

Log Quality Control An Integral Part of A Super Interpretation

Montney example illustrates
methodology

Log review by Robert V Everett Petrophysics, Inc.

Java Programming by Jamie Everett

Review by Mike Berhane, AER, PDHC Users Group & Ramona Jones, BA

*Special Thanks to Drs. Susan and Michael Herron,
Dr. Eric Eslinger, Dr. Tristan Euzen*

Outline

- There are excellent resources for Log Quality control of new wells. Example is the book by P. Theys. (otheys@aol.com)
- There are few examples of “here is an LAS; interpret it; by the way, check the logs first.”
- The summary presented provides the know-how to check the logs first.

Application: everywhere

Start of report

Check your data

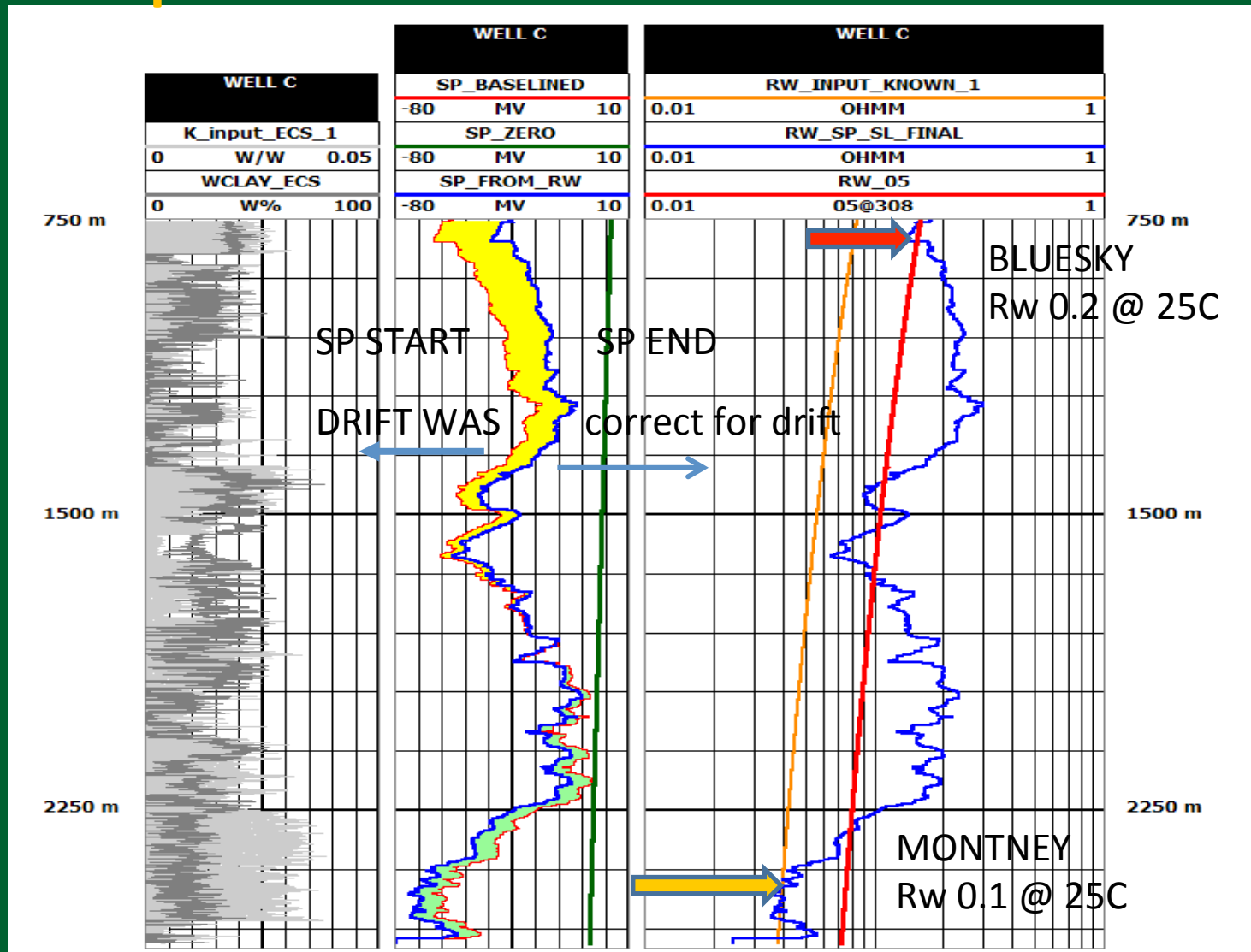
- Check your logs
 - Quad-combo-NMR
 - Use formation factor logs: $F = 1/\text{porosity}^m$
 - Do they fall in envelope ?
 - Elements – use sand classification (QA to Sh)
 - Aluminum, silicon, calcium, iron & sulphur
 - Agree with geology?
 - Pe from elements : match PEFZ from logs?
 - Grain density from elements : match mineral grain density and RCA grain density ?
 - Perm from elements : match perm from core ?

Check LOG DATA: F_LOG

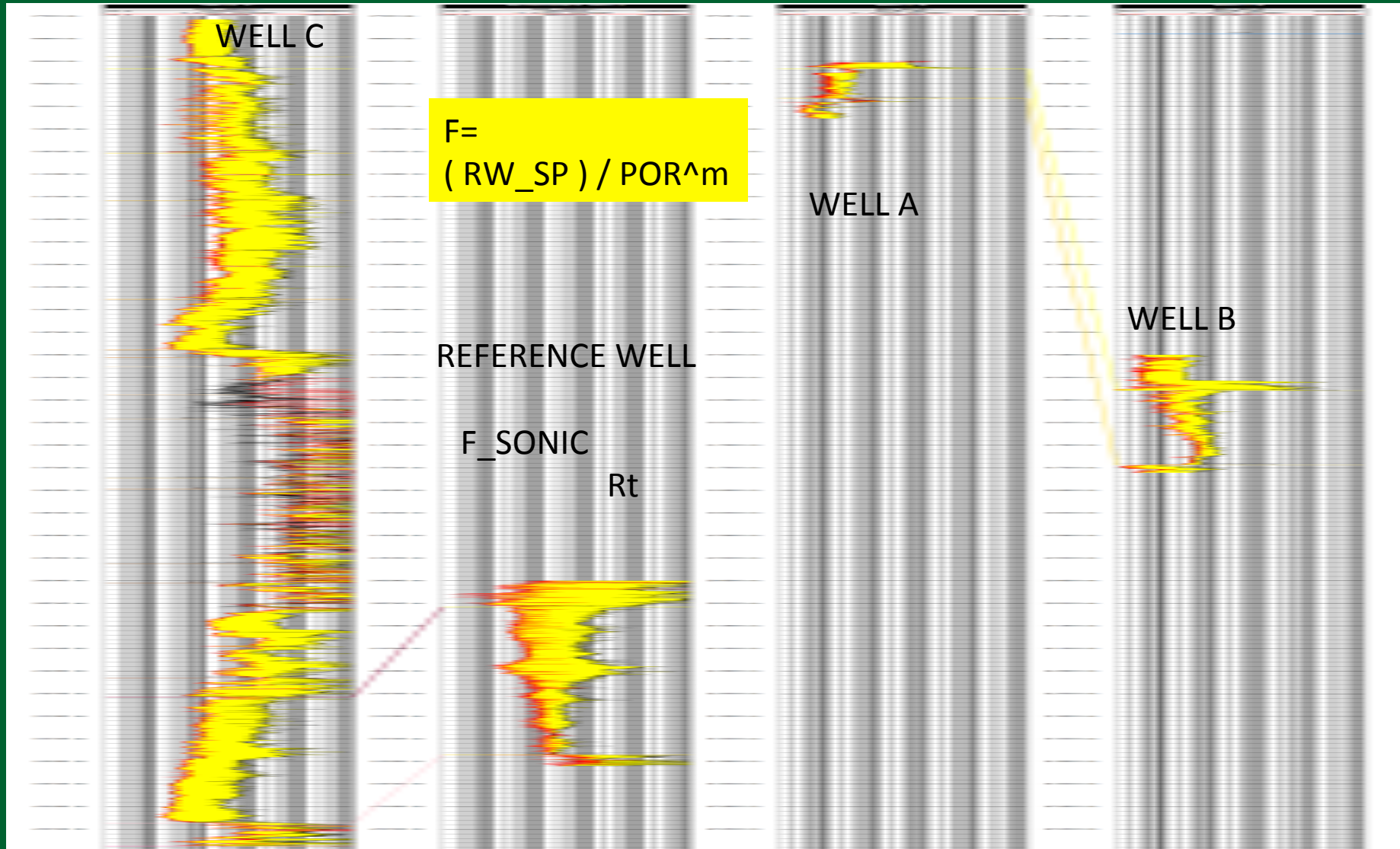
$$(F * R_w = (R_w_SP / \text{por}^{\wedge} m_zero) = F_Log)$$

- All total porosity data must fit between F_sonic & Rt
 - F_Density porosity
 - F_Neutron porosity
- Except when not a total porosity measurement
 - F_TCMR
 - F_CMRP_3ms

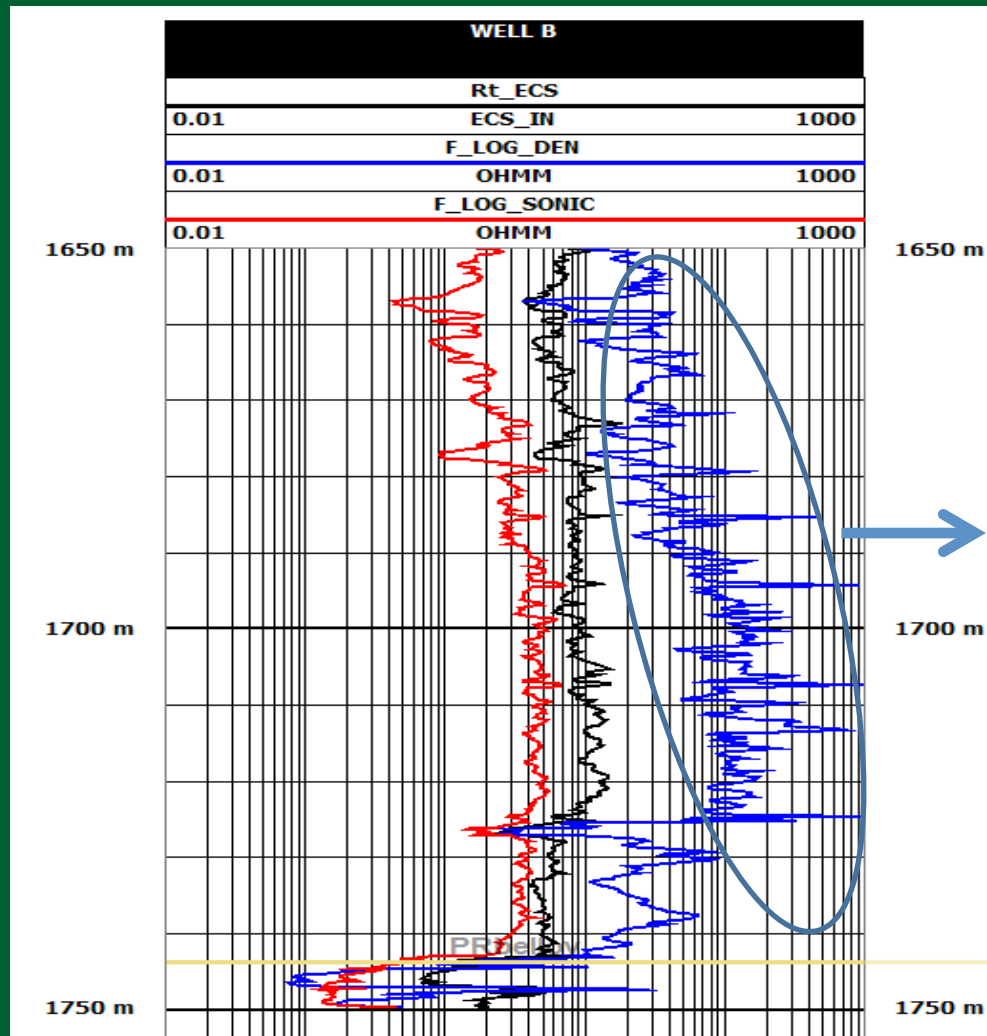
Step one LQC – Use SP for Rw



Step two - Check LOG DATA: F-LOG



LQC – Comparison, F-density & Rt



$$F\text{-den} = (1 / DPHI^{m_zero}) * R_{w_SP}$$

Where m_zero

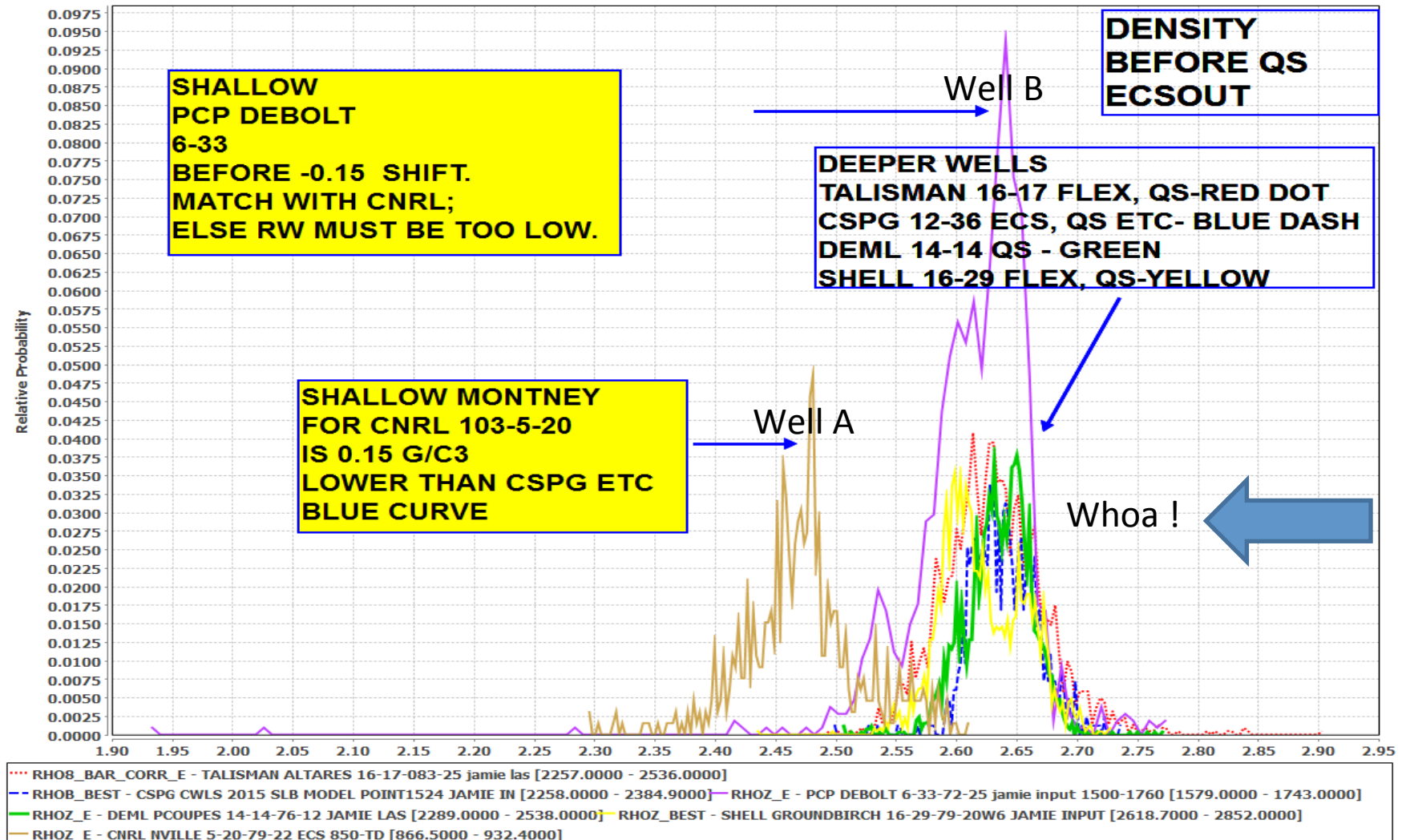
Auto-calculated from surface area
& grain density of minerals

MIS-CALIBRATED DENSITY

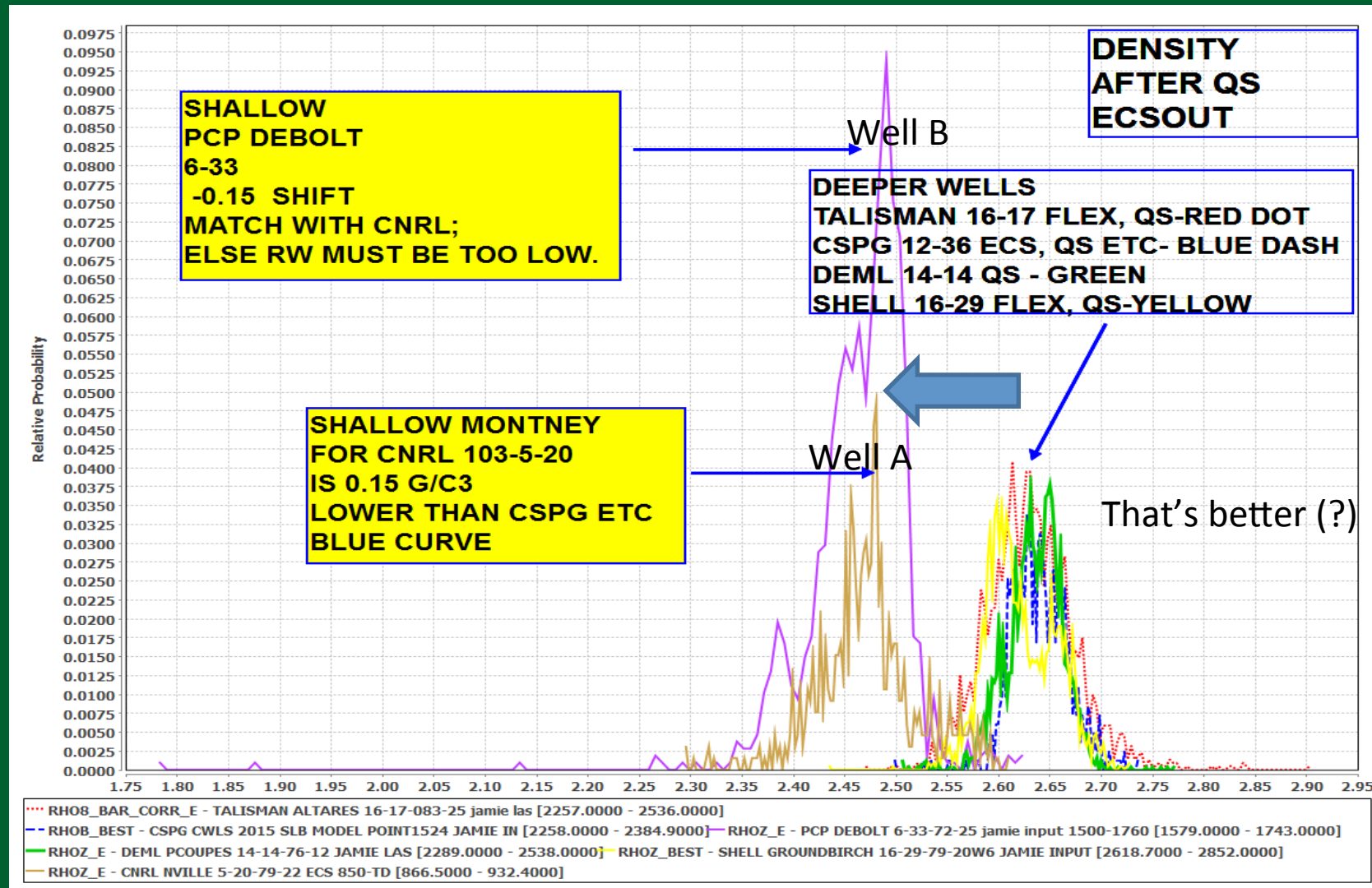
F-density CANNOT BE > Rt, PHYSICALLY.

Therefore, Surface area, Rhog, Rhob or
Rw is/are wrong

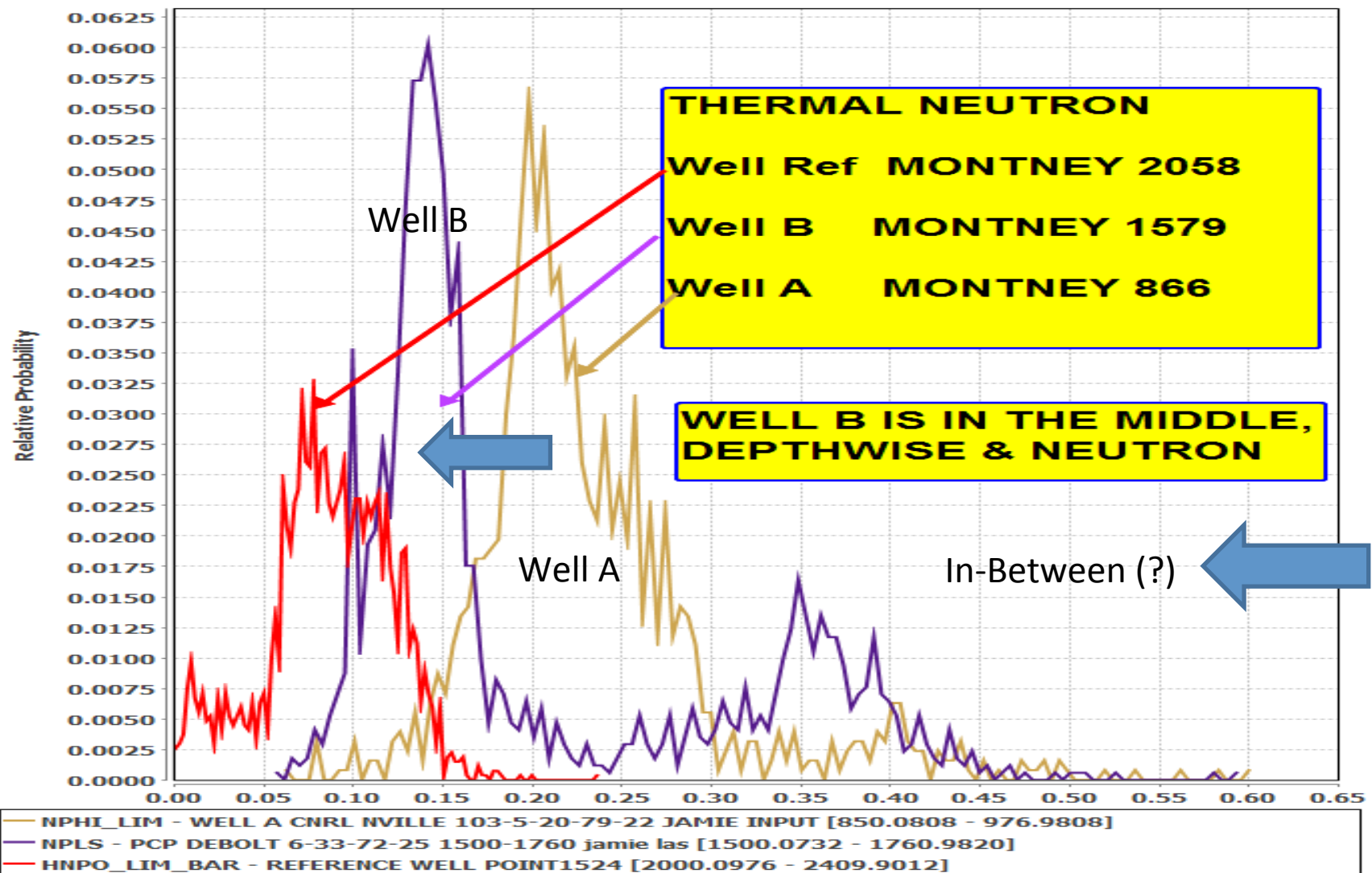
Do some frequency plots: Density



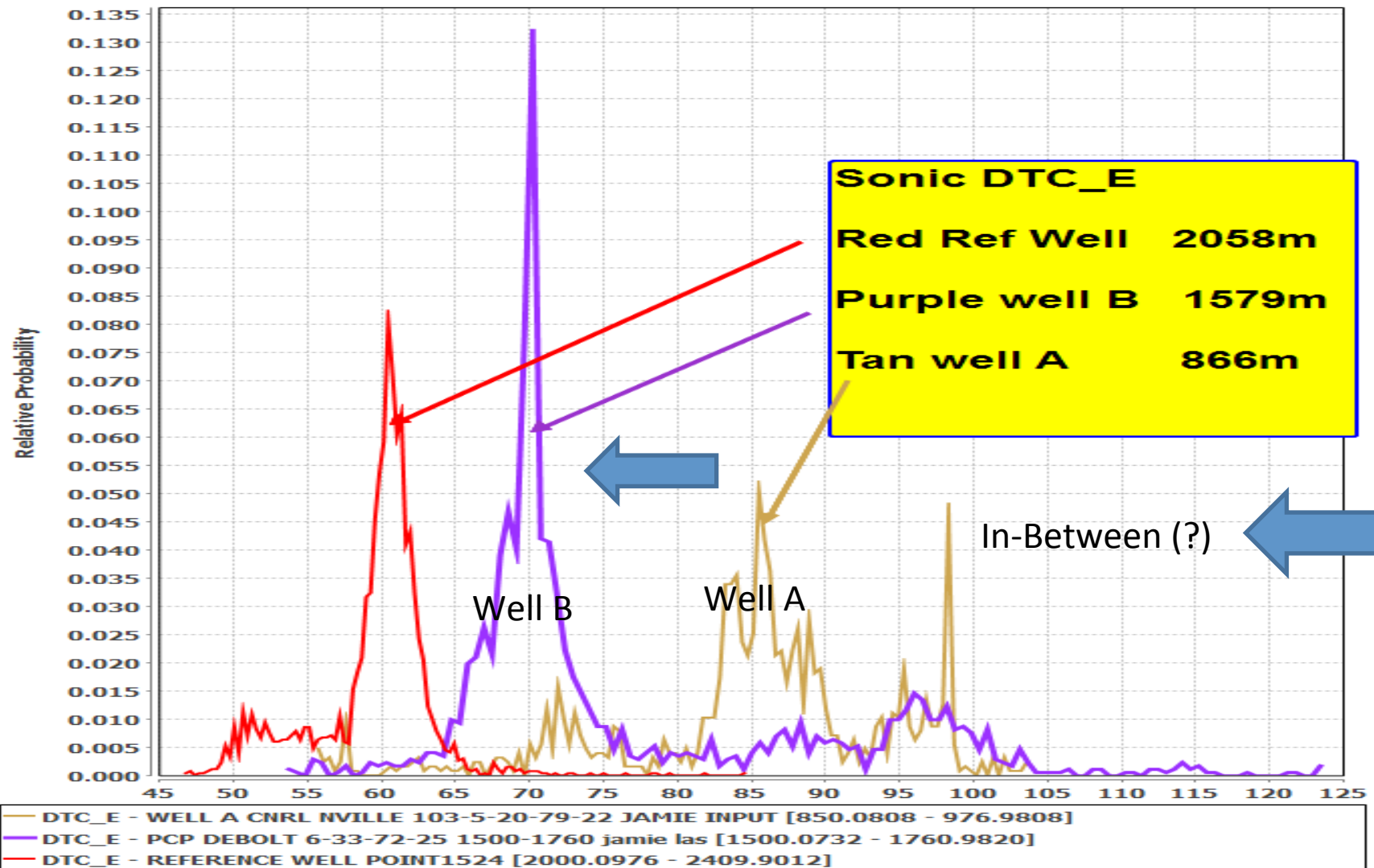
Frequency plots: provide density shift



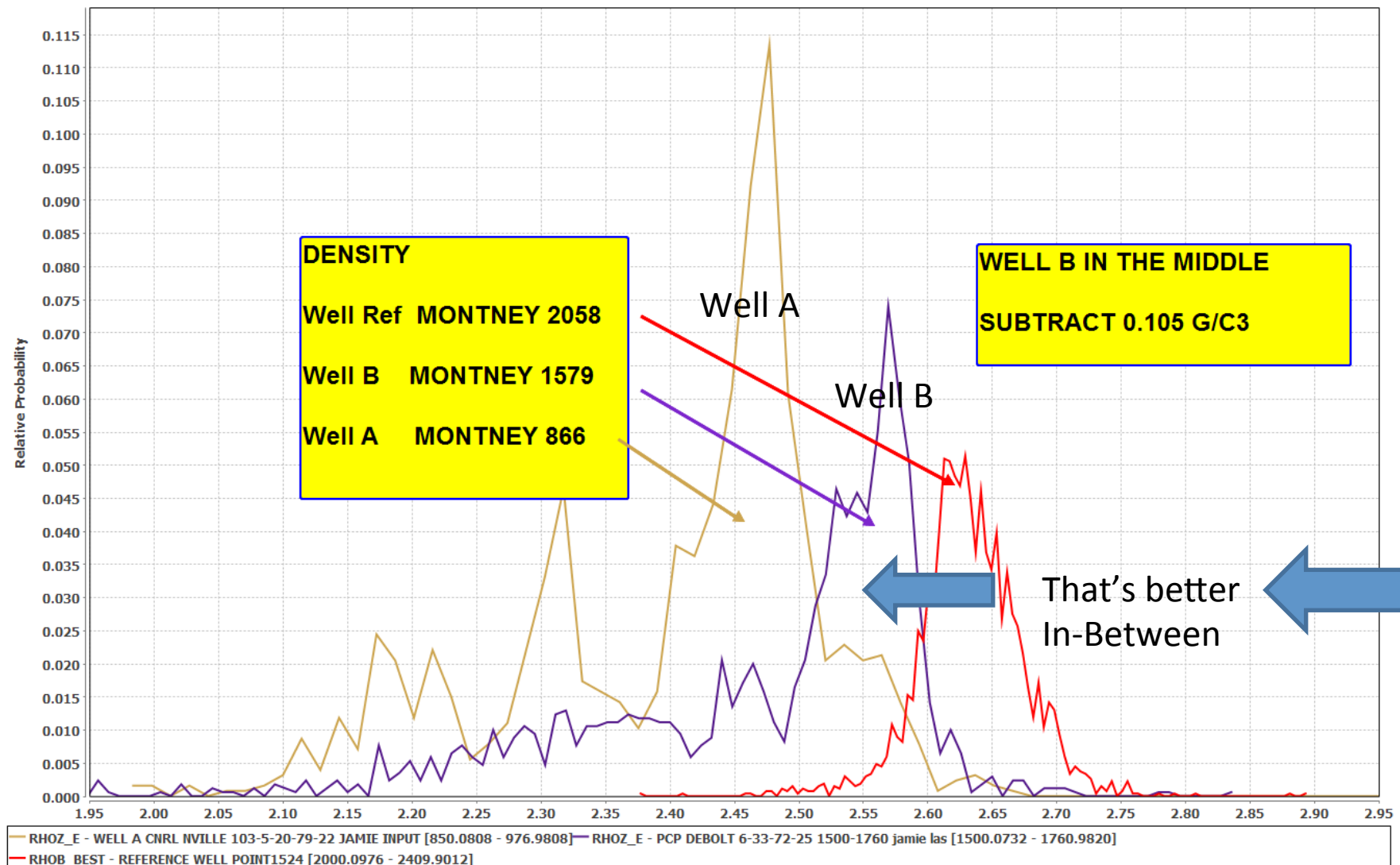
Frequency plots: Neutron



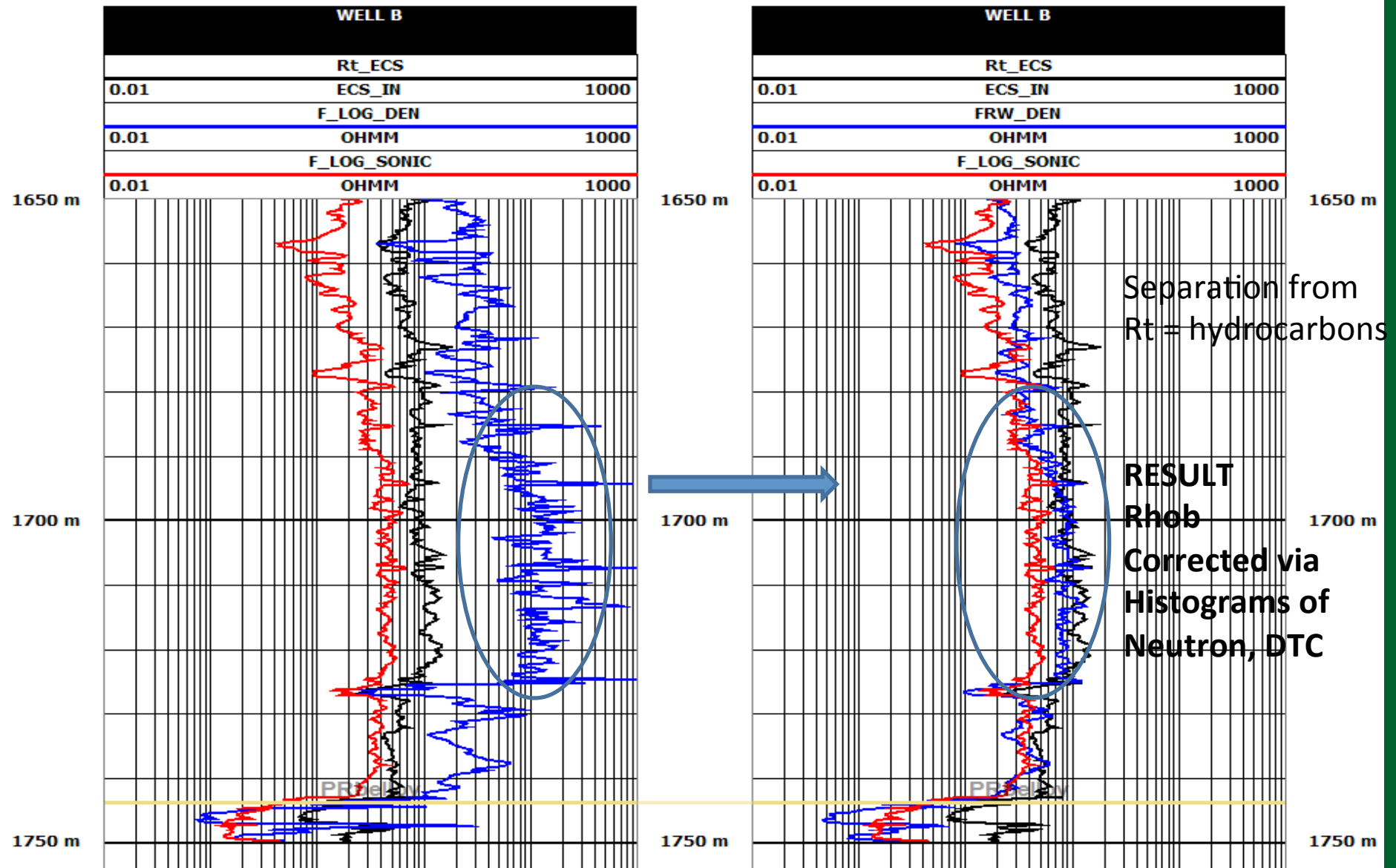
Frequency plots: sonic DTC



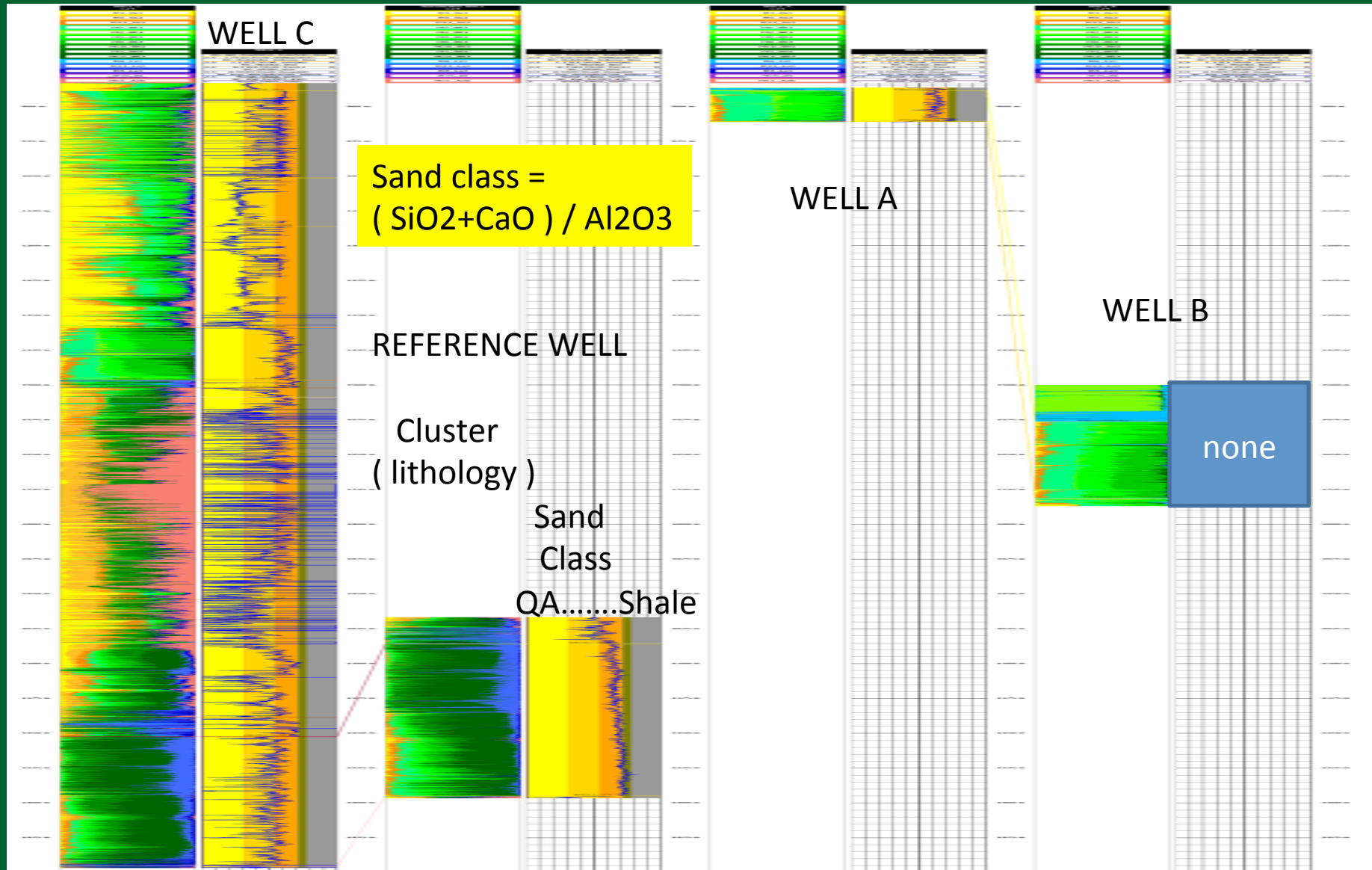
Frequency plots: provide density shift



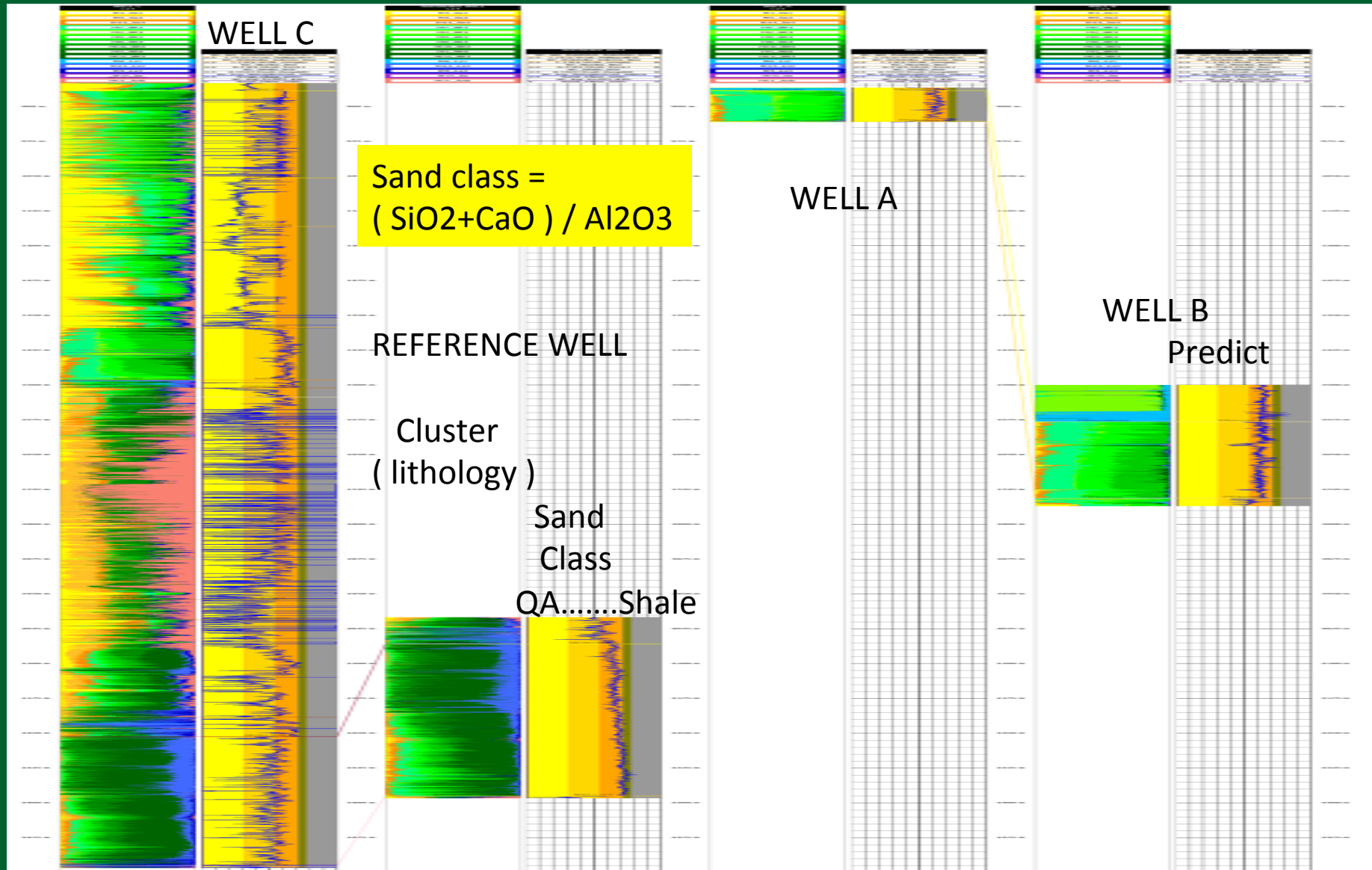
LQC – Result of check F-density



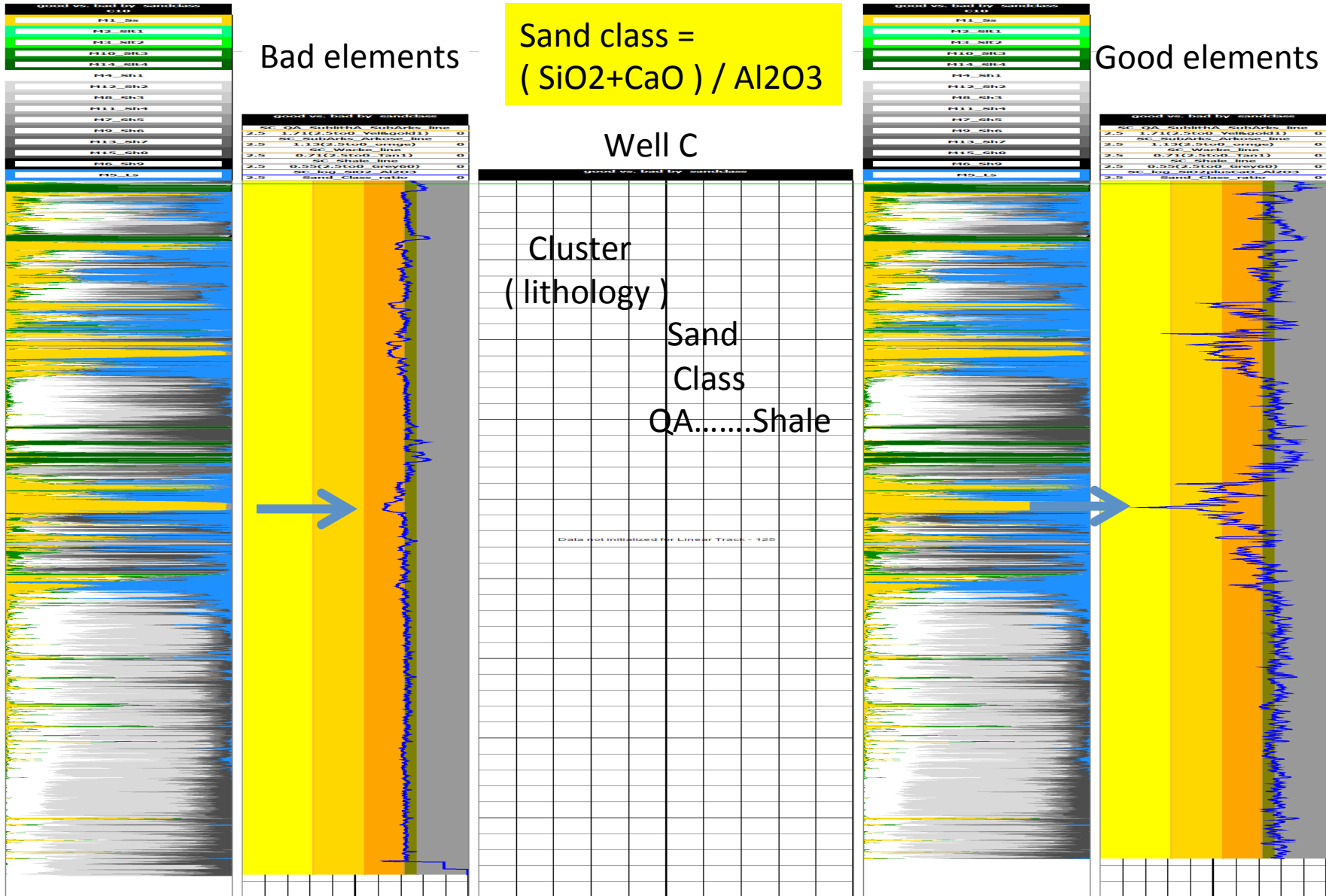
Check elements: Sand Class = Geology ?



Check elements: Sand Class = Geology ?



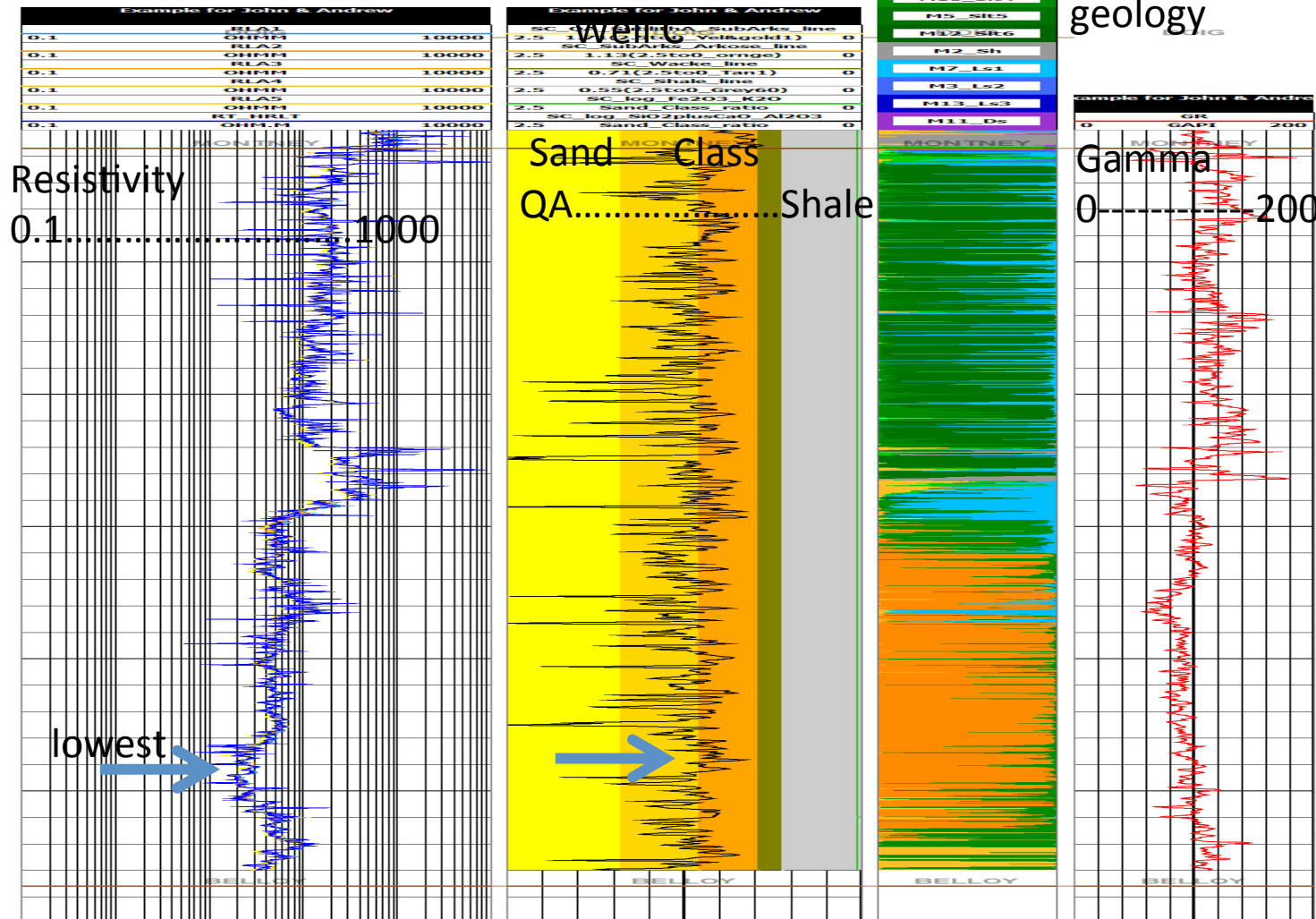
Example elements: Sand Class = Geology ?



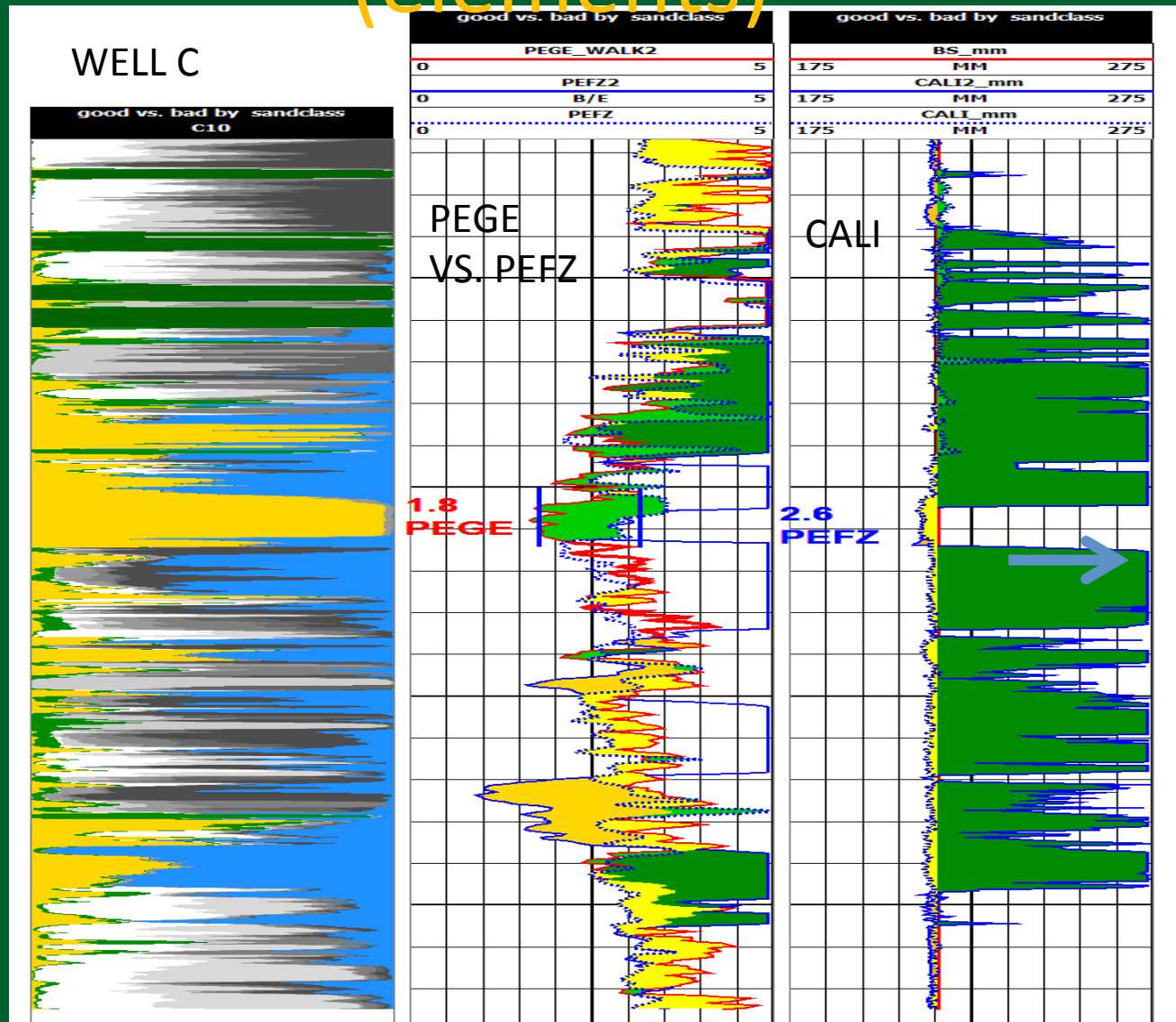
Elements: Sand Class = Geology ?

Sand class =
(SiO₂+CaO) / Al₂O₃

Good elements:
Sand Class fits
geology



Check LOG DATA: PEFZ vs. PEGE (elements)



That's it for Quick Look Quality Control

The logs are now calibrated and there are hydrocarbons

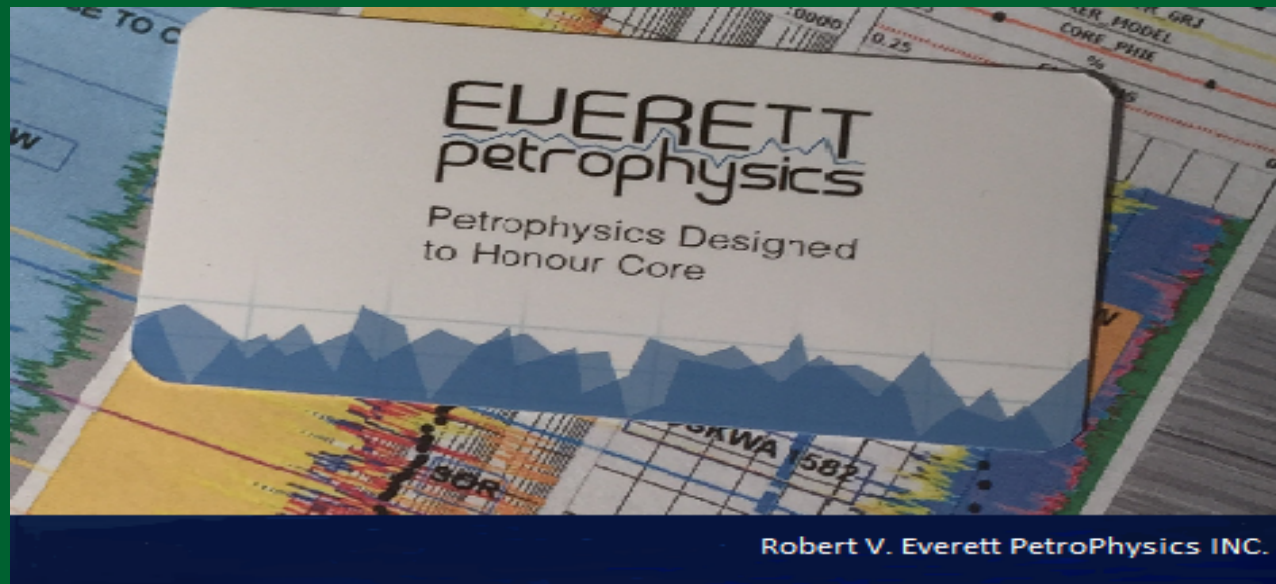
Continue with DETAILED 'Full ECS' interpretation
(but that is another story)

Summary and Conclusions

- There are excellent resources for Log Quality control. Example is the book by expert P. Theys.
- There are few examples of “here is an LAS; interpret it; by the way, check the logs first”
- The summary presented provides the know-how to check the logs first.

Application: everywhere

End of report



Our contact info. To be used in 2018 when the oil price comes back....☺

250-442-9696 Bob's cel

403-620-2403 Jamie's cel

Abstract

- ABSTRACT for 'A Super Log Interpretation Program Designed to Honour Core' from which the LQC was presented as the first part.
- We have unique, focussed, log interpretation program developed to:
 - Use one program for all lithologies to obtain Sw, porosity, perm, net pay, net to gross.
 - Use elements to describe lithology and interpret mineralogy: sandstone, carbonate, shale, and everything in between.
 - Use the SP to propagate Rw from one known-Rw zone to all zones in the well.
- Inputs: resistivity, sonic, dipmeter imager, density, neutron, gamma ray, free fluid, TCMR, T2LM, elements, SP, and Rw (for one interval).
- If missing any input curves, predict from offset well before entering computation program (including the SP).
- There are two related programs 1) Petrophysics Designed to Honour Core (PDHC) and 2) Element to Mineral program (ELM). One can use either or both. We usually start with PDHC and if necessary to fit core, use ELM.
- Calibrate computation output to core, when available, using revised input parameters. If much core, use it to generate core to lithology to mineralogy automatically using element to mineral program (ELM). If little core, run without core, make a dummy fake core and run using ELM to see if both methods agree.
- Both programs evolved from Excel programs which became too large to manage until they were converted to JAVA code. The PDHC, relies on a master Excel program. Required changes are input to this Master program and then easily converted to Java code: Excel can be used to experiment and develop ideas and it then can be turned into a more efficient Java program "semi-automatically". Any program you want to use can be converted in this manner. Rather than a user developing script just for a special equation, the entire Java program can be changed after the user has made few or many changes in Excel.
- Normally, changes to the PDHC program are implemented in a day to a week and then tested to ensure they really do what we want. For the ELM, Eric Eslinger maintains it via the Geological Analysis using Maximum Likelihood Systems. Since ELM is part of a huge system of programs, changes are continuously evolving and take longer to see results.
- We input parameters for pay, reserves, mineralogy from elements via an input list that is either a constant or is zonable, as required. The program, PDHC, is continuously evolving to meet our and customer requirements. Bob Everett, the originator with input from all of his friends, has a personal programmer, his son, Jamie, who makes use of his Masters in Biomedical Engineering program knowledge. Together log interpretation is straightforward, upgradable and wonderfully easier than any other method that Bob has used ☺
- The presentation illustrates how the programs are applied to minimize logging expense in new wells.

Biography

- **Biography, Bob Everett**
- Robert (Bob) Everett is the owner of Robert V Everett Petrophysics Inc. Bob works from his office in Merville, BC (Vancouver Island). He also works as a consultant for Eric Geoscience, using probabilistic interpretation methods. When living in Austin, Bob worked at the University of Texas at Austin on a Gas Research Institute tight gas project and consulted for UnoCal, Z & S Consultants and Baker Hughes in Houston.
- After graduating from UBC in 1964, as a Mechanical Engineer, Bob worked 17 years with Schlumberger of Canada, 4 years at Schlumberger Doll Research (SDR) and 6 years with Schlumberger Well Services in New Orleans and Austin. While at SDR, he worked as team leader tasked to build a better interpretation method than the prevalent volume of shale models, common in the 1970's. That is where he met the true genius in Drs. Michael and Susan Herron who developed the methodology presented in their papers.
- Bob's SDR team (not just me ☺) developed nuclear spectroscopy. Today, tools such as the ECS, LithoScanner, FLEx and GEM provide element measurements, enabling the use of nuclear spectroscopy interpretation methods.
- The methods can be applied to shales, clastics and carbonates. When combined with nuclear magnetic resonance, the combination of nuclear spectroscopy and nuclear magnetic resonance can be applied anywhere in the world to coax signals out of the rocks.

Biography

- **Biography, Jamie Everett**
- Jamie Everett has helped people solve their computer software technology challenges since graduating in 1991. He previously worked as a Software Developer for several large companies including Hewlett Packard, the National Institute of Health and Siemens.
- Today he enjoys work on the front line as Owner/Operator of Everett Energy Software Inc. and lead developer for Everett-Petrophysics.
- Jamie graduated from Bowdoin College, Maine in 1988 with a BA. in Physics and then attended Boston University, Massachusetts obtaining a MSc. in Biomedical Engineering in 1991.