CHAPTER 4

PETROPHYSICAL INTERPRETATION

MOHAWK B-93

PETROPHYSICAL INTERPRETATION – MOHAWK B-93

SOUTH WEST NOVA SCOTIA EXTENSION - CANADA – June 2015

Objectives:

The objectives of the well evaluation are to review test and log data to describe the main reservoir properties and lithologies encountered in the formations. The quantified results can then help to better constrain the gross depositional environment maps.
A deterministic petrophysical evaluation for shale content (VSH), effective porosity (PHIE) and water saturation (SW) has therefore been carried out for one (1) well Mohawk B-93. Secondly, the determination of lithologies from log data is performed through statistical electrofacies determination for the well according to previous statistical determination performed in 2014 Laurentian basin study on wells Bandol B-1, East-Wolverine G-37 and Heron H-73.

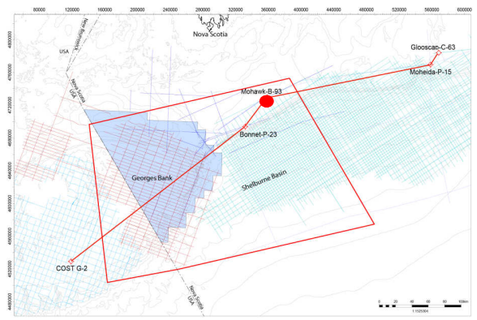

Figure 1: Study Area and Well Location

Well Database:

The log database consists of a full set of logs in well Mohawk. Log mnemonic equivalence as used in this project is listed in Table 1 together with the top and base depths (in MD) for the interpreted intervals.
Final well report is available with cuttings and sidewall core description which were loaded in the database as lithologies (Sandstone, Limestone, Glauconitic Sandstone-Siltstone, Mudstone-Claystone, Shale, Marl, Siltstone, Feldspathic Sandstone and Granite)

Well	GR (GAPI)	DT (µs/ft)	NPHI (v/v)	RHOB (g/cm3)	PEF (b/e)	RESD (Ohm.m)
Mohawk B-93	348-2120m	350-2124m	-	1063-2124m	-	350-2124m

Table 1: List of logs in well and interpretation intervals.

Log Analysis Methodology

A deterministic workflow was applied to identify the shaliness, porosity and water saturation. Log signatures in specific intervals and lithologies (based on cuttings data) were compared and analyzed in order to define specific interpretation parameters suitable for each interval (Figure 2). 9 lithologies were thus determined: Sandstone, Limestone, Glauconitic Sandstone-Siltstone, Mudstone-Claystone, Shale, Marl, Siltstone, Feldspathic Sandstone and Granite.
Shale volume evaluation was performed by calculating the shale content based on the gamma-ray using a curved relationship . A good correspondence was obtained between GR-based and Neutron-Density based shale volume curves.
Porosity was evaluated mainly by using a Porosity from Sonic as the Sonic log is present all along the well. A matrix composition effect on porosity could occur by using a sole indicator to compute the porosity, so the result was cross-checked by a Porosity from Density.
Matrix parameters defined from standard values according to the Lithological description and are set per interval:

Sandstone: Dtma=52.5us/ft; Rhoma=2.65g/cc
Limestone: Dtma=49us/ft; Rhoma=2.71g/cc

The porosity interpretation was compared to the occasionally available sidewall core porosity. The porosity interpretation defined total porosity and effective porosity, the latter corrected for the shale effect . The composite log is presented in Figure 3.

The water saturation in the formation is evaluated using a modified Archie, Indonesia method, accounting for the influence of shale on the resistivity measurement. Formation water resistivity was not measured for the Mohawk and the value used is based on the measured salinity of the water from the 2014 study on the Laurentian basin. The value for water salinity is 81 kppm NaCl , corresponding to an Rw = 0.045 @ 152°C. This salinity value is considered for all the well. The evolution of this resistivity with the temperature has been related to the thermal gradient defined for the formation.
The petrophysical parameters were set to standard values : a=1, m=n=2
No oil shows were recorded during the drilling of the Mohawk well.

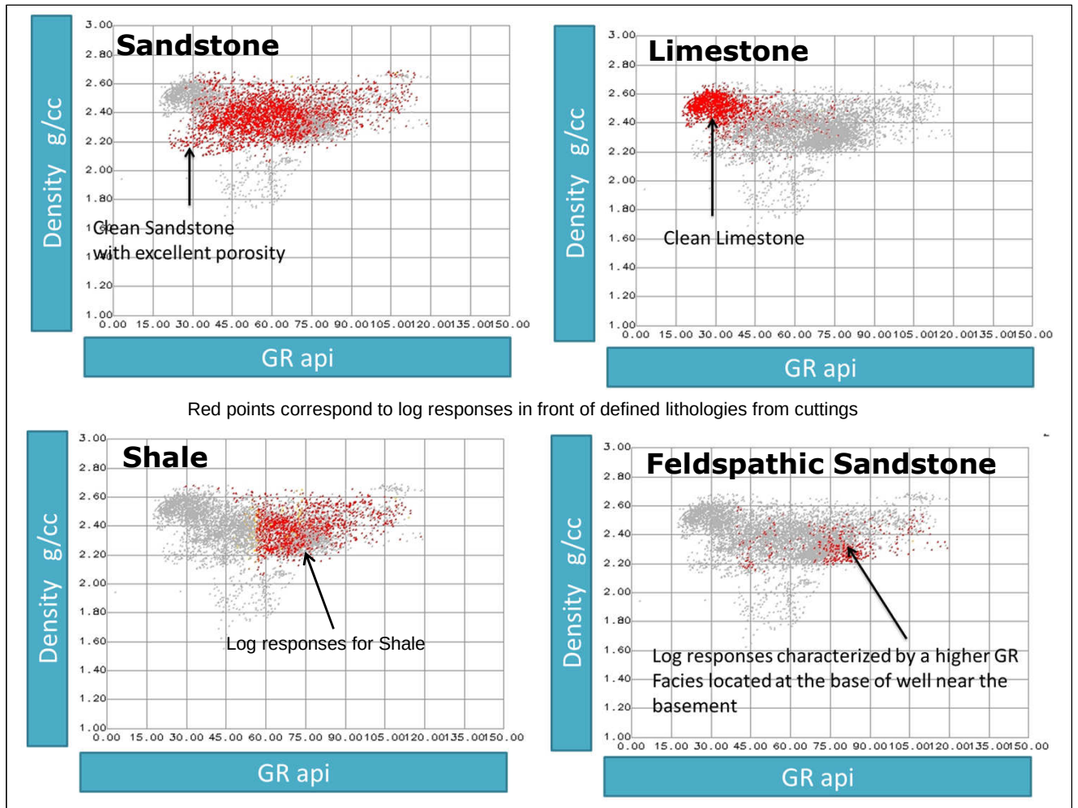

Figure 2: GammaRay-Density Cross-plots of typical lithologies identified from cuttings and logs

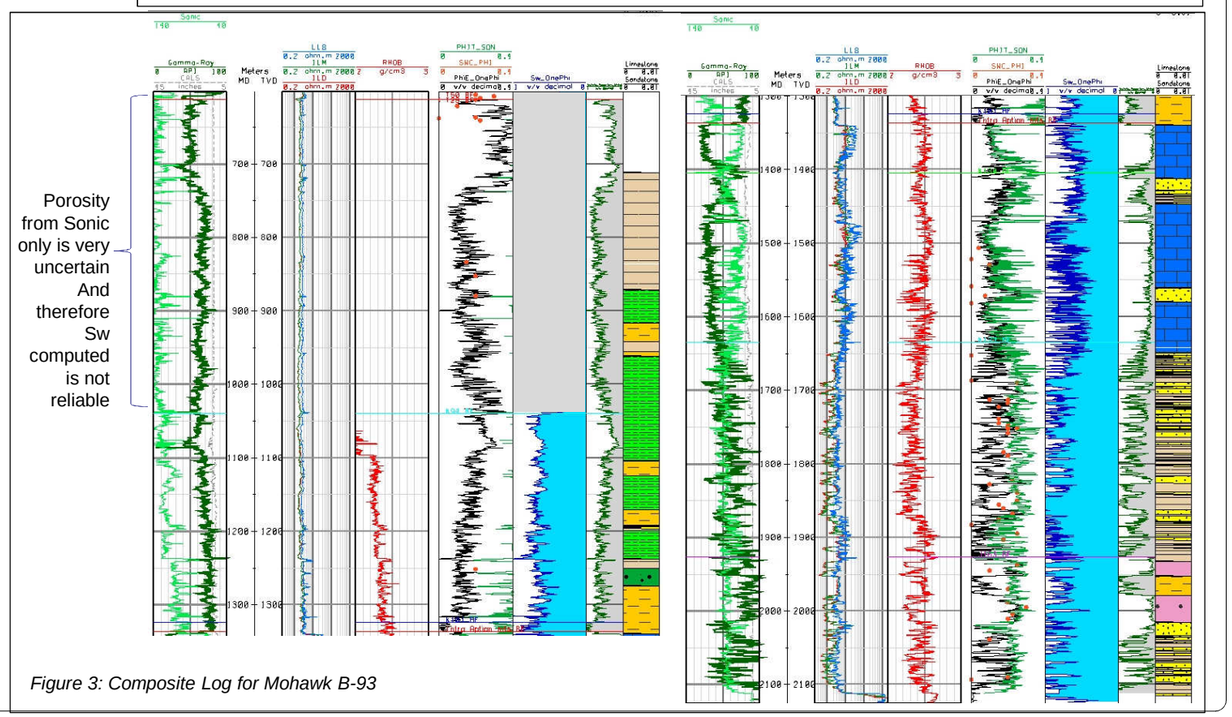

Figure 3: Composite Log for Mohawk B-93

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Objectives of the Electrofacies analyses:

A log-based facies analysis is performed to complement the evaluation of shale and porous volumes from logs to better constrain geological model and facies maps. This allows us to (1) compare cuttings lithologies with log readings at different scales of observations, (2) positioned results to log depths and (3) compare results with petrophysical analyses.

The well Mohawk B-93 was included in in the statistical electrofacies determination through cluster analysis performed on three (3) wells in the Laurentian basin study as performed earlier in 2014
A supervised approach using previously defined mapping codes was performed to extend the electrofacies defined for these three wells to the well Mohawk B-93 and yield electrofacies log.

Electrofacies Methodology and Results

A clustering technique (developed in EasyTrace ™ software) in a multidimensional space generated by selected input logs is used to group facies based on their characteristic log signatures.
In 2014 Laurentian Basin Study, Cluster analysis of log data was performed for the 3 wells, Bandol, East Wolverine and Heron, using the following logs: RHOB, NPHI, DT, VSHfin, PHIEfin. From cluster analysis 10 electrofacies were defined as training samples. (Figure 5). Lithologies from Cuttings description match fairly well with electrofacies.
The previously defined training samples are compared with Mohawk log responses (Figure 4). Similarities in facies definition can be found but some log responses are not represented by previously defined electrofacies:

- Sandstone, Claystone and Limestone from 2014 determiniation are well identified
- Chalk are grouped with Limestone points (Chalk was not described in Mohawk Lithological description)
- Group of points with Low Density and medium GR values are not covered by training samples from 2014 study (red circle)

The propagation of 2014 mapping codes was performed using the GR/DT/RHOB logs. The lack of Neutron log on Mohawk B-93 introduces uncertainty on propagation as Neutron was used in 2014 determination.
The results of the propagation is presented in Figure 5. The upper part of well is not covered by the propagation (RHOB is missing) and the cluster of points defined in Figure4 are set as Claystone or Limestone.
By comparing the EF results with the available lithological description from cuttings (Figure 6), a good match is observed except in the bottom part of the well where Limestone are predicted whereas Sandstone are described from cuttings .
Prediction of few amount of chalk facies whereas no clear evidence of Chalk comes from cuttings description.

Complete Statistical Electrofacies analyses using Mohawk and Bonnet Wells is therefore recommended to improve the lithological determination.

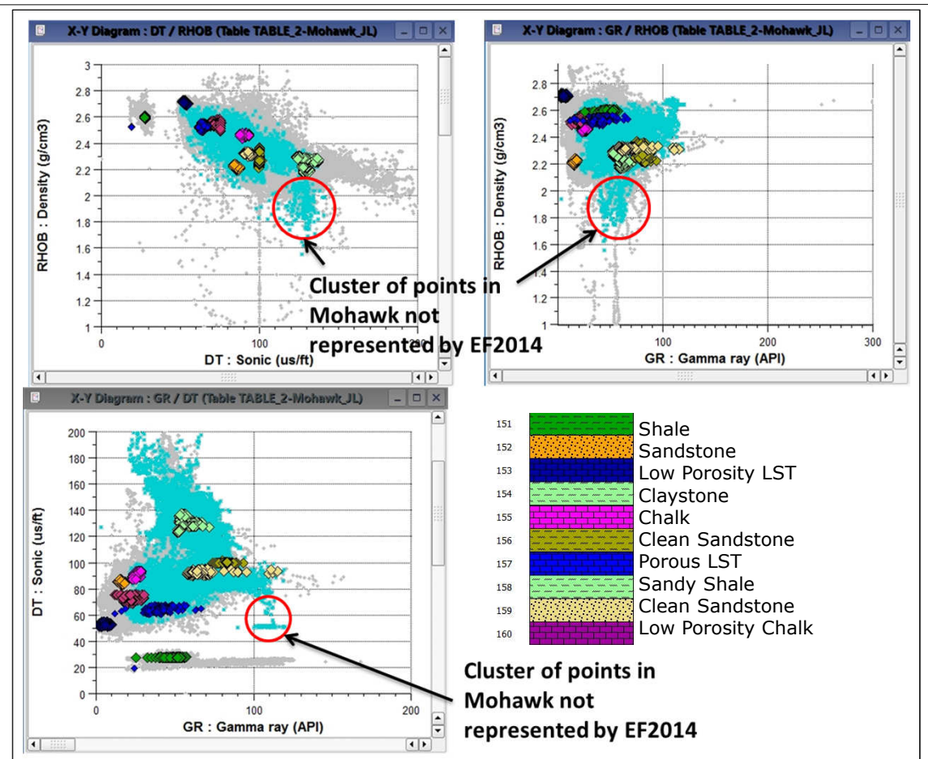


Figure 4: Display of training samples from 2014 study with Mohawk B-93 log responses (blue)

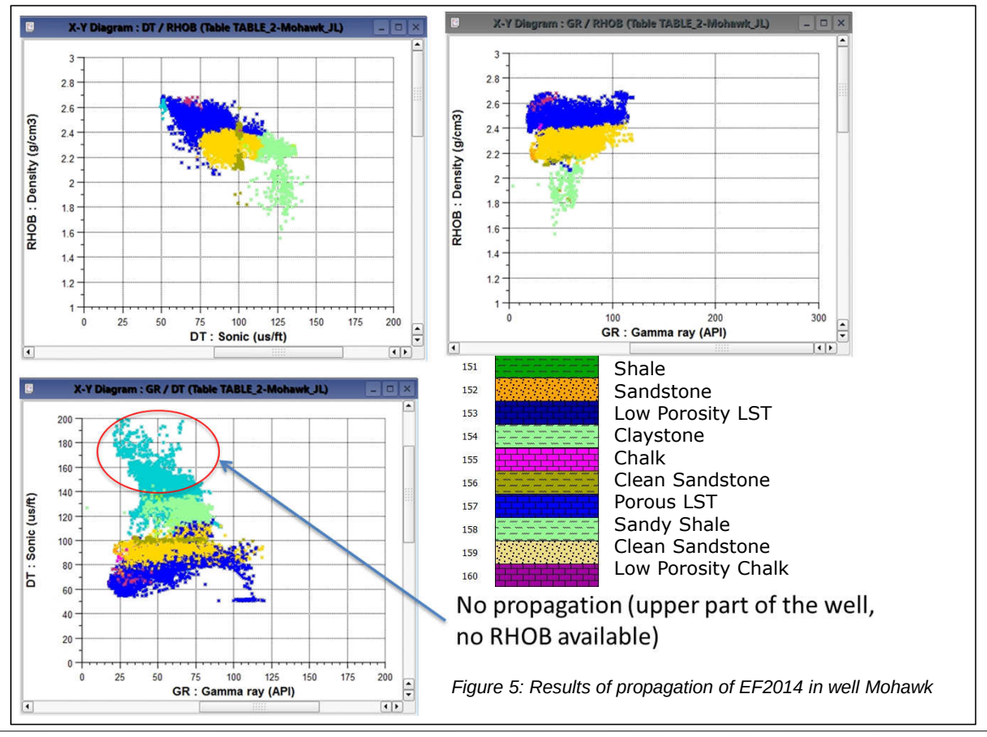
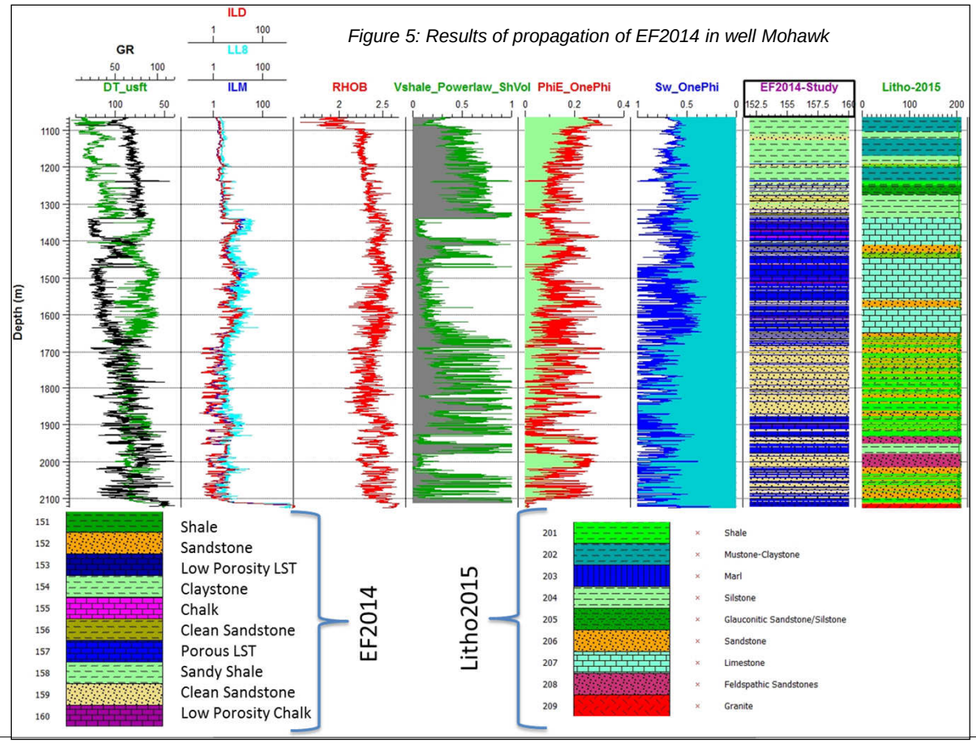


Figure 5: Results of propagation of EF2014 in well Mohawk



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