Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 87240
District II
1301 W. Grand Ave., Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

2009 MAR 9 PM 12 10

Form C-103
June 19, 2008

WELL API NO. 30-039-30148	
5. Indicate Type of Lease	STATE ☐ FEE ☒
6. State Oil & Gas Lease No.	
7. Lease Name or Unit Agreement Name: Carracas SWD	
8. Well Number # 2	
9. OGRID Number 162928	
10. Pool name or Wildcat Entrada-Chinle	

SUNDRY NOTICES AND REPORTS ON WELLS

(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well: Oil Well ☐ Gas Well ☒ Other

2. Name of Operator
Energen Resources Corporation

3. Address of Operator
2198 Bloomfield Highway, Farmington, NM 87401

4. Well Location

Unit Letter I : 1489 feet from the South line and 134 feet from the East line

Section 09 Township 32N Range 04W NMPM County Rio Arriba

11. Elevation *(Show whether DR, RKB, RT, GR, etc.)*
6222' GL

12. Check Appropriate Box to Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
PERFORM REMEDIAL WORK	☐	PLUG AND ABANDON	☐	REMEDIAL WORK	☐	ALTERING CASING	☐
TEMPORARILY ABANDON	☐	CHANGE PLANS	☐	COMMENCE DRILLING OPNS.	☐	P AND A	☐
PULL OR ALTER CASING	☐	MULTIPLE COMPL	☐	CASING/CEMENT JOB	☐		
DOWNHOLE COMMINGLE	☐						
OTHER:			☐	OTHER: Report TDS and BHP SWD-1068-A			☒

13. Describe proposed or completed operations. (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompletion.

Per SWD-1068-A report TDS and BHP (See attached documentation)

TDS Bluff/Entrada = 36,000 ppm

BHP Bluff/Entrada = 3,831 psi

Note: Extra copy of Sundry included to NMOCD Aztec to Send to NMOCD Santa FE - attention to Mr. Will Jones.

Spud Date: Rig Release Date:

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE [signature] TITLE District Engineer DATE 12/17/2008

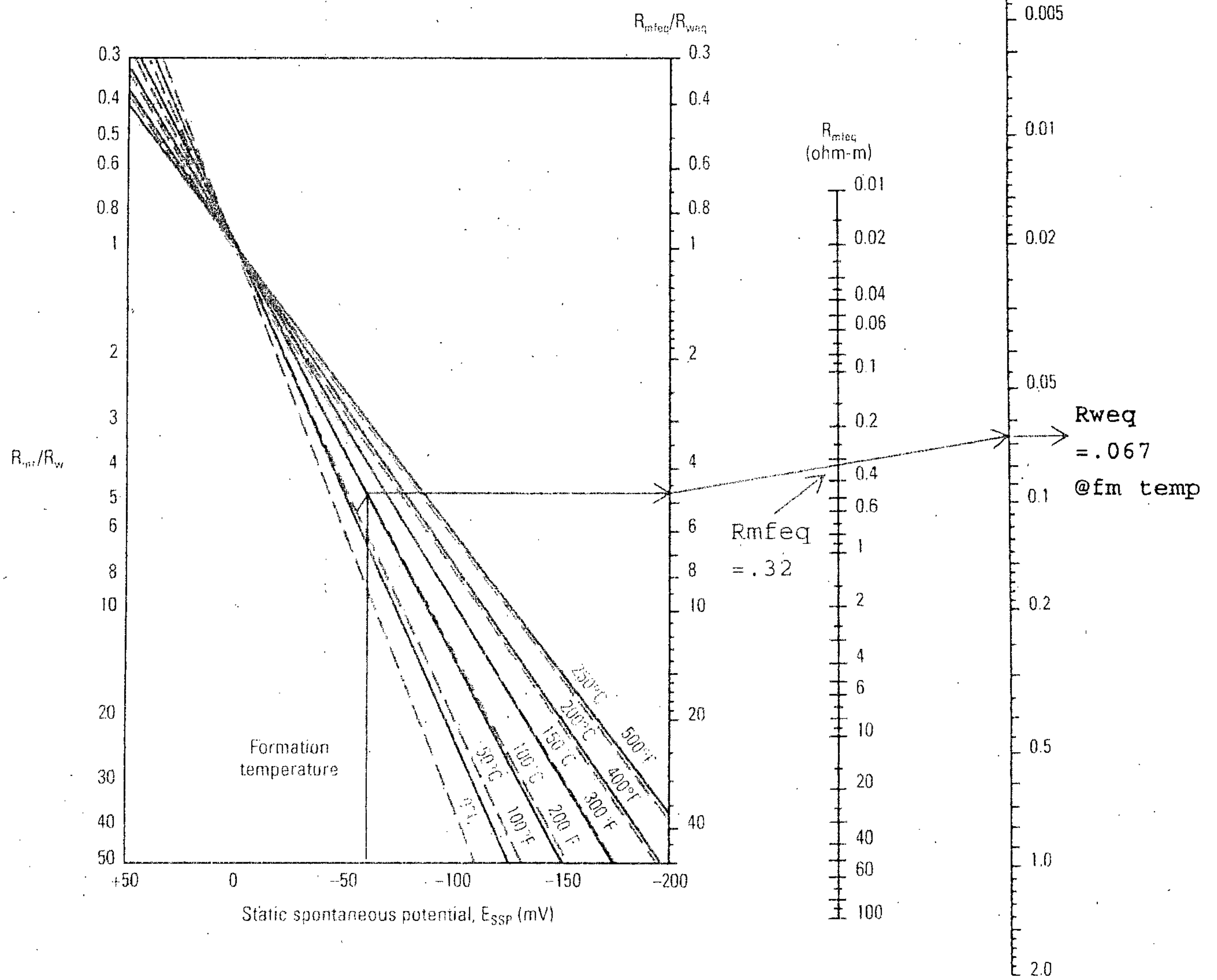
Type or print name Patricio W. Sanchez E-mail address: psanchez@energen.com PHONE 505.325.6800

For State Use Only

APPROVED BY ______ TITLE ______ DATE ______
Conditions of Approval (if any):

R_{weq} Determination from E_{SSP}

Energen calculations for Bluff formation water PPM from SP:
Rmf = 1.072 @ 80 deg (from log header)
Rmf = .38 @ 211 deg (fm temp) (see Gen-6)
Rmfeq = Rmf x .85 = .38 x .85 = .32
SSP = -60 mv (from log SP)
Rweq = .067 @ fm temp (see SP-1)
PPM = 36,000 (Gen-6)



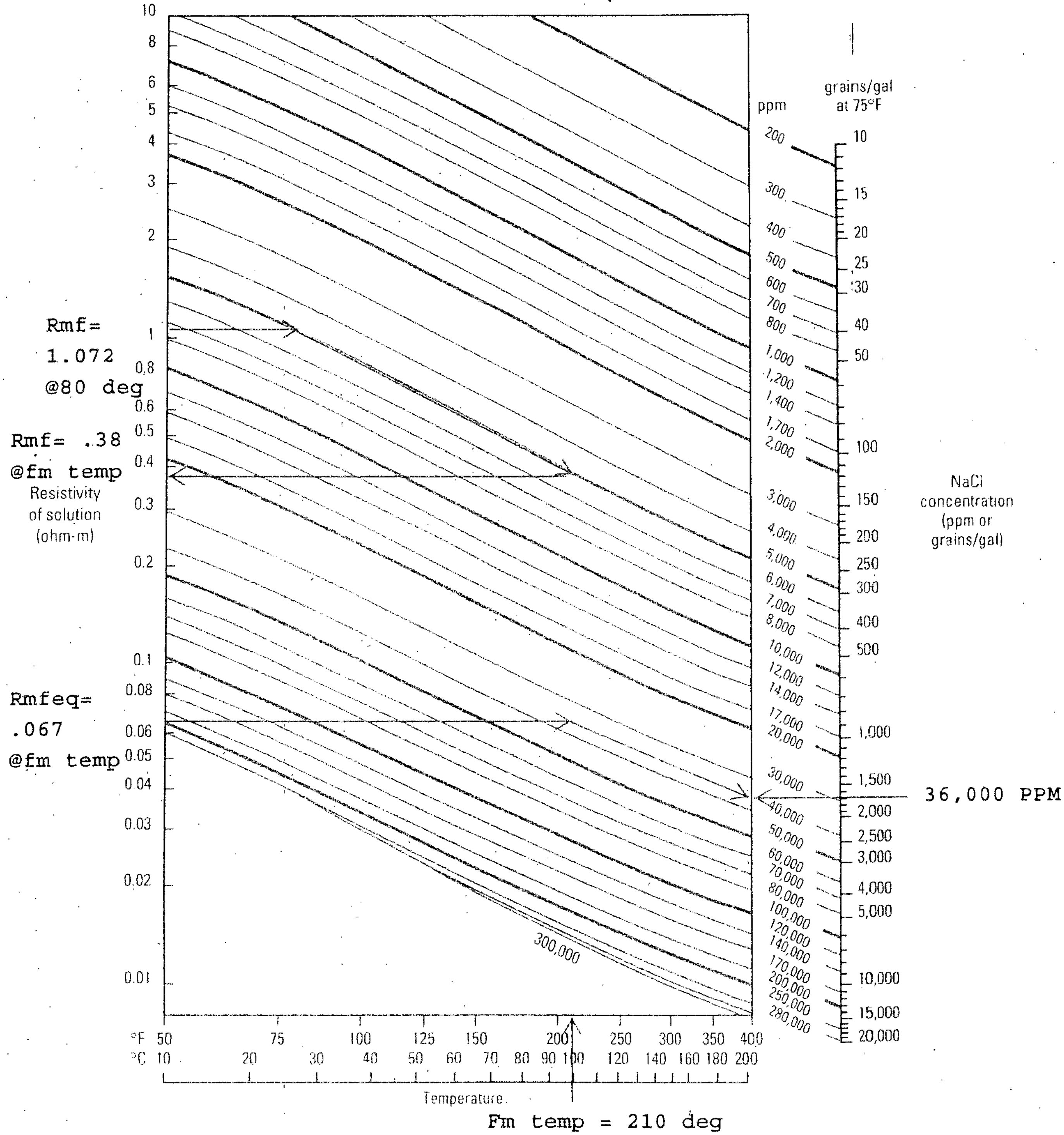
Schlumberger

Resistivity of NaCl Water Solutions

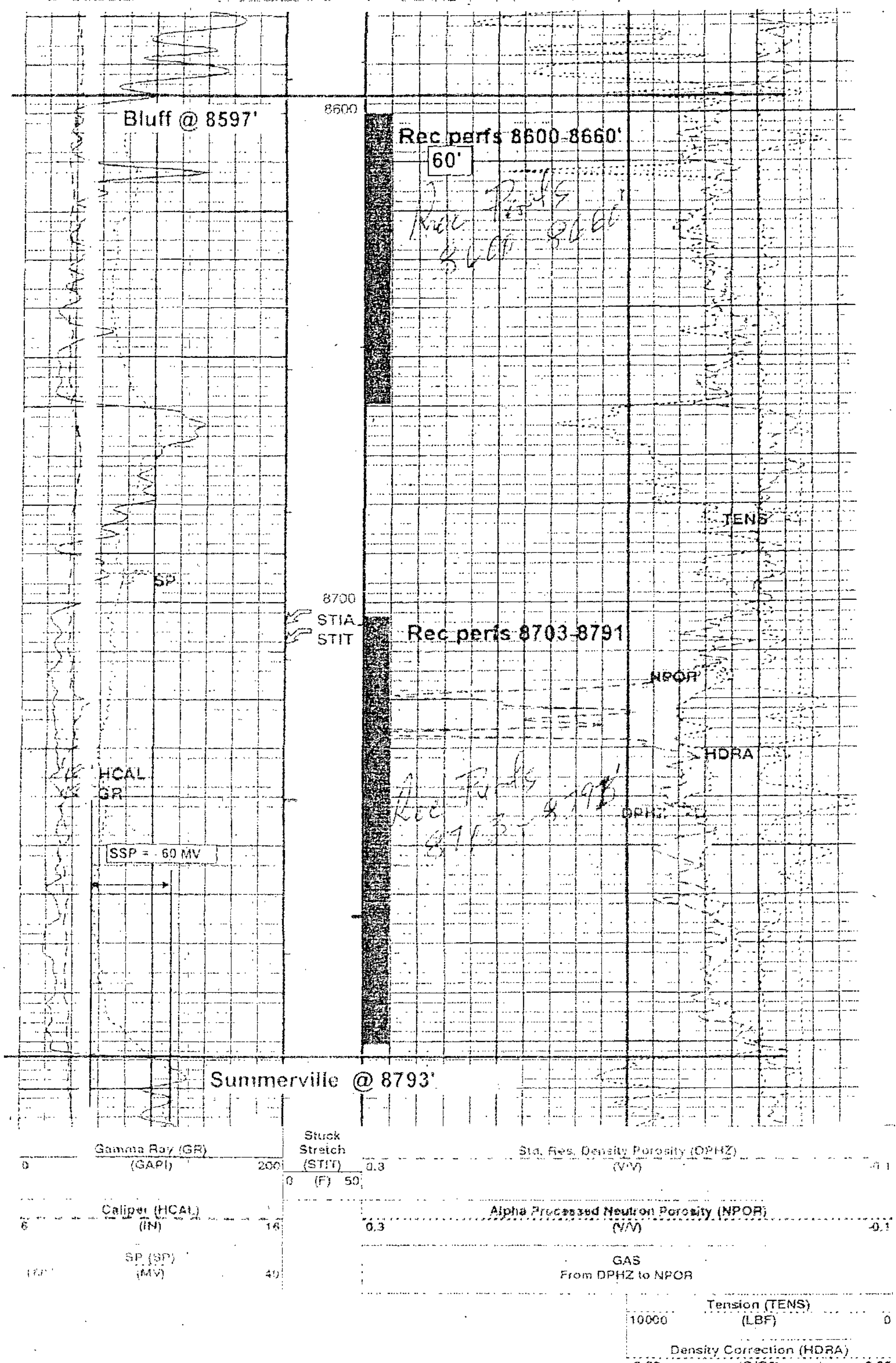
Gen-6
(former Gen-9)

Gen

Conversion approximated by $R_2 = R_1 [(T_1 + 6.77)/(T_2 + 6.77)]$°F or $R_2 = R_1 [(T_1 + 21.5)/(T_2 + 21.5)]$°C



Energen Resources Carraca SWD #2 - Compensated Neutron Density log



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FORMATION WATER RESISTIVITY (R_W) DETERMINATION: THE SP METHOD

USHIE, FA

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ABSTRACT: Formation water resistivity represents the resistivity value of the water (uncontaminated by drilling mud) that saturates the porous formation. It is also referred to as connate water or interstitial water. Its resistivity can be determined by a number of methods, one of which is by the SP curve discussed in this work. Analysis of wire-line log data depends on the assumption that the only conductive medium in a formation is the pure water which supplies the energy and drive in reservoirs. So, physical properties of this formation water can be determined, one of which is its electrical resistivity and this eventually leads to water saturation determination – an important aspect of reservoir evaluation. This paper presents a review and comparative assessment of the graphical, vis-à-vis the calculative means of R_w determination by the SP method. @*JASEM*

Many of today's oil reservoirs are composed of sediments, which were once deposited in Marine, deltaic and other aquatic environments. Consequently, these sedimentary beds were originally saturated by salt water. Part of this water was displaced in the process of diagenesis and oil accumulations, the other remains, suspending the hydrocarbons because of their density contrast. That which remains generally is known as "Connate" or "Interstitial" water because the water was "born with" and is stored in the interstices of the sediments.

Schlumberger (1989) defined formation water as the water uncontaminated by drilling mud that saturates the formation rock. Analysis of wire line log data depends on the assumption that the only conductive medium present in the formation is the pore water; the matrix and hydrocarbons are non-conductive. Physical properties of this formation water can be determined, one of which is electrical resistivity. Formation water is the free water which supplies the energy for the water drive in reservoirs; and its resistivity is variable depending on the salinity, temperature and whether or not the formation contains hydrocarbons. At a given salinity, the higher the temperature the lower the resistivity, and the water resistivity at any formation temperature, can be calculated from the water resistivity at another formation temperature, knowing both the temperature and temperature offsets using this formula:

R_w at FT_2 = $R_w FT_1, (FT_1 + C)(FT_2 + C)$.
Where FT_1 = Initial formation temperature
FT_2 = Formation Temperature for which R_w is being determined.
C = 21.5 for Temperature in °C (Smolen, 1977).

It has also been established (Schlumberger, 1989) that the water resistivity determined from a hydrocarbon-bearing zone is usually greater than that from the zone bearing only formation water. Determination of formation water resistivity is very important in calculating water and/or hydrocarbon saturation, in the determination of salinity if temperature is known and in understanding the variations of resistivity from the well wall into the formation by comparing it with the resistivity of the mud filtrate. In both SP and R_{wa} comparison methods, wire-line logs provide all the needed parameters to determine the formation water resistivity.

THE SP METHOD

In many cases, a good value of formation water resistivity R_w can easily be found by the SP curve read in clean (non-shale) formations because the SP can be used to distinguish lithology such as shaly from sandy formations. The static SP (SSP) value in a clean formation is related to the chemical activities (a_w and a_{mf}) of the formation water through the formula:

$$SSP = K\log \frac{a_w}{a_{mf}} \quad \text{.....................} (1)$$

Where K = Constant and varies in direct proportion with temperature especially in NaCl solutions
K = 61 + 0.133T in °F
K = 65 + 0.24T in °C
a_w = Chemical activity of water
a_{mf} = Chemical activities of mud filtrate.

For pure Nacl solutions that are not too concentrated, resistivities are inversely proportional to activities. Therefore,

$$SSP = -K\log \frac{R_{mfe}}{R_{we}} \quad \text{.....................} (2)$$

Where R_{we} = 0.075/S_w at 77°F (25°C) and is the equivalent formation water resistivity; and R_{mfe} = equivalent mud filtrate resistivity.

After we have been able to relate these resistivities to the SP value for a particular zone, we would then follow the procedure below in determining the formation water resistivity (R_w) using the SP method.

1. Establish the shale baseline on the SP curve.
2. Pick out clean permeable zones.
3. Do all the thick zones have about the same SP value? If yes, then pick any thick zone, but otherwise, pick thick zone near and/or the zone you are interested in.
4. Determine the formation temperature i.e. the temperature of this zone chosen, using surface temperature, the bottom hole temperature and the total depth with the formula:

$$T_f = (T_{TD} - T_0)\frac{D_f}{T_D} + T_0$$

Where T_f = Temperature of the formation in °F or °C.
T_{TD} = Temperature at total depth (Bottom hole Temp.) in °F or °C.
T_0 = Mean surface temperature (in °F or °C).
D_f = Depth to formation (in *ft* or *m*).
T_D = Total depth (in *ft* or *m*).

5. Now, from the R_{mf} and R_m values recorded on the log heading, determine the R_{mf} and R_m values at that particular formation temperature using the formula:

$$R_{mf} \ at \ T_f = R_{mf} \ at \ T_0 (T_0 + C / T_f + C)$$

Where C is the temperature offset.
C = 6.8 if imperial units are used and 21.5 if metric units are used.
T_0 = Initial temperature at which R_{mf} was first measured.
R_m = Resistivity of mud, usually recorded on the log heading

6. Now read off SP amplitude from shale baseline to maximum constant deflection.
7. Determine bed thickness from SP deflection points.
8. Check whether the SP needs correction. If need be, correct for bed thickness, hole diameter, invasion and resistivity contrasts using the appropriate charts.
9. Now, knowing the formation temperature (T_f), the static SP or SP (Corrected), recorded opposite a porous and permeable, non-shaly formation can be transformed into the resistivity ratio R_{mf}/R_{we} in two ways: graphically as in figure 1 and by calculation.

Graphically by use of chart:
With the ratio R_{mfe}/R_{we} now determined and the resistivity R_{mf} of a sample of mud filtrate measured, the equivalent formation resistivity, R_{we}, is easily calculated. However, the mud filtrate resistivity reported on the log heading or calculated at the formation temperature is its actual resistivity not its equivalent resistivity (Edwards *et al* 1963). To convert the measured mud filtrate resistivity (R_{mfe}, the following rules are employed:

(a) For predominantly NaCl Muds.

i. If R_{mf} at 75°F is greater than 0.1ohm-m, use R_{mf} 0.85ohm-m at Formation Temperature. This relationship is based on measurements made on many typical muds.

ii. If R_{mf} at 75°F is less than 0.1ohm-m, use the NaCl (solid curves) in figure 2 to derive a value of R_{mfe} from the measured R_{mfe} value corrected to formation temperature.

(b) For fresh water or gypsum muds: the dashed curves of the chart in fig. 2 are used to convert R_{mf} to R_{mfe}.

(c) Lime-based muds, despite their name, usually have negligible amounts of calcium and are treated as regular mud (see rule a).

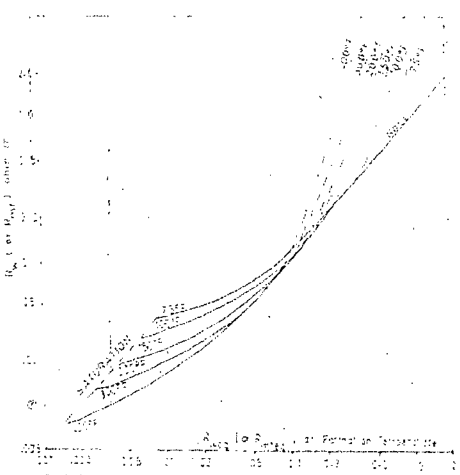
(d) For predominantly NaCl Muds.

iii. If R_{mf} at 75°F is greater than 0.1ohm-m, use R_{mf} 0.85ohm-m at Formation Temperature. This relationship is based on measurements made on many typical muds.

iv. If R_{mf} at 75°F is less than 0.1ohm-m, use the NaCl (solid curves) in figure 2 to derive a value of R_{mfe} from the measured R_{mfe} value corrected to formation temperature.

(e) For fresh water or gypsum muds: the dashed curves of the chart in fig. 2 are used to convert R_{mf} to R_{mfe}.

(f) Lime-based muds, despite their name, usually have negligible amounts of calcium and are treated as regular mud (see rule a).



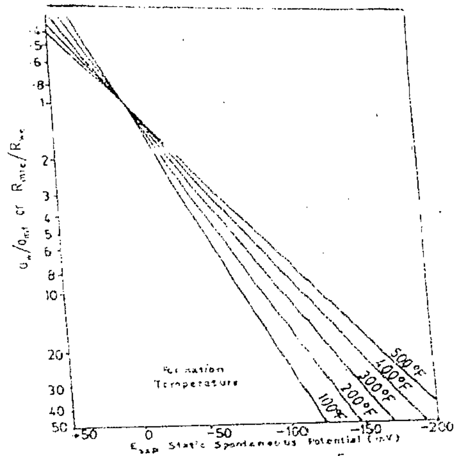


Fig. 1: R_{we} determination from E_{ssp} (clear formation)

By Calculation:

The log units should be metric for the calculation to be done.

(i) First determine the R_{mfe}

(ii) If R_{mf} at $T_f \leq 0.1$, then $R_{mfe} = (1.46\ R_{mf}$ at $T_f + 77)$.

(iii) If R_{mf} at $T_f > 0.1$, then $R_{mfe} = 0.85$ft at T_f.

(iv) But

$$SSP = K \log R_{mfe} / R_{we} ,$$

$$\frac{SSP}{K} = Log\ R_{mfe} / R_{we}$$

$$\therefore R_{mfe} = \frac{R_{mfe}}{R_{we}} = 10^{(-SSP / K)}$$

Lets denote $10^{(-SSP/K)}$ as R_{sp}.

$$\therefore \frac{R_{mfe}}{R_{we}} = R_{sp}$$

$$\text{and} \therefore R_{we} = \frac{R_{mfe}}{R_{sp}}$$

10. (a) Determine R_w from R_{we} value. The chart in Fig. 2 is also used to convert R_{we} to R_w. The solid curves, for very saline brine are derived from laboratory data on pure Nacl solutions. Thee solid curves are used for R_{we} and R_w values less than 0.1 ohm-m, they assume that in formation waters of this salinity Nacl is the dominant salt.

(b) By simple calculation as follows:

i. If $R_{we} > 0.12$, then R_w at T_f
$(0.58 - [(6.9 R_{we} + 2.4)]$

ii. If $R_{we} \leq 0.12$, then R_w at Tf
$(77 R_{we} + 5) / 146 - 337 R_{we}$

11 Check R_w from Sp against another source.

PRECAUTION AND CONCLUSION

The static SP value can only be obtained directly from the SP curve, if the bed is clean thick, porous and only moderately invaded; and if the formation is saline and the drilling mud is not too reactive. These conditions are not always met. When they are not, the recorded SP deflection (in milivolts) must be corrected to a static SP value for bed thickness, hole diameter, invasion and resistivity contrasts (Pirson, 1963, Frick 1962).

It is assumed that the recorded SP curve seldom contains an electrokinetic potential component. Although this is generally the case very low permeability formation, depleted pressure formation, or the use of very heavy drilling mud give rise to a significant electrokinetic potential. In these cases, an R_w derived from the SP curve will probably be too low, so other sources of R_w data should be explored (Tixer et al, 1965). Knowledge of R_w values is invaluable. It opens the lock to some other important parameters in formation evaluation. Rw is useful in calculating water saturation in the formula

$$S_w = FR.{}^{R_w}\!/_{R_t}.$$

When water saturation is known, then hydrocarbon in place, HC = ($1-S_w$), is derivable. And since qualification on hydrocarbons and calculation of reserves is indispensable in production, formation water resistivity, R_w, remains one of the most important interpretational parameters in well log analysis.

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Form TA-0000-0005

ENERGEN RESOURCES

AN ENERGEN COMPANY

Engineering Chart

Sheet No.
File SWD-1068/1068 A
Appn:
Date 12-15-2008
By pwg

Subject Carracas SWD #2 (API No. 30-039-30148)
Estimated BHP (From shut-in Pressure)

SWD-1068-A

(I) Well operations shut-in (August 2008 to December 2008)
- After intial completion well.

- Assume well is now stable.

BHP = P_{TBG} = 50 psig + Fluid Column.
(P_{TBG}; 8.42 ppg 2% KCL)

BHP = 50 psig + 0.052 × 8.42 ppg × 8,750'

BHP = 3,831 PSI

Estimated BHP = 3,831 PSI
BLUFF / Entrada