Well Log Quality Control: What You Don't Know Can Hurt You*

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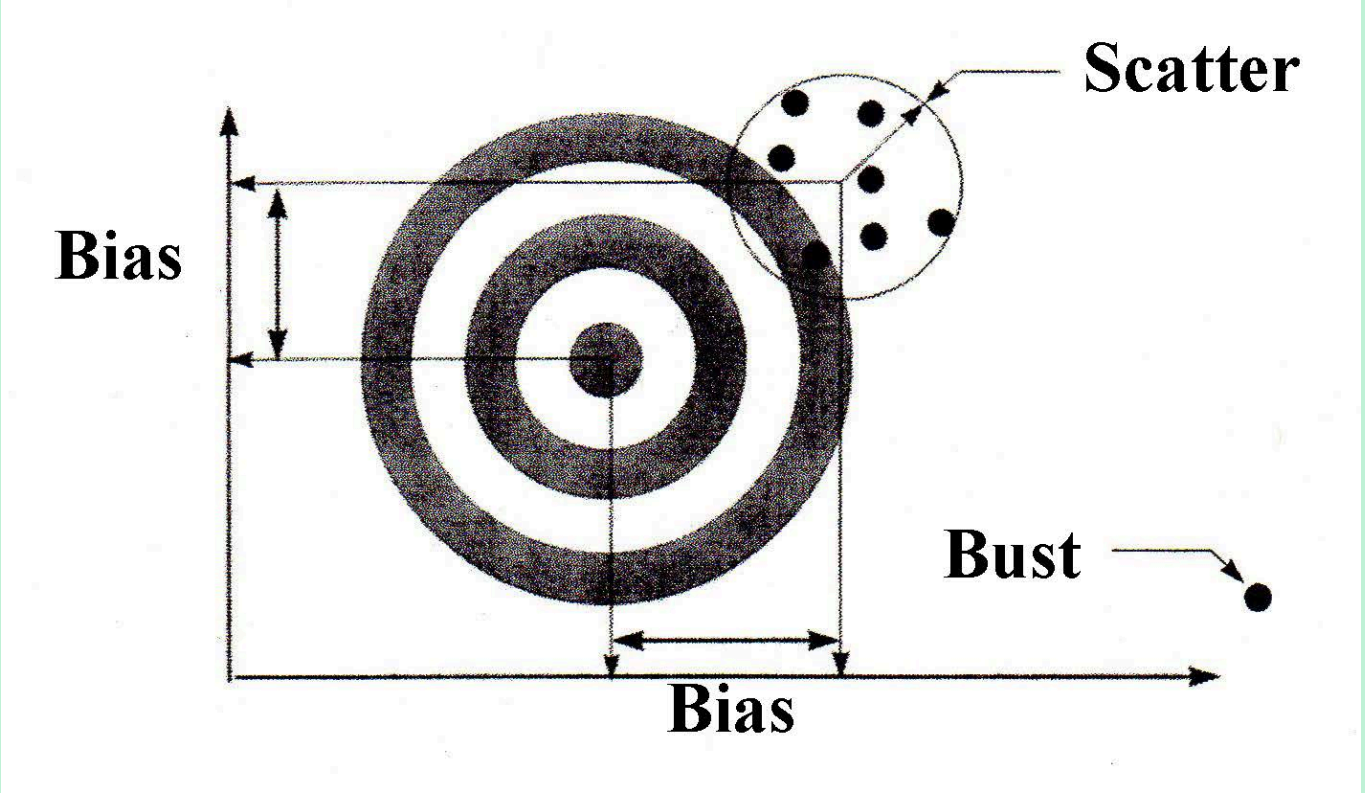
Abstract

Well Logs form the foundation upon which Oil and Gas reserves are based. Logging vendors are responsible for delivering data that has been acquired with instruments what were calibrated and run properly, providing documentation of this in both delivered hard and soft copy data. The client representative needs to verify that this has been done, before signing the vendor invoice, as the logging witness. Failure to do so can have severe repercussions, if "Stated Reserves" include data from miscalibrated and/or improperly run logs. Simple, straightforward, well site techniques are demonstrated which would allow the client representative to quickly determine if the vendor has properly done their job.

Well Log Quality Control

What you don't know CAN hurt you!



Reserves

$$STOOIP = \frac{7758 A h \phi (1 - S_w)}{B_{oi}}$$

- STOOIP: Stock Tank Original Oil In Place
- A: Area of Structural Closure, in Acres
- h: Average Reservoir Net Thickness, in ft
- Ø: Average Reservoir (fractional) Porosity
- S_w: Average Reservoir (fractional) Water Saturation
- B_{oi}: Initial Oil Formation Volume Factor

Why Is Log QC Important?

- Well Logs are the foundations upon which Reserves are estimated.
- Reserves are the Bank Accounts for Petroleum E&P organizations.
- E&P organizations that *do not replace produced reserves* are not long for this world.
- A Junior E&P firm developing a World Class Heavy Oil Resource had ***Billions*** of Bbl Oil Stated Reserves called into question because of Log Quality Problems.

Log QC Responsibilities

- Vendors are responsible for delivering data that was measured with instruments that were properly calibrated and working correctly.
- Clients and/or their representatives are responsible for seeing that this is done.
- Clients that accept the vendor products at face value***, probably get what they deserve***.

How Petrophysicists Spend Their Time

- Clients often criticize Petrophysicists for taking too long and costing too much.
- A recent LinkedIn Petrophysics discussion thread revealed that Petrophysicists spend, on average, between ***50% - 75%***, of their time doing data Quality Control:
  - If anything, modern logs have increased this load because there is so much more to review.
  - Digital files, without paper prints, only make the situation worse.

Foundations of Well Log Product Quality

Data Consistency & Concise Presentation

Tool Calibration & Reliability

Contractor Performance

>>> Client Preparation <<<

Wellsite is the Front Line for QC

- While the equipment is on site and the well bore is open, Back-up sondes can be run.
- Once the well has been cased, the best the vendor can do is offer discounts against future work.

Written Protocols

- Services Requested
- Who will “call Out” the vendor
- Logging sequences and tool stacks
- Calibrations expected
- Logging operations
- Displays
- Back-up and special equipment
- Specialist Engineer
- Hard and soft copy delivery
- Special conditions

Calibration Philosophy

Well Logging Tools are Calibrated by Adjusting their Response to Read some Predetermined value, in a Situation for which the Response is: Known

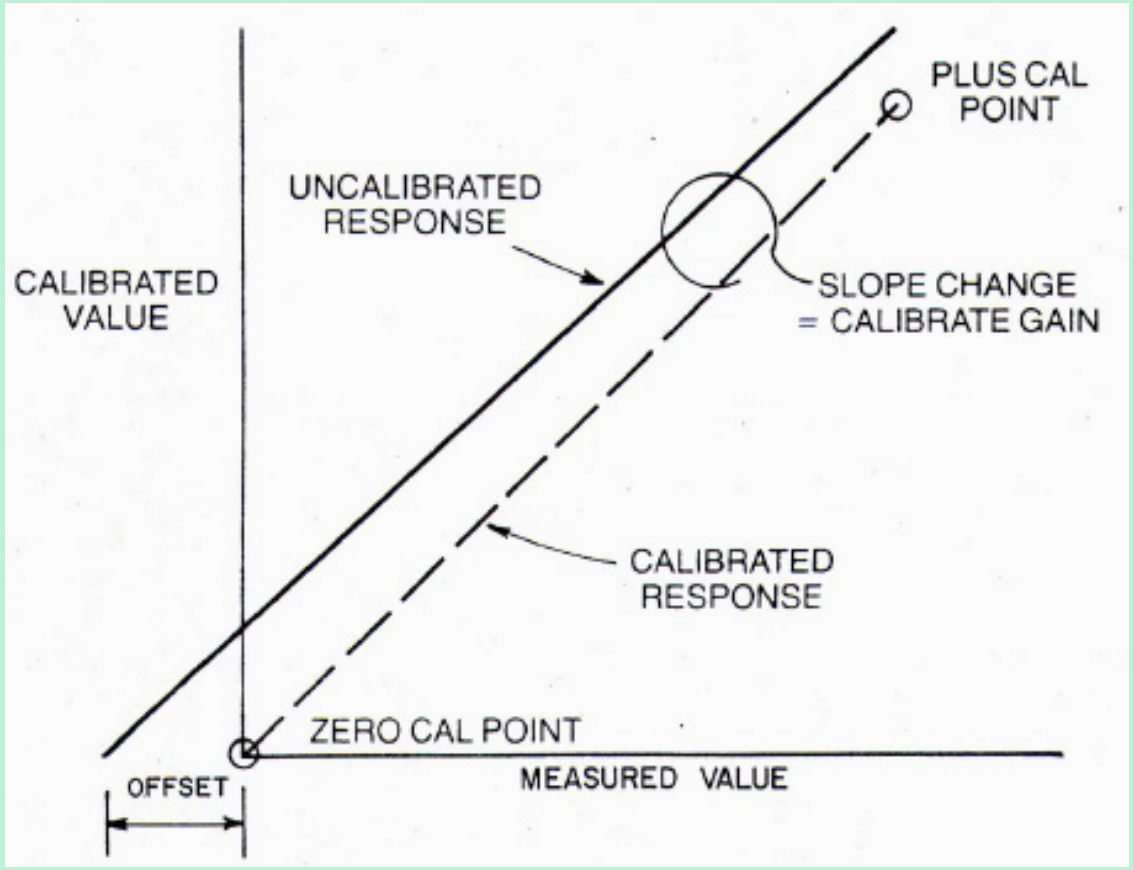
Corollary-1

The Only Time We know, for Certain, that Logging Tool is Working Properly, is During Calibration

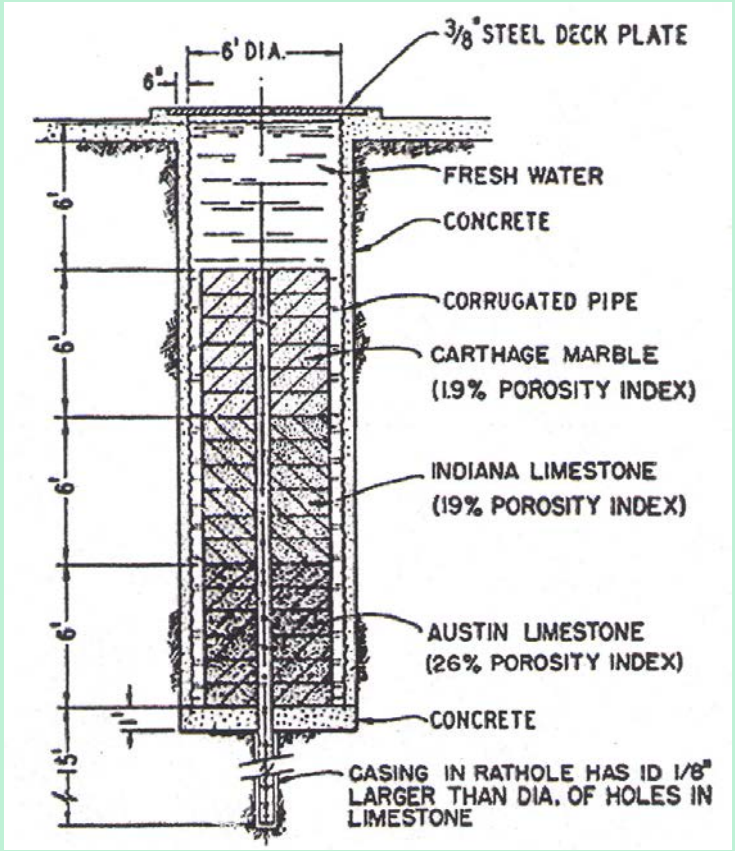
Corollary-2

Calibrate and Check Calibrations Often

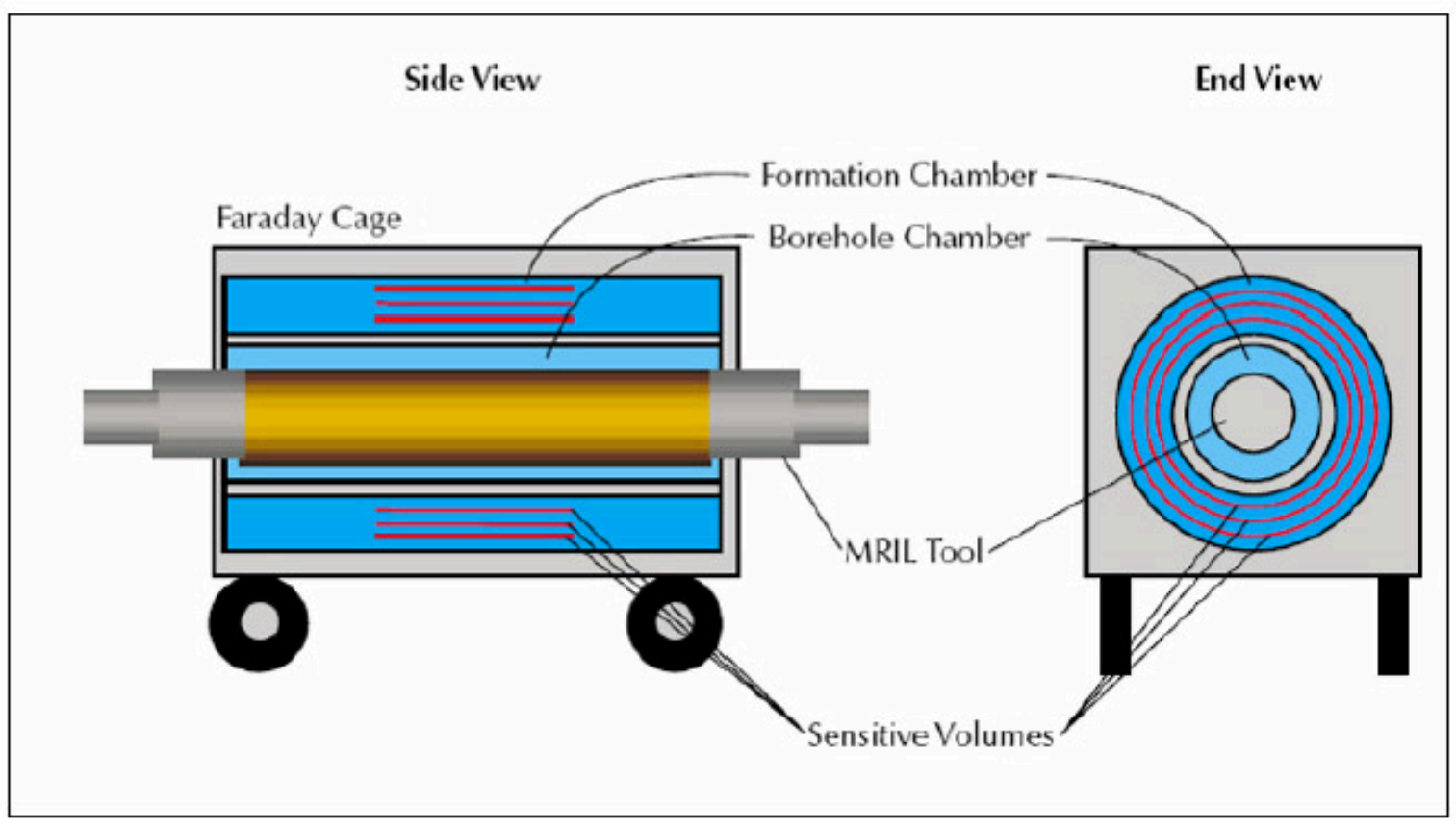
Linear Calibration Concept



API Test Pits – Primary Standard



Shop Calibrators – Secondary Standards



Field Calibrators – Tertiary Standards

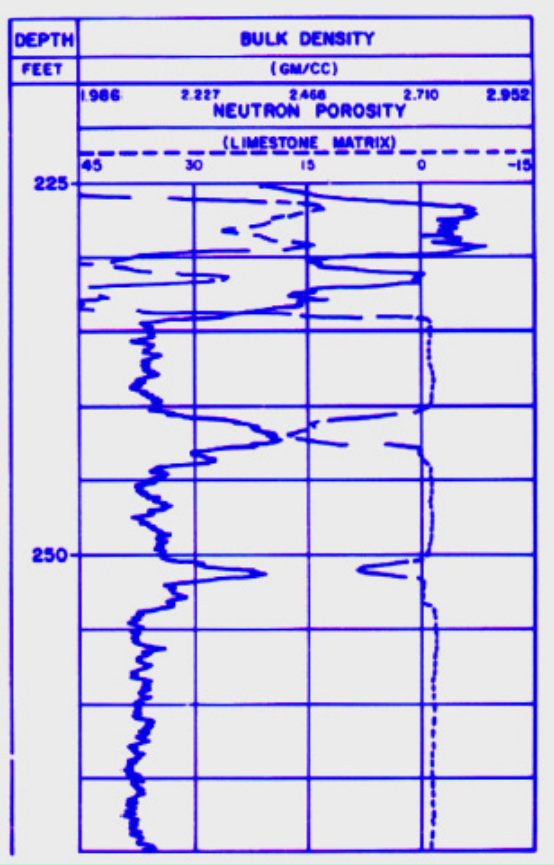
Logging Job Calibration Protocol

- Shop Calibration:
  - Should be as recent as possible (request to have it done before the unit leaves the shop).
  - Do not accept a tools with a shop calibration over 30 days old.
- Pre-Log Calibration Check:
  - Check against drift from Shop Calibration.
- Logging Trip Calibration Checks:
  - Repeats, Casing Signal, Evaporite Beds, etc.
- Post Log Calibration Check:
  - Check against drift from Pre-Log Calibration Check.
- Calibrations ***Must Be*** Documented on Detailed Log Prints

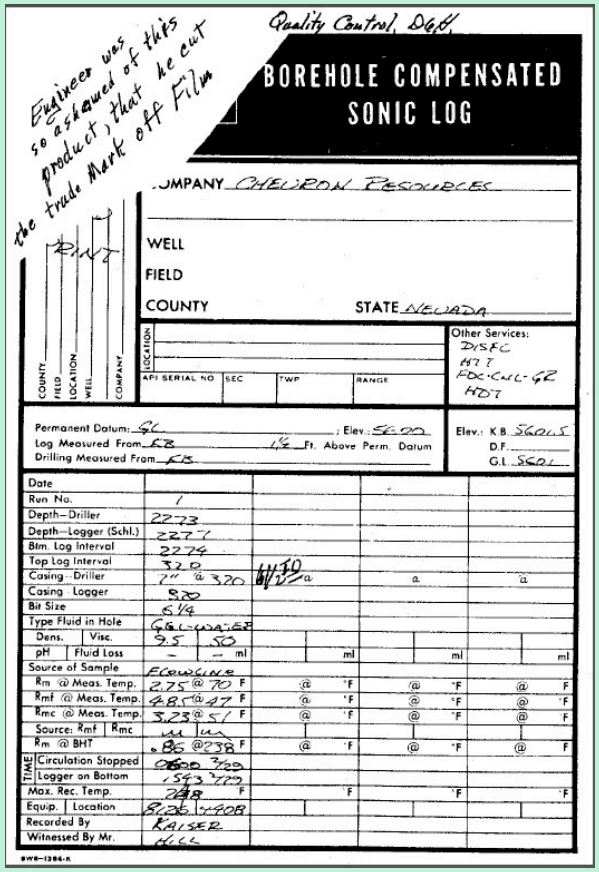
Not all Logging Jobs Are Routine

Not all Shop Calibrators are Equal

Massive Anhydrite Density & Neutron Check



No Vender Wants to Deliver Bad Data



Engineer was so ashamed of this product, that he cut the trade Mark off Film

Quality Control, D&A

BOREHOLE COMPENSATED SONIC LOG

COMPANY CHEVRON RESOURCES

WELL

FIELD

COUNTY STATE NEVADA

LOCATION

API SERIAL NO | SEC | TWP | RANGE

Other Services:
DVSFC
HNGT
FDC-CNL-GR
HDT

Permanent Datum: GL ; Elev.: 5600
Log Measured From KB 14 Ft. Above Perm. Datum
Drilling Measured From KB

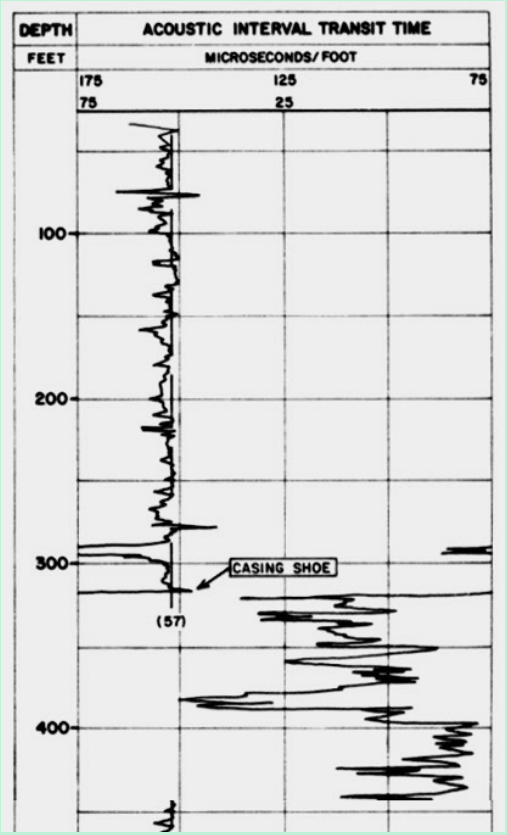
Elev.: K.B. 5614.5
D.F.
G.L. 5601

Date				
Run No.	1			
Depth—Driller	2273			
Depth—Logger (Schl.)	2277			
Btm. Log Interval	2274			
Top Log Interval	320			
Casing—Driller	7" @ 320	@	@	@
Casing—Logger	320			
Bit Size	6 1/4			
Type Fluid in Hole	GEL-WATER			
Dens. | Visc.	9.5 | 50			
pH | Fluid Loss	– | – ml	ml	ml	ml
Source of Sample	FLOWLINE			
Rm @ Meas. Temp.	2.75 @ 70 F	@ °F	@ °F	@ °F
Rmf @ Meas. Temp.	4.85 @ 47 F	@ °F	@ °F	@ °F
Rmc @ Meas. Temp.	3.23 @ 51 F	@ °F	@ °F	@ °F
Source: Rmf | Rmc	M | M			
Rm @ BHT	.86 @ 238 F	@ °F	@ °F	@ °F
TIME Circulation Stopped	0600 3/29			
TIME Logger on Bottom	1543 3/29			
Max. Rec. Temp.	238 F	°F	°F	°F
Equip. | Location	5136 | 4408			
Recorded By	KAISER			
Witnessed By Mr.	HILL			

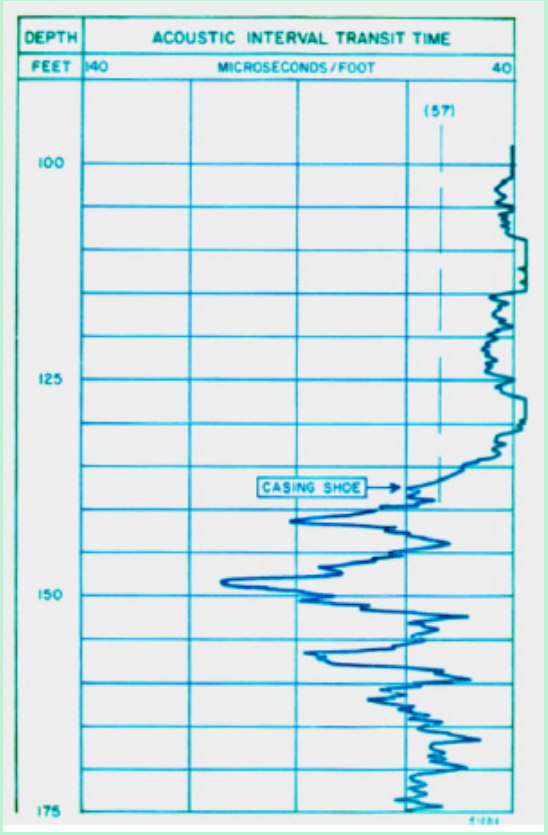
SWS-1384-A

Acoustic Log Casing Check

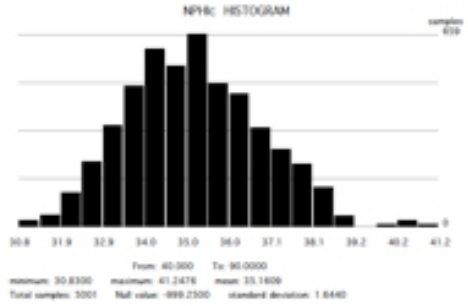
Good Csg. Check



Bad Csg. Check

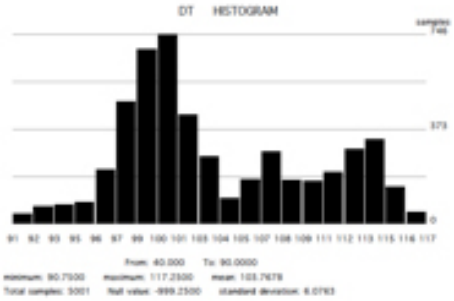


Do Your Porosity Logs Agree?



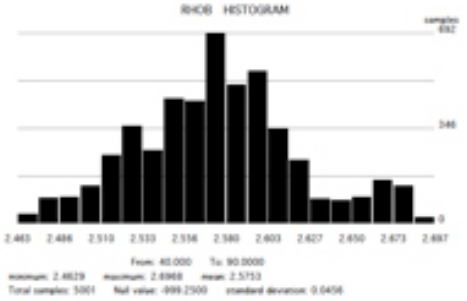
Neutron Sandstone Porosity

Mode: 35.0 – 35.5%



Acoustic AFF Sandstone Porosity

Mode: 31.25 – 31.75 % & 35.0 – 35.5 %

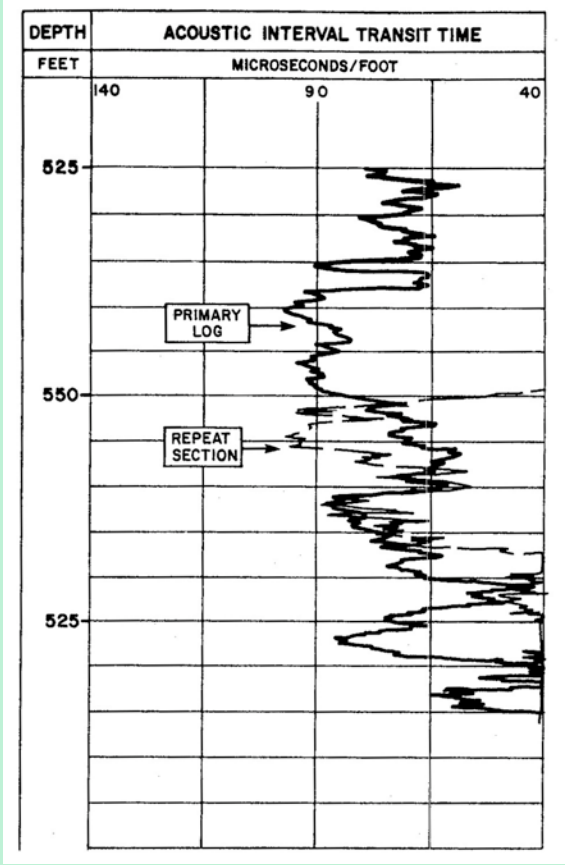


Density Sandstone Porosity

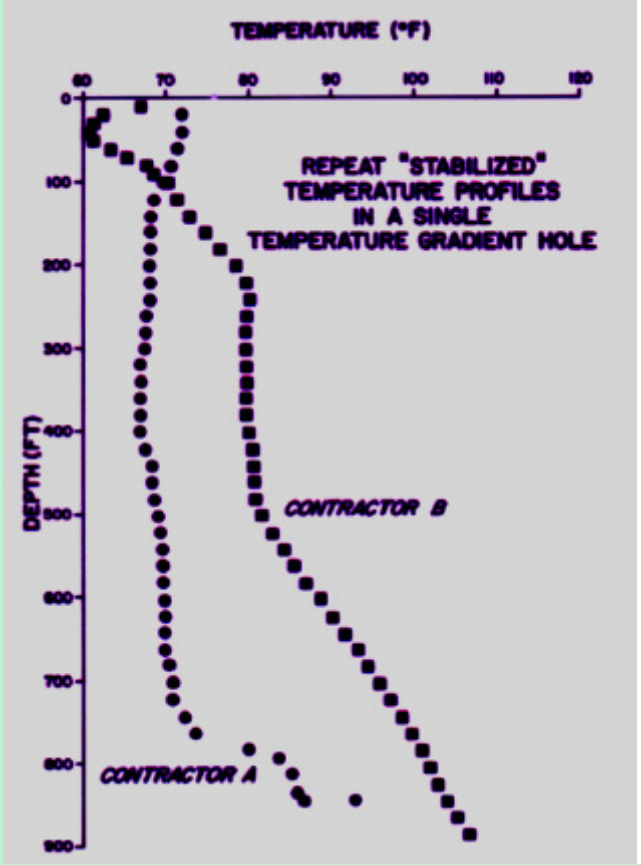
Mode: 4.24 – 4.90%

DGH, 20.04.15

Do Your Logs Repeat?



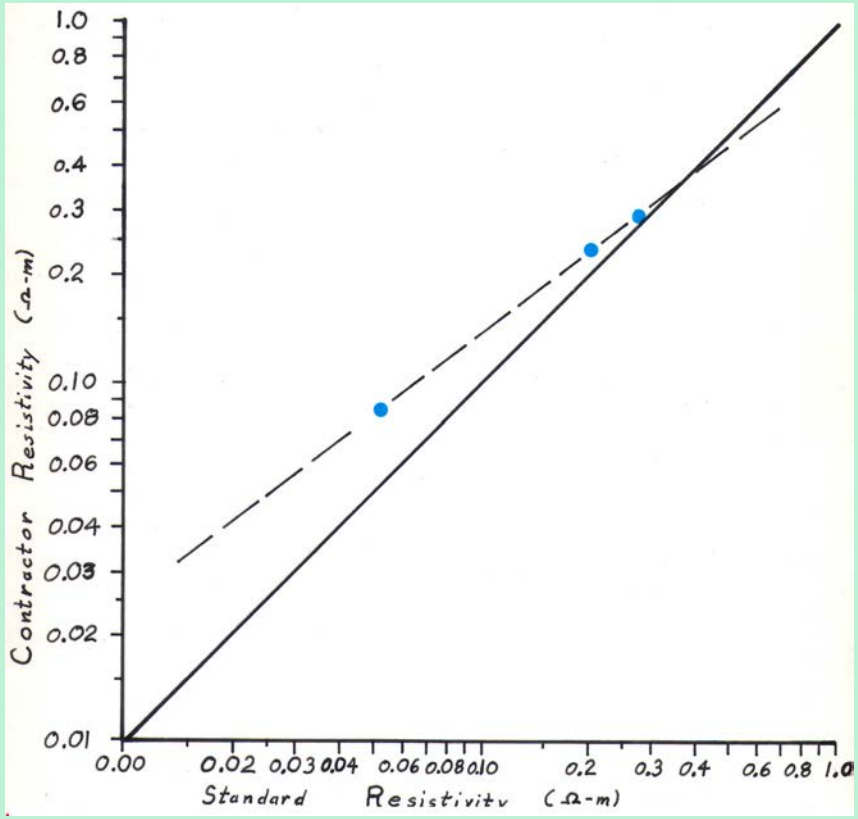
Two Versions of Truth



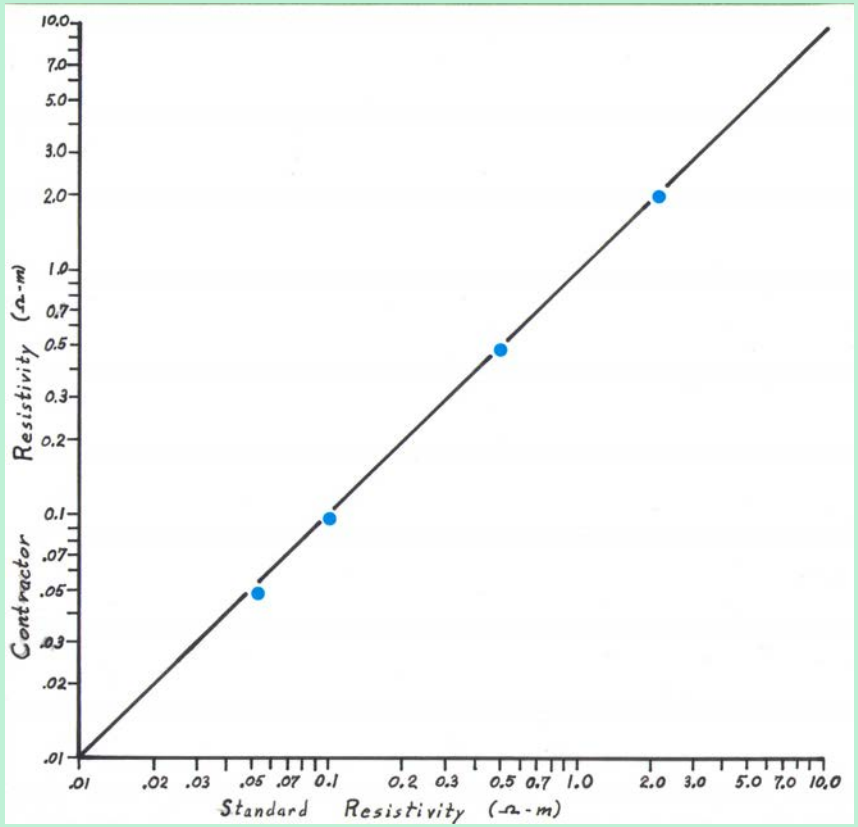
Gamma Ray Drift

Fluid Resistivity Bridge Check

Bad Calibration

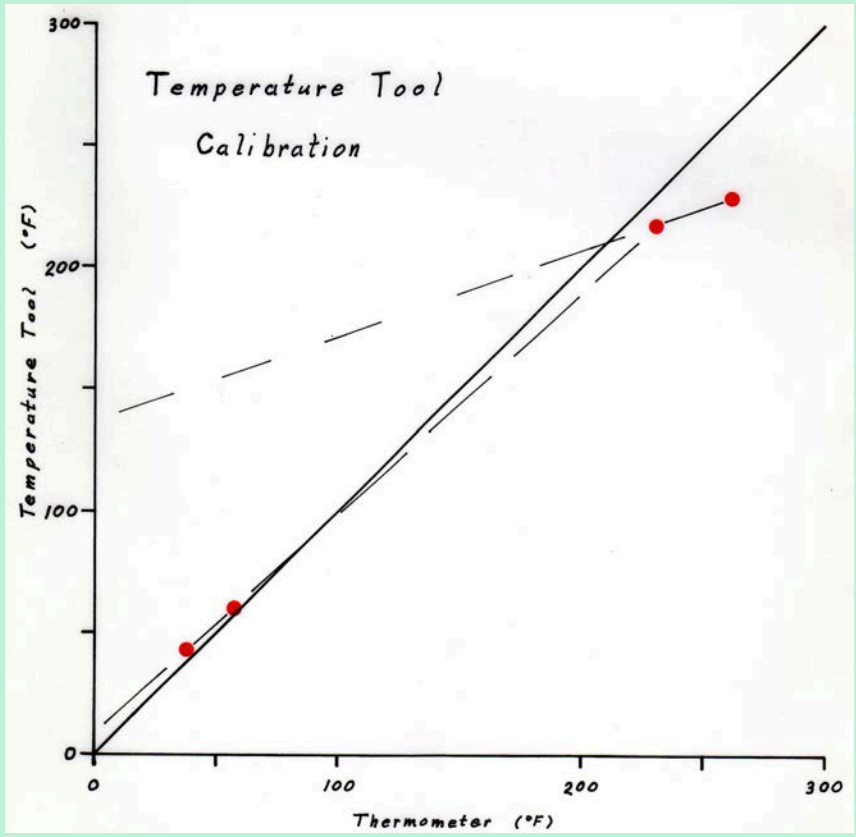


Good Calibration

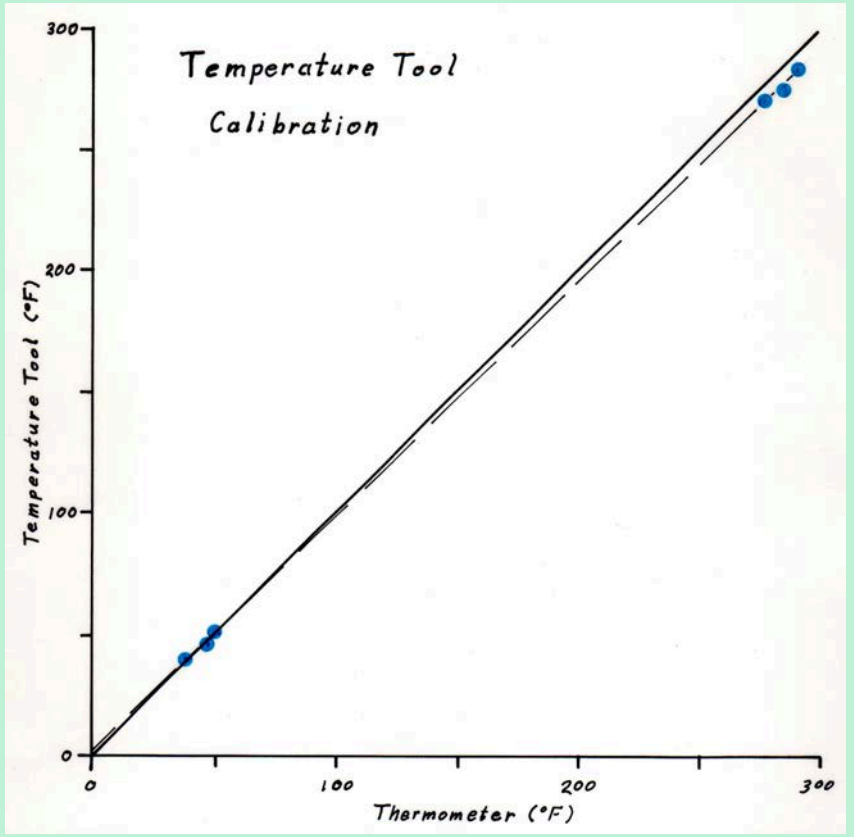


Temperature Tool Calibration

Bad Calibration



Good Calibration



Log QC Summary

- It's NOT Rocket Science.
- You ***Do*** need to know what should happen, ***and make certain that it does***.
- It sometimes takes a little creativity.
- It can make a ***BIG*** difference in the quality of your reserves estimates.

Thank you for your Attention