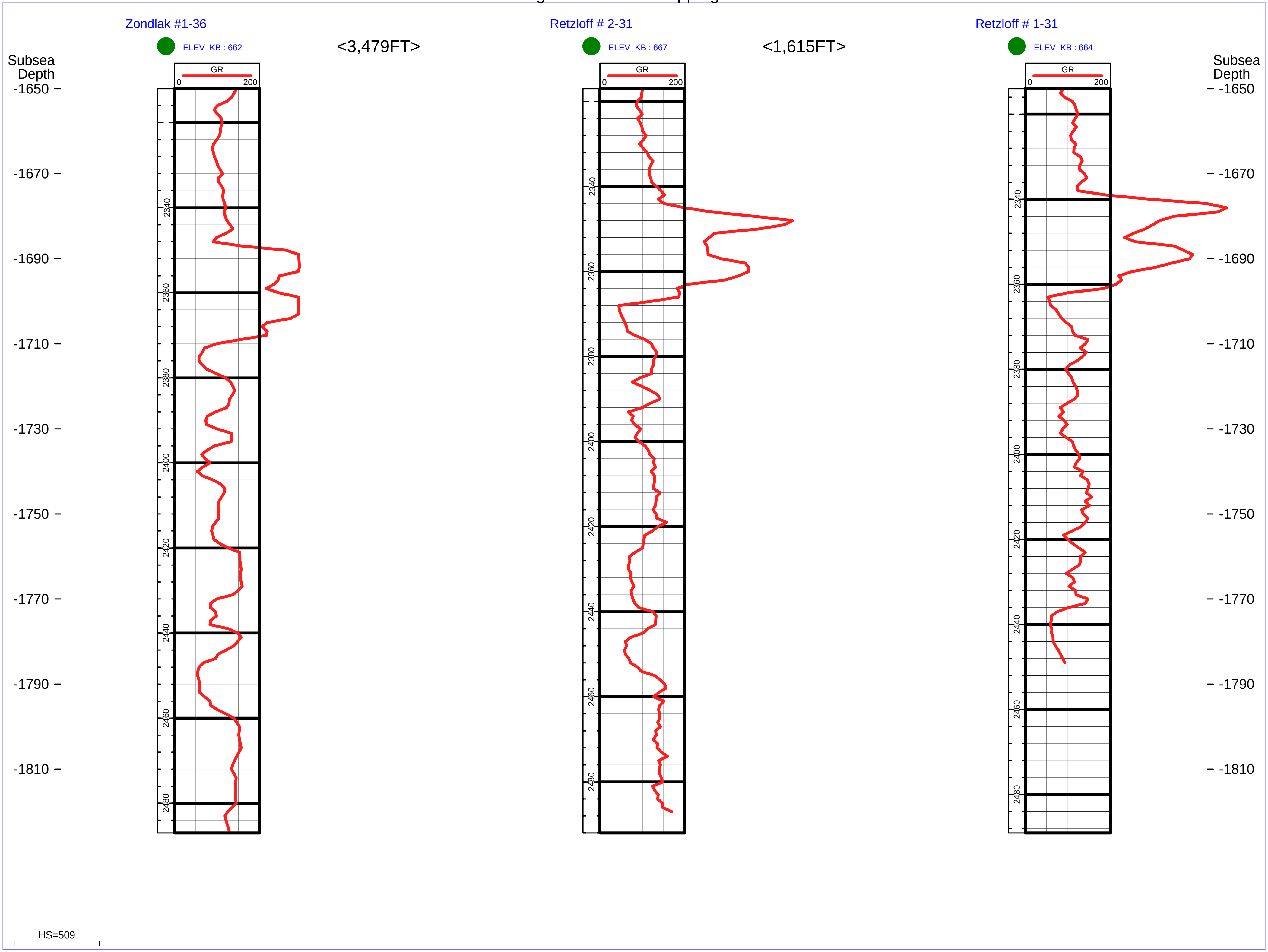
Berea log correlation & mapping Section 5



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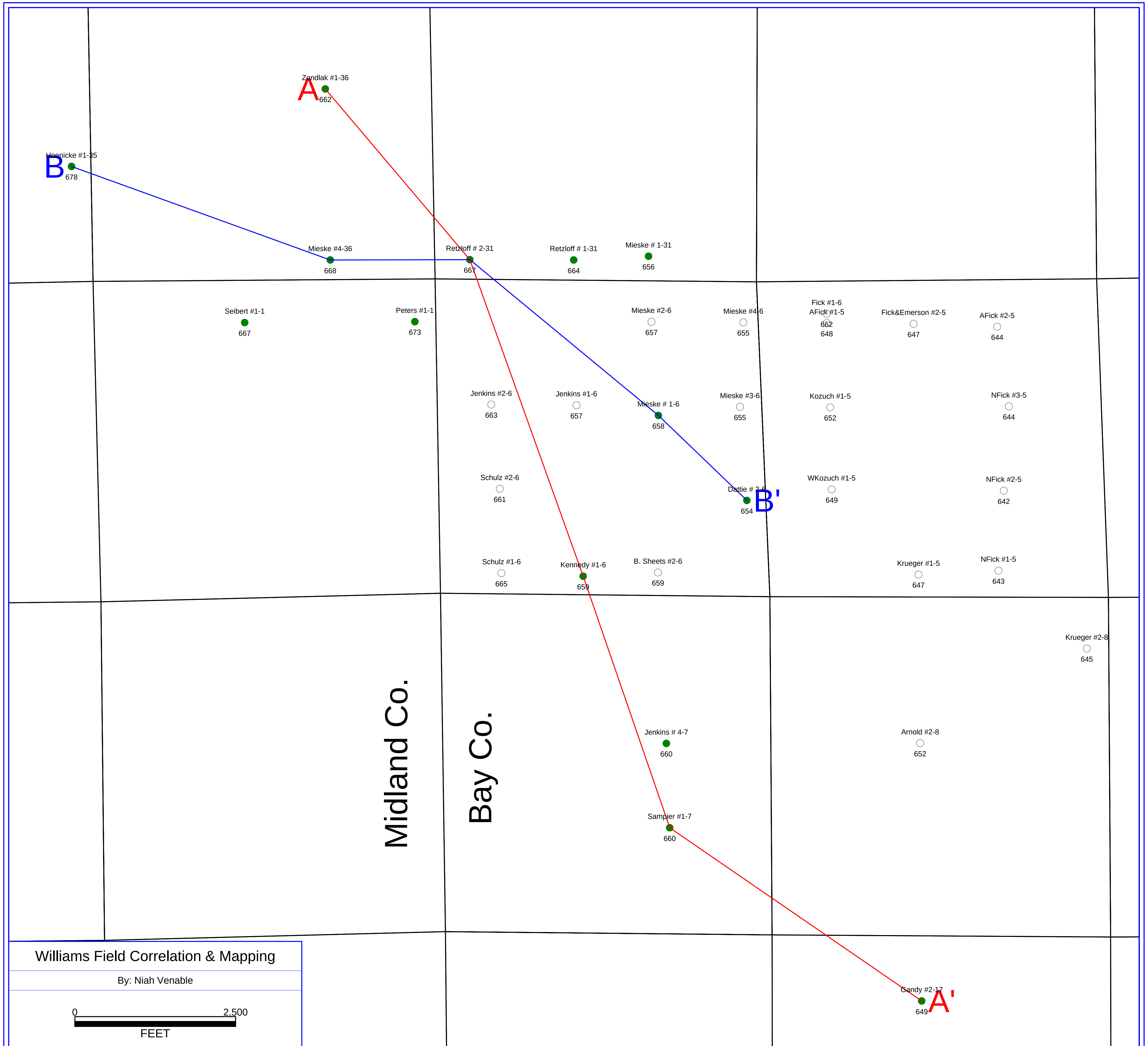

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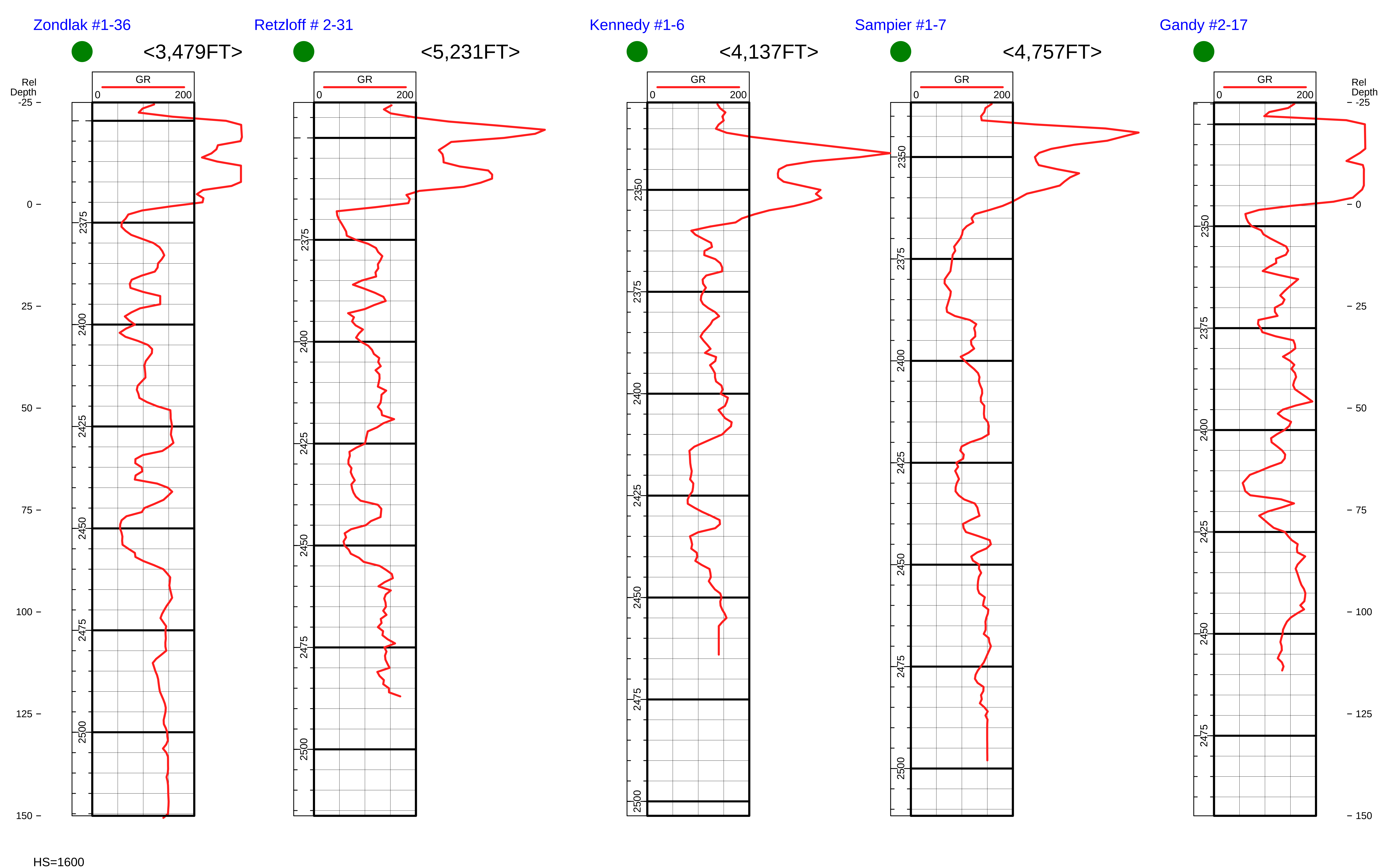
Berea log correlation & mapping Section A - A'



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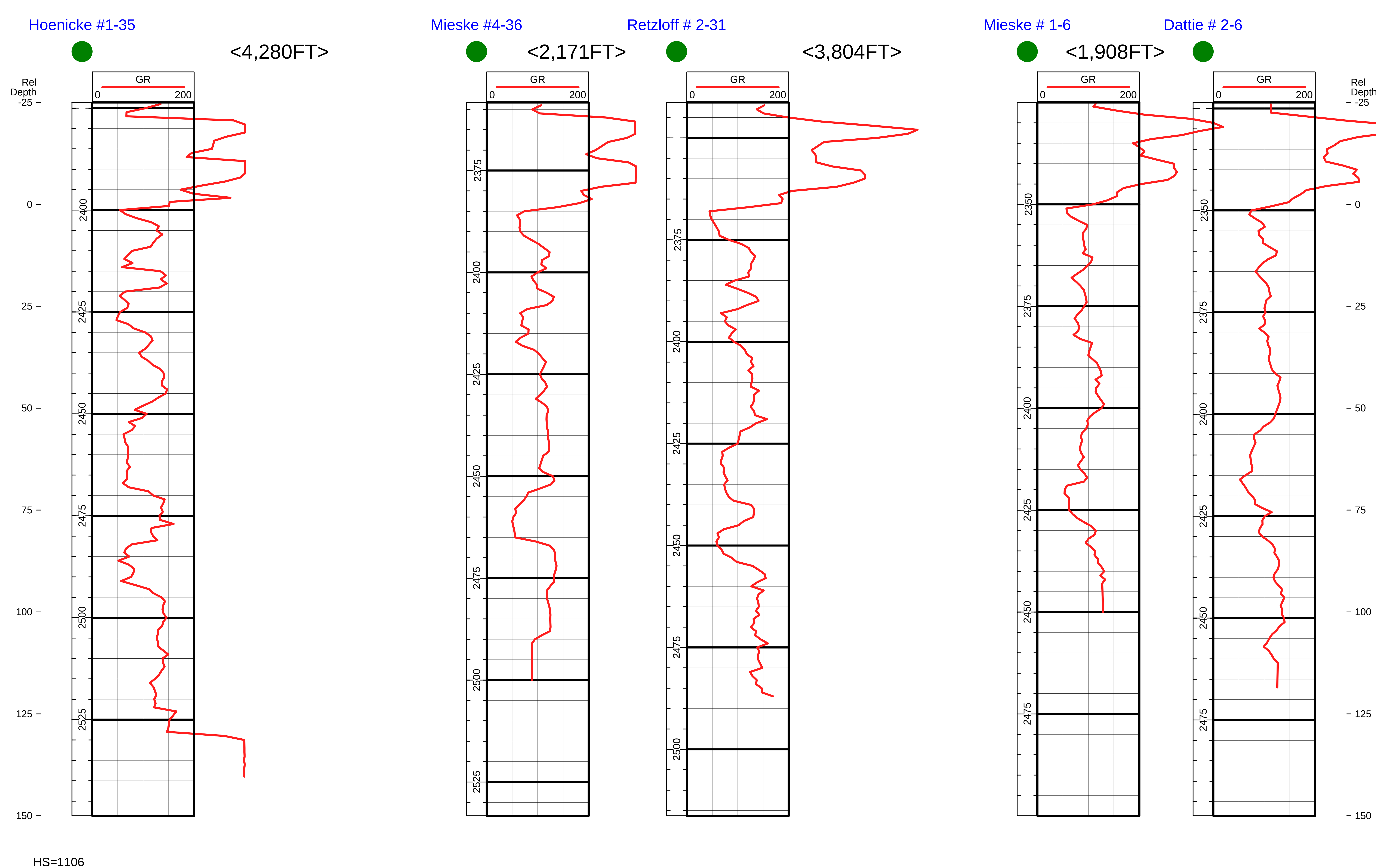
Berea log correlation & mapping Section B - B'



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