The Using of Vp/Vs Ratio and P-Impedance for Differentiate Both Fluid Sand Lithology Depending on Rock Physics Templates Model of Mishrif and Nahr Umr Formations in Kumait and Dujaila Oil Fields Sothern Iraq

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ABSTRACT

This study attempt to explore the local rock physics modeling to reach the best solve in case of some difficulties such as missing some logs in reservoir prospects. This research applied to three wells Kt-1, Kt-2 and Du-2. Some Petro-physical properties measured from the logs and others by using a particular equations and empirical such as the shear wave velocity which is extract from the P-wave velocity. The rock physics application using relation cross-plots between acoustic impedance versus Vs/Vs ratio were match the result of therock physics templates model to separate the lithological units of sand and shale in the wells and carbonate rock in the reservoirs of interest with the aid of the relevant rock physics models. The acoustic impedance (AI) versus Vp /Vs ratio cross-plots indicate the type of fluid from the log and identified shale, sand bodies and oil or water bearings carbonate rockzones in Mishrif and NahrUmr Formations in Kumait and Dujaila oil fields, southern Iraq. The study represent a successful attempt to obtain the lithological and fluid types depending on rock physics templets model instead of the interpretations of logs of the reservoir.

KEYWORDS: *Seismic inversion; Rock physics templates; Vp/Vs ratio; Acoustic impedance.*

INTRODUCTION

Various types of lithology influence the acoustic impedance (AI) (Bjorklykke, 2010).The acoustic impedance seismic inversion is done to obtain the modulus which used to investigate the presence of hydrocarbon depending on the 3-D seismic survey. Usually the high AI values related to shale presence, while the low AI indicate a hydrocarbon-bearing sand in case of clastic sediments and carbonate reservoirs which effected by lithology types. The acoustic impedances values affecting the reflection coefficients, which match the synthetic seismograms that can be note on the seismic section (Bjorklykke, 2010). The elastic properties are very necessary to ensure an effective reservoir interpretation. The rock physics consider the best relationship between geological parameters and

geophysical measurements. Rock physics is useful in quantitative seismic interpretation. The rock physics methods used to improve the reservoir detecting and the fluid types delineation. Elastic properties such as density, velocity, AI, and ratio of Vp / Vs play a key role in characterizing the reservoir as they relate to the reservoir characteristics. Information on rock physics is linked between elastic properties with reservoir properties, such as porosity, water saturation, and volume of shale, to specify these elastic properties. A framework for the effective characterization of reservoirs may be used to model the rock physics (Avseth et al., 2005; Avseth et al., 2006; Andersen and Wijngaarden, 2007). The lithology and fluid content or saturation cannot be exactly determined in the reservoir property analysis by determining various clusters in the elastic property cross. The determination of lithology, porous fluid, sizes and pore shapes are important in petro-physical studies. The determination of the lithology and the pore fluid is important parameters for relatively successful hydrocarbon exploration and production. The accurate lithology and pore fluid determination assists to obtain many parameters such as porosity, saturation, and permeability. The hydrocarbon content depends on the type of the lithology and on the pore types (Hami-Eddine et al, 2015). The information of pore types, and lithology can be contribute the petroleum engineering decisions. The core samples study can be used to obtain reliable information concerning the rock, pore types. Basic sample analysis for predicting lithology and porous fluids is costly and normally takes time and effort to determine the lithology and pores using cuttings from drilling operations. The using of lithology and pore fluid information depending on the well log data is relatively easier and cheaper than the other the methods. The details sub surface geological information; well logging recorded provides interested geological information (Serra, 1982). Brigaud et al. (1990) mentions that the well records give better information than the laboratory measurements.

In this research an idea were suggested to link framework templates physics rock with Vp/Vs ratio versus AI depending on evaluating the well logs in study area in order to separate the fluid types (oil or water) and the lithology rock types of Mishrif and Nahr Umr formations.

Study Area
The study includes Kumait oil field in Mayssan governorate and Dujaila oil field in north eastern Nasiriyah City as shown in Figure 1. Four oil wells were considered, these are Kt-1 and Kt-2and Du-1 and Du-2.

Base map preparation
Base map 3D survey prepares and loaded seismic data in GeoFrame4.5 workstation software available in Oil Exploration Company (O.E.C). Kumait and Dujalia fields were included four wells in the study. Also includes definition of the geographic coordinates in UTM coordinates system in a studying area as shown in Figure 2.

SUBSURFACE GEOLOGY

Mishrif formation in Kumait field
The thickness of Mishrif Formation in Kumait-1 about 311 meters at depth (3049 to 3360) and in Kumait-2 its thickness 310 meters from depth 3063 to 3373m, (Alwan, 2015). Mishrif in Kumait-1 is water reservoir, and consists of limestone calcareous and wackestone, Figure (3). Mishrif Formation considered as the main reservoir in Iraq. The rocks of the upper part of the bottom Mishrif Formation consists of limestone rocks with good reservoir properties and this is considered part of the main reservoirs of the Mishrif Formation in the southern fields (Alwan, 2015).This Formation is highly heterogeneous (Sadonni, 2005) .This Formation is divided into four zones from the base upward, upper Mishrif, MD, MC, MB members and upper Mishrifzone MA. The lower Mishrif zone MD comprises the sub-basinalfaci. MC zone consist of limestone contains Rudist build-up, Zone MB comprises compact marl-limestone. Finally, The upper Mishrif Zone MA characterized by the restricted shelf facies, (Aqrawi et al., 2010). These facies one merge into each other's and the boundary between them are not sharp. Zone MC considered as the main reservoir in the Mishrif Formation (Gaddo, 1971) (Aqrawi, 1998). The underside of the lower part of the reservoir is characterized by

poor reservoir characteristics because it contains mud materials and therefore is considered as non-reservoir rocks (Alwan, 2015).
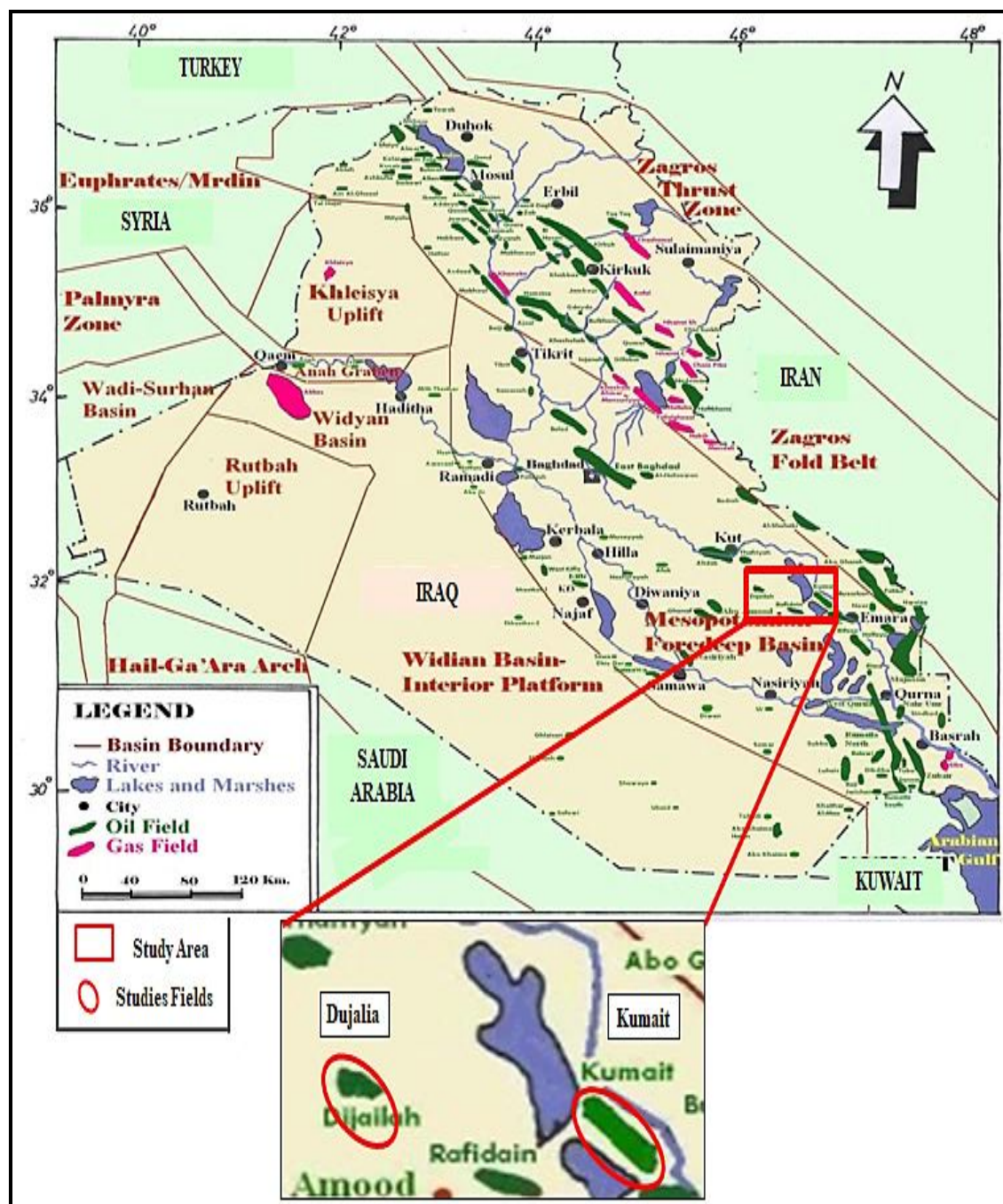

Figure 1: Location map of the study area.
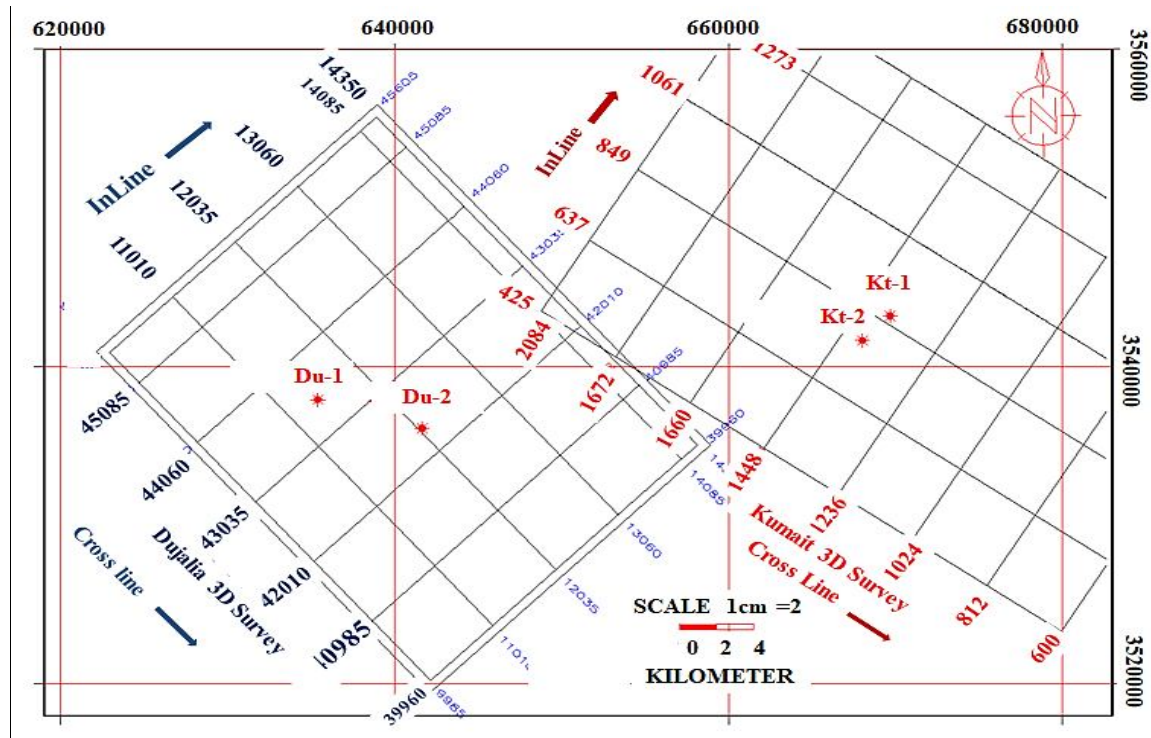Source: after (Al-Ameri, et al., 2010).

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Figure 2: Base map 3D survey of study area.
Source: data derived from (Geofrome software version 4.4, 2016), authors' processing.

PERIOD	EPOCH	FORMATION	DEPTH (m.)	LITHOLOGY	LITHOLOLOGOCAL DESCRIPTION
CRETACEOUS	UPPER	Khasib	3049		Lst .sft . mrl. w. Lst .ooL
		Mishrif	3360		Lst.hd.xin.Chk. glc
		Rumaila	3423.5		Lst. hd. xin. calc. arg.
		Ahmadi	3446.5		Mrl.m.hd.pyr
	LOWER	Mauddud	3700		Lst.Sft.por.Chk.foss
		Nahr Umr	3848.5		Lst. Sft. arg. pyr. w. Mrl. m. hd. s
		Shuiaba	4020.5		Lst .Sft. Chk. por

Figure 3: Geological column in Kt-1 well.
Source: modified from Alwan , 2015).

Figure 4: Geological column in Kt-2 well.
Source: modified from Alwan, 2015).

NahrUmr formtion in Kumait field

Bellen et al., (1959) refer to Nahr Umr Formation and defined in Nahr Umr structure southern Iraq. Salman and Mesopotamian tectonic zones located in southern parts of Iraq, The average thickness of this formation is about 360 m. The thickness of the formation in southern Iraq and Kuwait is about 400 m, while in south of Baghdad it is 160 m. The two main deep-centers in central and southern Iraq match to the areas which receive clastic from the Arabian Shield and Rutba uplift. NahrUmr Formation includes consolidated and unconsolidated sandstone interbedded with shale. Dark shale interbedded with amber, lignite, pyrite sandstones and fine-grained sandstones is formed and observed in southern Iraq. This formation overlay by Mauddud Formation. The thickness of NahrUmr Formation in Kumait-1 about 148.5 meters at depth (3700 to 3848.5) m and in the Kumait-2 its thickness 158metersfrom depth (3707 to 3865) m. (Alwan, 2015),the reservoir point of view it was possible to distinguish sand units separated by covers of layers of nonporous shale rock, Figure (3) and Figure (4).

Mishrif formation in Dujaila field

The Mishrif Formation is one of the important oil reservoirs in the south and central Iraq and the only oil reservoir in the Dujaila field and specifically at the upper part of this reservoir according to the results obtained through the drilling of the wells Dujaila-1 and 2 and the conclusion of all the studies that has been reviewed.

The most important characteristics that made this formation is important is the existence of the rudist masses where these fossils are characterized by the fact that they have shale with channels and gaps that give high porosity to the rock texture, in addition, the broken shale of these shale have been deposited in the form of granular tissue in the shallow areas, which gave the rock texture high porosity and permeability. The thickness of Mishrif Formation in Dujalia-1 about 323 meters at depth (2839 to 3162) m. and in the Dujalia-2 its thickness 309 metersat depth (2816 to 3125) m. (Jassim, 2013), Figure (5).

Nahr Umr formtion in Dujaila field

The thickness of Nahr Umr Formation in Dujalia-2 about 139 meters at depth (3471 to 3610) m. From the reservoir point of view it was possible to distinguish sand units separated by covers of layers of nonporous shale rock and limestone. The logs data are not available in Dujaila-1well (Jassim, 2013), Figure (5).

PERIOD	EPOCH	FORMATION	DEPTH (m.)	LITHOLOGY	LITHOLOLOGOCAL DESCRIPTION
CRETACEOUS	UPPER	Sadi	2580 / 2635.3		Mrl.,sil.,org.,gic.
		Tanuma	2799		Mrl., sil., arg. pyr, w. Lst., sil- silty-hd Sin., arg., mrl.
		Mishrif	2816 / 3125		Lst.,slty- hd, sin., on hd, fess, w. Chl Mrl. ,in upper pl.
		Rumaila	3185.5		Lst. , md- hd, sin, fess,pyr., arg.
	LOWER	Mauddud	3211 / 3471		Mrl., sil , w. sh. silty-hd, fiss.caic.
		Nahr Umr	3610		lst., silty- hd.,&.sin chk., arg.,w. chl loss.
		Shuaiba	3745.3		Mrl.,sit.,pyr.,w.sh.,fisss.& sil.St. calc.
		Zubair	4062		Dol.,md-hd.,sin.,pyr., arg.

Figure 5: Geological column in Du-2 well, after.
Source: modified from Jassim, 2013).

Castagna's Eguation

One of the most commonly used equations for predicting shear wave velocity (Vs)from primary wave velocity (Vp) is the Castagna equation. Castagna et al (1993) suggested mathematical equations for shear wave velocity estimation in sandstone, granite, shale, and dolomite rocks. Since this study essentially deals with the formation of carbonate and sandstone, we use the proposed carbonate rock equation that is presented as:

$$Vs = -0.05509Vp2 + 1.0168Vp - 1.0305 \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

In this equation, Vs and Vp are, respectively, shear and compressional wave velocities and unit of Vs and Vp is ft/us (foot to microsecond).

The mudrock line, also called Castagna's equation or Castagna's relation in rock physics and petrophysics, is an empirical linear relationship between seismic P-wave velocity and S-wave velocity in brine-saturated siliciclastic rocks (i.e., sandstones and shales). The equation reads:

$$Vp = 1.16Vs + 1.36 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where Vp and Vs refer to P-wave velocity and S-wave velocity, respectively.
Velocities are given in kilometers per second (km/s) or m/msc.

The name of the equation refers to John Castagna, professor of exploration geophysics at the University of Houston, who discovered the relation, (Castagna et al., 1993).

METERIAL AND METHODS

The well log dataof this study depends on information from the data bank of the Oil Exploration Company (OEC). The data were input by using emerge application technique and applying by Hampson-Russel system available in OEC to perform testing and application required. Seismic inversion techniques using time information to extract acoustic impedance log information and used to obtain acoustic impedance (AI) with data through used sonic and density logs. All logs information is available for only three wells in this study these are Kt-1, Kt-2, and Du-2. The data logs picked and arrangement and digitized for the three considered wells. The output information data logs such as P-wave (sonic) and density logs loadedto Hampson-Russel system the data available for Kt-1, Kt-2 and Du-2 wells. In this research, shear wave velocity is estimated using available data from P-wave log by empirical equations such as Castagna et al., (1993) to predict empirical Vs from other logs. These empirical relationships offer a good result, and the reliability of other rocks and fluid type to providing a physical model (Wang, 2000). The relation between Vp and Vs in well Kt-1&2, and Du-2 can be predicted Vp/Vs ratio from transform P-wave log. The relationship can be finding between Vp/Vs ratio and AI in these well to draw the cross-plot which it depend on rock physics templates model (RPT) to match the results analysis. Depending on Hampson-Russel software (emerge application) and the mention predicting empirical equations and from the available Vp wave logs the Vs log data were predicate. Following the mention procedure the authors obtain the values of Vs which plotted as a log data with the Vp and density log data Figure (6) and Figure (7).
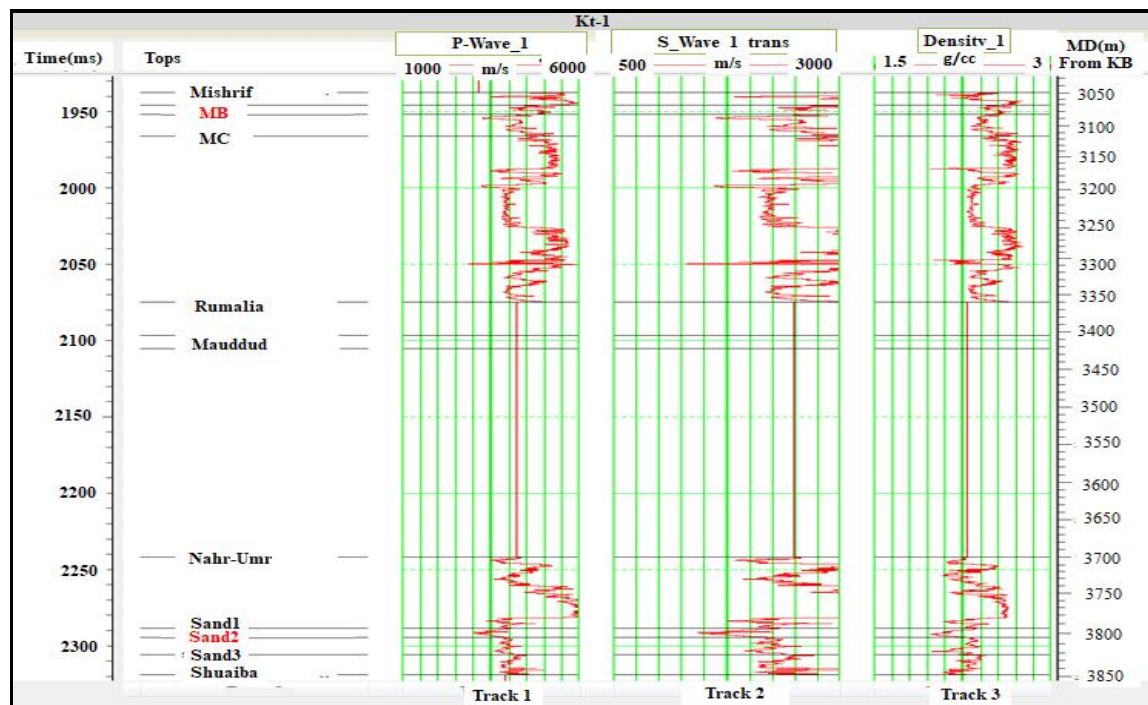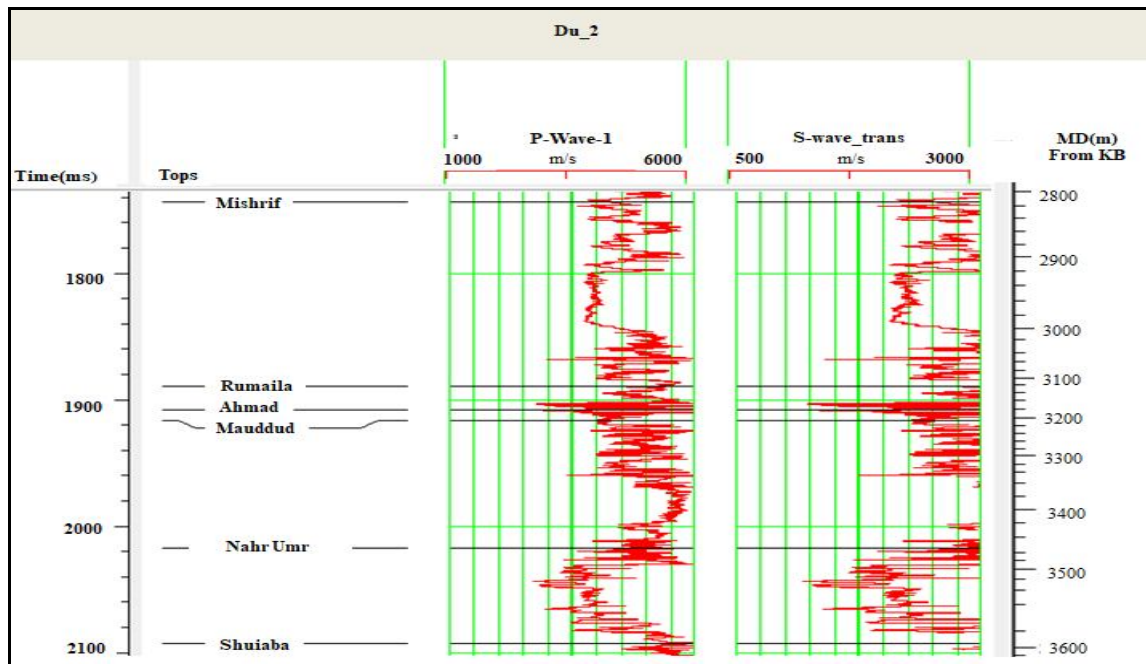

Figure 6: Well data which include tops, P-wave, predicted S-wave and density (Rhob) logs on sit Kt_1 well.
Source: data derived from Hampson-Russel software, 2012), authors' processing.

Figure 7: Shows predicted S-wave from P-wave sonic log on site Du-2 well.
Source: data derived from Hampson-Russel software, 2012), authors' processing.

Rock physics

Rock physics considered as good tool for analysis, the reservoirs lithology, fluid, and geological deposition environment which are important in determination the physical properties. It can be used to enhance and construct a template that described the characterization of the reservoir (Avseth et al, 2010). The Physical properties of the rocks are an important approach to give detail information about the reservoir rock. The most important physical properties in reservoir study are porosity, stiffness, compressibility. The main aims of the developments in this subject concentrated on find a relationship between the physical properties and the seismic reflection data. The detection and construct a predictive theory for such case in each field will give very important information to obtain better investment to the oil fields. The physical properties study provides valuable information, which may be integrated with geotechnics, petro physics, seismic data, and internal rock properties like pore fluid porosity and mineralogy to complete all related information concerning hydrocarbon investments.

Rock physics analysis

This analysis is used for cross-plotting to obtain the elastic properties characterization and use to construct a physics models in order to determine the fluid and lithology. The cross plotted represented as color-coded between AI versus Vp / Vs ratio. Greenberg and Castagna (1992) transform the Primary (P) wave velocity to Secondary (S) in water-saturated silica rock as compared to sand. The rock generally has a high Vp / Vs ratio. The ratio of Vp/Vs of the hydrocarbon content is usually lower than the saline solution because the P wave velocity is more sensitive to fluid alteration than the S wave velocity. So the Vp / Vs cross plot versus AI consider as a good indicator of lithology and pore fluid, Figure (8). The change of the Vp/Vs ratio values related with fluid type variation, and that the cross-plots for each the Vp/Vs ratio and P-impedance with shear wave velocity can be used to distinguish the effects of both lithology and fluid. The difference in acoustic impedance (velocity or density) and Vp / Vs ratio affects the petro-physical attributes, intercept and slope. The Vp/Vs ratio and P-impedance also used to differentiation the sand from shale, the pore fluid gas from water, and the impact of porosity (Avseth and Veggeland, 2015). The decrease in the Vp/Vs ratio and AI will indicate an increasing of gas saturation, while the increasing of AI and decrease Vp/Vs ratio will

indicate an increasing in cement volume. The decreasing of AI and increasing the Vp/Vs ratio will indicate an increased porosity. The Vp/Vs ratio and IA values plot can be used to diagnose the lithology and fluid types. This approach can be applied to separate carbonates from sandstone and shale depending on seismic data, A summarizes regions of different pore fluids and lithologywere shown in Figure (8), (Avseth and Wijngaarden, 2006).
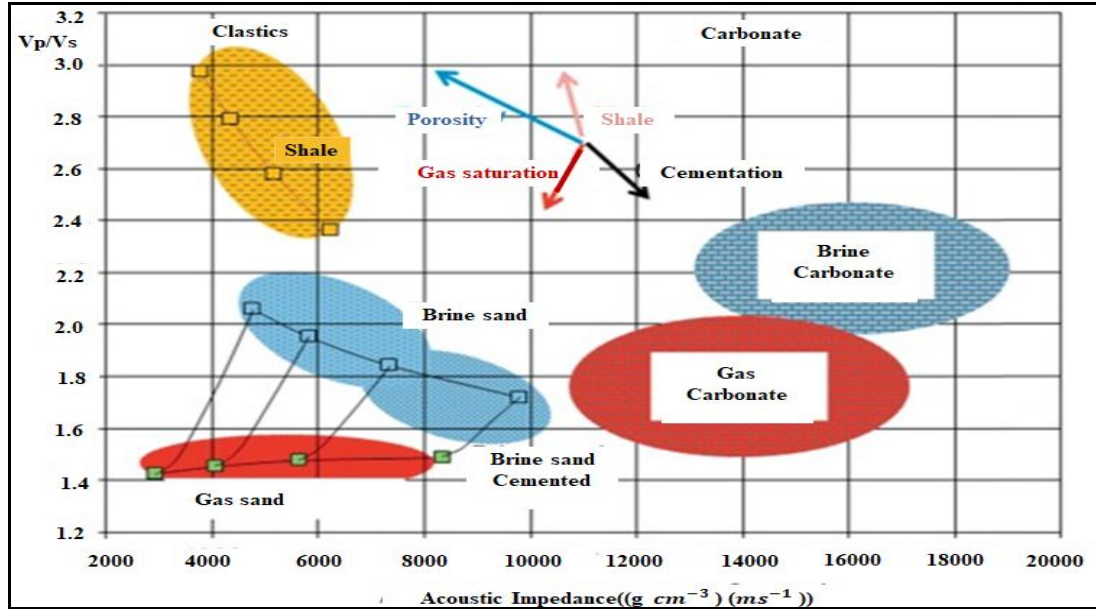

Figure 8: The different lithology according to the relation between Acoustic Impedance and V_p / V_s ratio.
Source: after Avseth and Veggeland, 2015).

Hydrocarbon Effect on Vp/Vs Ratio

Hydrocarbons have an effect on sandstone Vp/Vs ratio and AI. Hydrocarbon bearing sands show a decrease in Vp (due to a significant reduction in bulk modulus and moderate decrease in density), but a slight increase in Vs (due to decrease in bulk density).The combined impact in the hydrocarbon-bearing sands is indeed slightly lower than the Vp / Vs ratio, Figure (9).
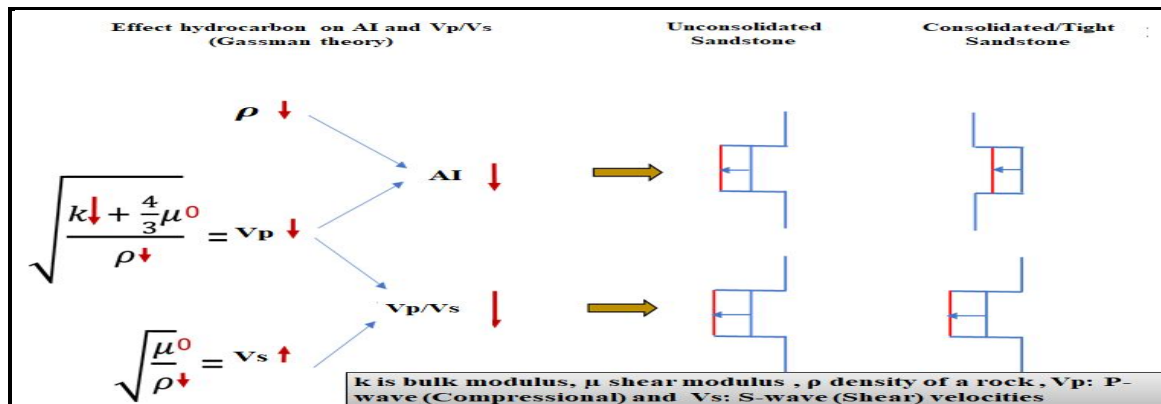

Figure 9: The effect of hyrodrocarbon on Acoustic Impedance (AI) and Vp/Vs ratio on sandstone rocks.
Source: after Avseth and Veggeland, 2015.

The Odegaard/Avseth rock physics templates (RPTs)

The physical properties of rock model construction were requiring building a framework for efficient reservoir description (Andersen et al, 2007). The influence of lithology and fluid content or saturation can be considered as the main factor to be predicted in the reservoir analysis. The interpretation of the obtain physics template depends on the different clusters in cross-plot elastic property which depend on the separate the colored and different depth in cross plot. Using rock physics models (RPTs) that are charts and graphs can be used to verify existence of accumulation hydrocarbon in non-prospect areas and support in seismic interpretation and to confirm prospect reservoir. RPT considered as an assistant tool to verify the important components in the production of reservoir blocks are diagnostic models of rock physics and relationships between Gassmann fluid substitutions. The effectiveness of RPT analysis depends on selecting appropriate model and valid geological information about the reservoir. The common type of RPT is between the AI and Vp/Vs ratio, as a integration of these two elastic properties is a feasible tool to predict the type of fluids and lithology (Odegaard and Avseth 2004, Avseth et al, 2005). Shear modulus parameters (μ) of Lame and Lame, elastic impedance (EI), shear impedance (SI), AI are types of RPT. Gassmann fluid replacement may be researchers combining the above-mentioned depositional and diagenetic trend models to predict the existence of lithology and hydrocarbons and to make model or templates of rock physics. The successful application of this attribute to the detection of reservoirs and eventual use of seismic reservoir characterization, we will perform a analysis of rock physics and a cross-plot. This will give a full idea of the range of Vp / Vs ratio that we predict in the study area for the reservoir units and other formations. Rock physics prototype (RPT) framework for brine and hydrocarbon saturated sandstones and shales at AI and Vp/Vs cross-plot space (Avseth and Veggeland, 2015). This template consists of models for various predicted lithology and fluid scenarios, calibrated for a given reservoir and in a specific sedimentary basin. These models play an important role in understanding the reaction of the elastic parameters (Vp/Vs and AI) to variables in litho-fluid change and reservoir properties, and in interpreting the quality and characteristics of the reservoir, The elastic parameters are represented by Vp/Vs and AI, which are extracted depending on well logdat and seismic data. Schematic rock physics templates (RPTs), consisting of rock physics models combined with Gassmann theory, for the description of regions in AI versus Vp / Vs cross-plot where various facies and porous fluids are to be plotted (Avesth et al., 2010), Figure (10).
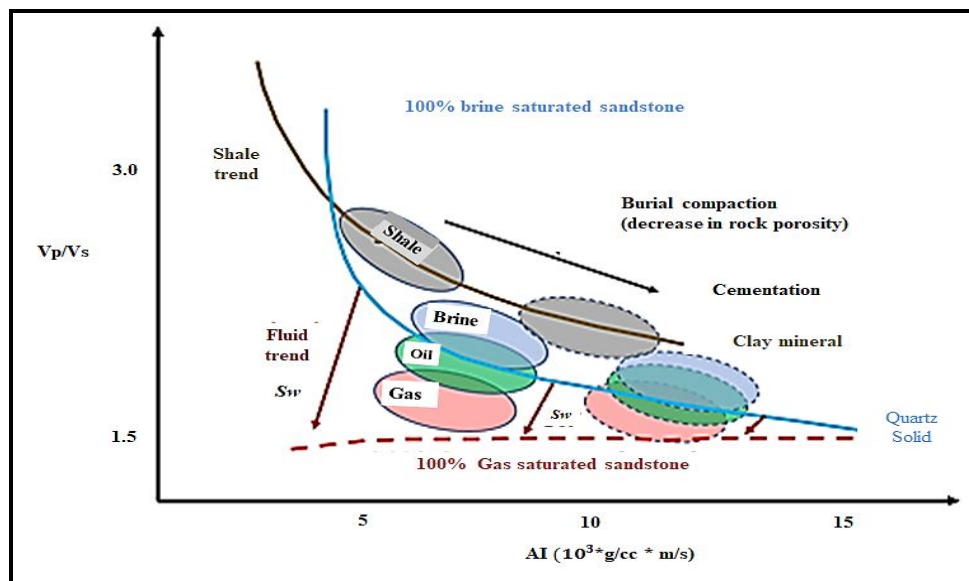
Figure 10: A framework for Rock Physics Template (RPT) in Acoustic Impedance (AI) versus Vp/Vs space for brine and hydrocarbon saturated sandstones and shales.
Source: after (Avseth and Veggeland, 2015).

RESULTS

Crossplot of Vp/Vs versus acoustic impedance (P-impedance) Kt-1 and 2 wells

The compression (P-wave) and shear (S-wave) velocity ratio with AI determined the fluid inside of the wells as shown in Figure (11). The result analysis indicates presence relationship between Vp/Vs ratio versus AI by drawing cross plot for each the wells of Kt-1 and 2. The range of AI ranges from approximately 5500 m/s*g/ccc to 14500 m/W*g/ccc whereas Vp/Vs has range data of approximately 1.5-2.2. Shear waves cannot propagate during fluids, shale is represent high values in each Vp/Vs and AI than sand and carbonates containing hydrocarbons which indicate the lower AI and Vp/Vs values. The body of the sand contains accumulation of hydrocarbons with a higher acoustic resistance and a lower value of Vp/Vs than the shale, hence AI and Vp/Vs are considering a suitable tool for fluid identification. The density of sand is lower than the density of shale and water-saturated sand is higher than sand-bearing hydrocarbons because it is denser than oil (Oyetunji, 2013). The shale clusters which shown in red-colored represented by low-density values while oil-bearing carbonate and sand represent brown and yellow-colored clusters with higher density in Kt-1 and Kt-2 wells, Figure (11). Also, for each point color in curve, the lithology relationship between AI and Vp/Vs and the trend in depth. The relationship between the methods and tools used by RTP physics rock prototype to determine fluid type in wells can be well linked to lithology and the evaluation results. It is observed that the quality of limestone carbonate differ from one well to other, and this significantly deform the sensitivity of the fluid to hydrocarbons. Oil-saturated carbonate in Kt-1 and Kt-2 wells show an increase in acoustic impedance compared to cap-rock shale, while water-saturated carbonates in wells appear an increase in AI compared to saturated carbonate from oil. A significant variation in carbonate over a short distance with shale content would also result in a similar alteration in seismic response.
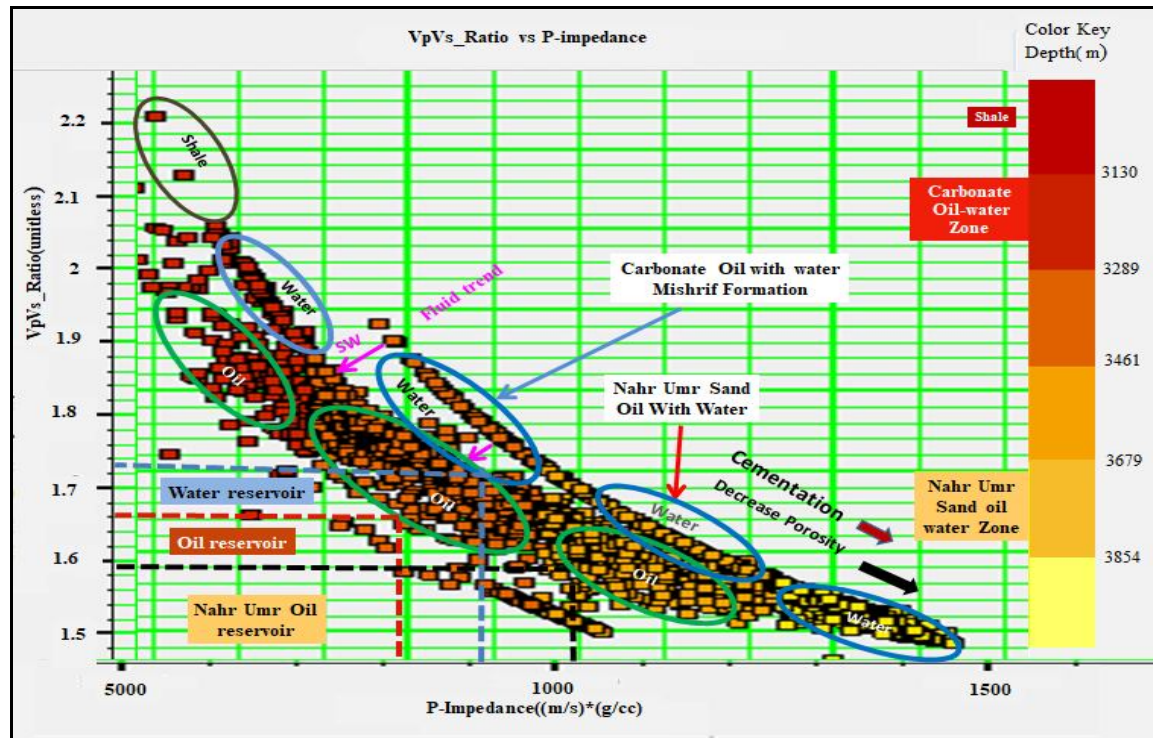

Figure 11: Cross plot of Acoustic Impedance (P-Impedance) log versus real Vp/Vs ratio logs for lithology Mishrif and Nahr Umr Formations (carbonate hydrocarbon saturated and shale) in Kt_1 and Kt_2 wells as color code.
Source: data derived from Hampson-Russel software, 2012), authors' processing.

Crossplot of Vp/Vs versus acoustic impedance (P-Impedance) for Du-2 wells.

Accurate analysis was performed within Mishrif carbonate zones of sandy shale penetrated by the wells in Nahrumr zones. Additionally Vp / Vs against cross-acoustic cross-plot study carried out for Du-2 well. Figure (12) which was achieved by author and showed the crossplot clearly indicates Mishrif carbonate and NahrUmr sandy shale Formations, and wells Du-2 shown in factoil-water carbonate with decrease Vp/Vs and AI values, and use this method to separate fluids (oil or water), The ratio of Vp / Vs and AI in oil is relatively low than that of water in the Mishrif carbonate zone. Due to the very low shear modulus, the saturated water in the Mishrif carbonate zone through at deposition should really have high Vp / Vs (Taufik, 2016). The data well logs are available only in the Du-2 well, and the sandy shale zone appears in the Nahr Umr formation, showing clusters with low Vp / Vs and a slight increase in the acoustic impedance values reflecting the water zone. Furthermore, the Vp /Vs ratio will gradually reduction as pressure, depth and burial raise. In comparison, as grains are stacked together and cemented, AI can increase. Clay as well as carbonates has larger Vp/Vs than quartz, so the impact of mineralogy will be important in RPT. whether the clay particles are pour filling, increase can be observed of AI, and decrease when the clay particles laminate. The increased shaliness, consequently, would have various effects on the AI dependent on the clay particles which are lamination or pour filling. After that, with an increase in hydrocarbon saturation, the ratio of Vp/Vs and AI value will decrease.
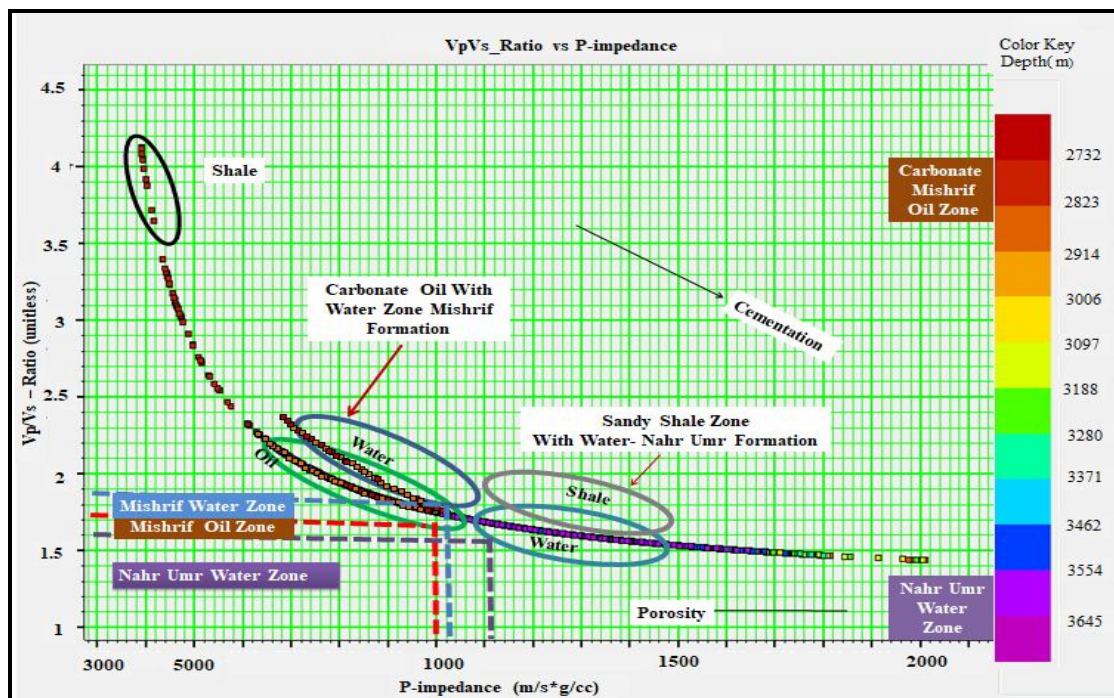

Figure 12: Cross plot of Acoustic Impedance (P-Impedance) log versus real Vp/Vs ratio logs for lithology Mishrif and Nahr Umr Formations (carbonate hydrocarbon saturated, sand and shale) in Du-2wellas color code.

Source: data derived from Hampson-Russel software, 2012), authors' processing.

The cross-plot shown in the Dujalia field in Figure (12) reveals a variety of visible point clusters. As a result of the group's ellipse including using three clusters, these clusters are interpreted as shale oil, carbonate oil with a water zone in Mishrif zones, and sandy shale with water in Nahr Umr formation which matches to petro physical interpretations in well logs. The distance algorithm can statistically

analyze these clusters (Russell et al, 2003).The convergence of densities between oil and water, the difficulty of separating the liquids. The highly dense value clusters was showed that the shale as shown in Figure (12) which it illustrates Vp/Vs ratio by cross-plotting versus AI colored in well Du-2, Vp / Vs range from about 1.52 to 4.3, and AI ranges from 3800 m / s*g / cc to 16500 m / s*g / ccc. The low density of carbonate oil enclosed in the Mishrif zone with a polygon dashed line (red color) has been separated by a slight increase in the density of carbonate water represented by dish line (blue color) and the other side of the other polygon shows high-density wet shale expressed by dish line (Purple color) in the Nahr Umr sandy shale zone.

Vp/Vs ratio versus acoustic impedance
Through the well logs information recorded from Kt-1 & Kt-2 wells in the field of Kumait and Du-2 well in the field of Dujaila, note the cross-plot between the VP/VS ratio and the P-impedance of the well logs, Figure (13) and Figure (14).
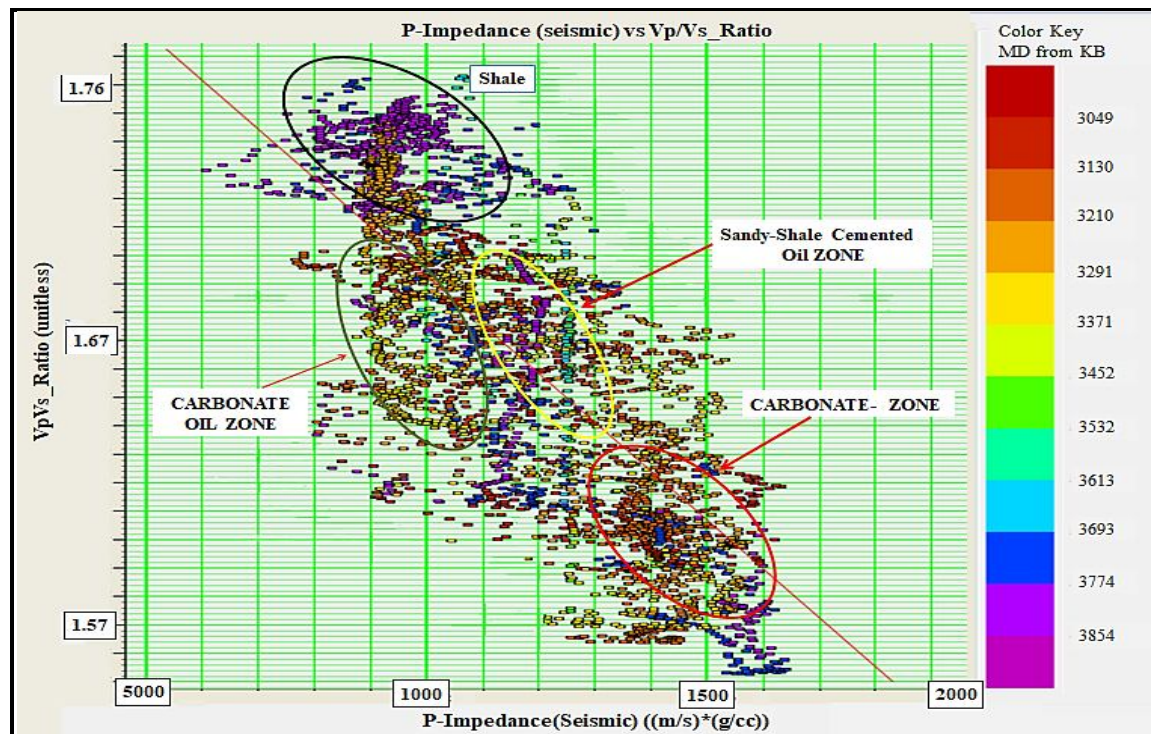
Figure 13: Cross plot between predicted Vp/Vs ratio log and Acoustic Impedance (P-Impedance) using Kt-1 and Kt-2 well log data in the Kumait field. The various elliptical zones correspond to interpreted zones in the well.
Source: data derived from Hampson-Russel software, 2012), authors' processing.

These figures were achieved by authors for both the models and compared of well log and seismic data as well as for the interpretation. The Vp (sonic) log was calculated and the Vs (dipole sonic) log was estimated using Castagna's equation (Castagna et al., 1985), the color scale in the cross plots shows the depth in meters. The oil shale, sand, carbonate and oil zones are interpreted from well logs, referring to elliptical regions on the plot represent the different patterns has reflected these fluid and lithology units. The cross plot divides the zone of hydrocarbon reservoirs within Nahr Umr Formation and within Mishrif Formation into four groups which would include the shale (blackellips), carbonate oil zone (green ellipse), the carbonate zone (red ellipse) and the shale-sand zone (yellow ellipse).The cross-plot can be used to represent the fluid and lithology, thus the conditions in the reservoir can be calculated by the Vp / Vs versus the acoustic impedance attribute.
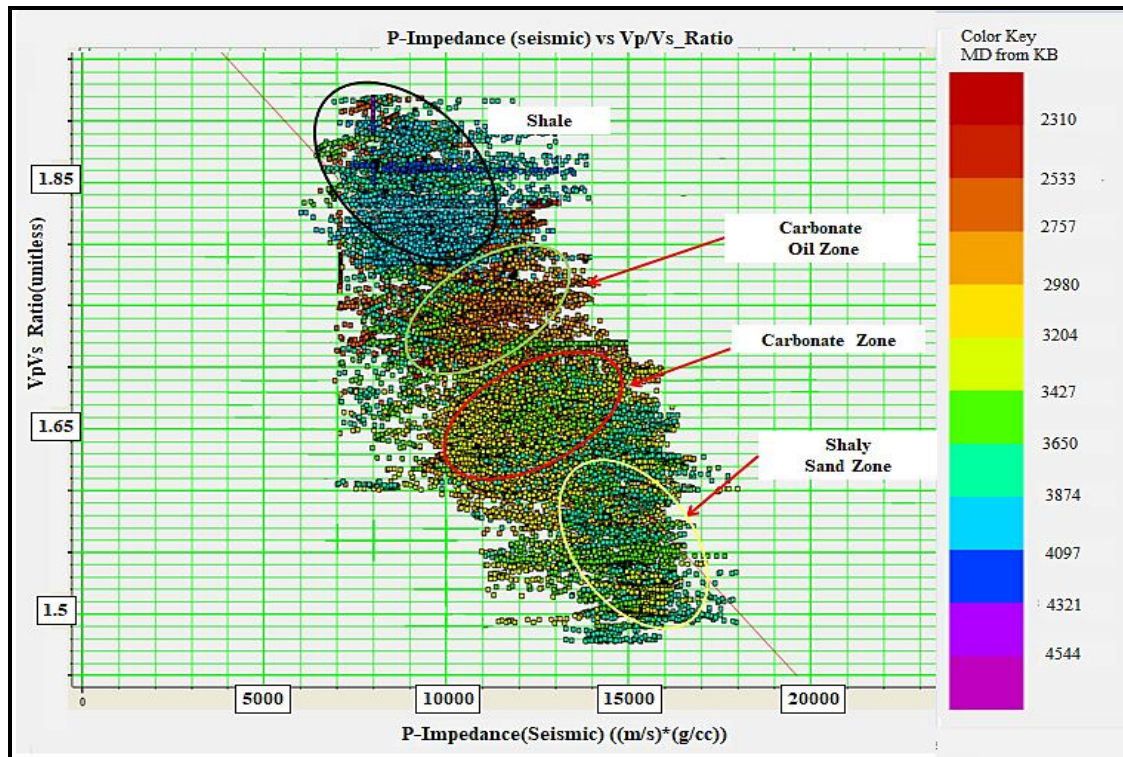
Figure 14: Cross plot between predicted Vp/Vs ratio log and Acoustic Impedance (P-Impedance) using the results of a simultaneous post-stack inversion using Du-2 well log data from the Dujali field.
Source: data derived from Hampson-Russel software, authors' processing.

CONCLUSION

The cross-plotting elastic parameters were used in an attempt to investigate interfere in the reservoir properties using by rock physics templates (RPTs) or rock physics models, graphs and charts are introduced. This method is restricted in local geology, so it is consider mostly only for the local geological restriction, such as lithology, porosity and the discrimination of fluid from carbonate and sandy shale good relationship between acoustic impedance and lithology discernment with the Vp/VS ratio is obtained. The study results proved that the rock physics models helped in separate carbonate and sand from shale. The compression wave and shear wave ratio versus AI through the cross-plots colored log may differentiate the water-saturated shale from the oil sands and carbonate rocks. The results of this study also determined by using the rock physics properties with the Rock templates model to recognize the different types of lithology (carbonate, sand, shale), and fluid (oil or water) separately it is found that density and velocity are the main factors affecting the distinction between the type of lithology and fluid for each unit in formation. The result of the study proved the importance of the area as a prospect hydrocarbon region.

Acknowledgments

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