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## How to Build New Interpretation Concept using Dynamic Data: A case Study in Carbonate of Upper Cibulakan, North West Java Basin, Indonesia

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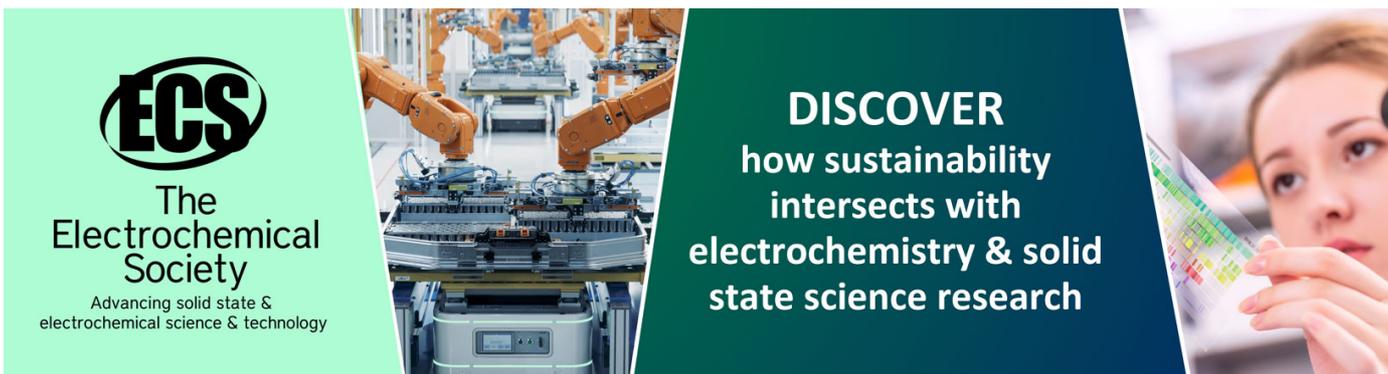
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# How to Build New Interpretation Concept using Dynamic Data: A case Study in Carbonate of Upper Cibulakan, North West Java Basin, Indonesia

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**Abstract.** Bravo Structure is one of the Pertamina EP gas producing field in North West Java Basin region. This structure located at Subang about 10 km southeast from City Subang. The objective of this structure is a vertical compartment of carbonate due to diagenetic effect and transgression. This evident cause shale deposited and divide multi-layer carbonate reservoir. The carbonate lies at Cibulakan Formation and has three reservoirs: Z-14, Z-15, and Z-16 limestone. Since each reservoir has different pressure data and CO<sub>2</sub> contain, so it becomes challenges to make new interpretation and to know those compartments between reservoirs. To look up geometry distribution detailed, this structure is reinterpreted using 3D seismic (2014) and new concept depositional environment based on wells correlation and core analysis. Generating seismic interpretation using seismic inversion and attribute. Amplitude envelope and instantaneous frequency are calculated to obtain sweetness. Both of them are built by 3D volume seismic. High magnitude from amplitude envelope is used to characterize geometry distribution of carbonate while instantaneous frequency determines low frequency because of gas distribution. The result of this study suggests vertical and lateral carbonate distribution characteristics Meanwhile sweetness attribute can determine gas contain in each layer Z-14 and Z-15. Vertical distribution of Z-14 layer about 140 m (porosity 7-11%) and Z-15 about 70 m (porosity 8-13%). Finally, interpreting carbonate both Z-14 and Z-15 as shelf margin that new concept gives a chances to develop this structure and optimize reservoir management.

## 1. Introduction

Bravo structure is one of PT Pertamina EP gas producer field in North West Java Basin region. It is part of Subang Field which located southeast from Subang city. Based on Regional Geology, it lies at Pamanukan High formed as result of *bed rock* lifting with a north-south orientation and it is part of Pasir Putih sub-basin system. This high is surrounded by fault system which separates Kepuh low at East and Pasirbungur low at West [1].

This structure has three main wells which are: Bravo-01, Bravo-02, and Bravo-03. Among those wells data, the objective of this structure is vertical compartment of carbonate due to diagenetic effect and transgression. Those processes cause shale deposited and divides into multilayer carbonate reservoirs. In this case, these carbonate reservoirs that lies in Upper Cibulakan Formation divided into



three reservoirs; those are Z-14, Z-15, and Z-16 layer. Interpretation and analysis for that carbonate vertical compartment using the different pressure and high CO2 contain of each reservoir (Figure 1).

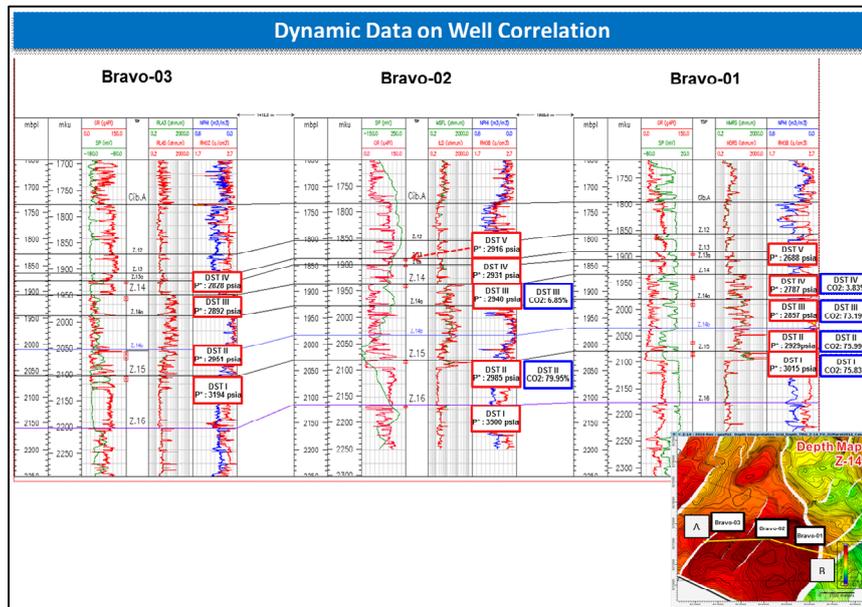


Figure 1. Well data correlation shows different pressure and CO2 contain each layer.

Table 1. Core analysis results Well Bravo-01

Depth (Metres)	Permeability (mDarcies)	Porosity (%)	Res. Liq. Sat		GD	Lithological Description
			Oil	Total Water		
1897	1.01	15.44	5.96	47.15	2.637	SD: gy, med hd, vgy, sbrnd, w strd, tr.calc, sli foss, sli arg, patchy brn flu, slow lt yell-lt brn uniform cut
1935.5	13	20.70	1.02	63.46	2.707	LM: (Packstone) gy-lt brn, hd, l.foram, algae, coral, pp-mott, mott lt yell flu, slow lt yell-milky uniform cut
1992	3.98	11.34	0	69.97	2.707	LM: (Wack-Packstone) gy, hd, l.foram, algae, styl, no flu, no cut
2061	3.63	12.70	0	65.14	2.698	LM: (Granstone) lt gy-wht, hd, l.foram, algae, pp lt yell flu, slow lt yell-milky strw cut
2081.5	21	11.03	0	67.48	2.722	LM: (Packstone) gy, hd-vhd, foram, l.foram, moldic, no flu, no cut

First, to look forward geometry distribution and depositional environment of the reservoir, it is reinterpreted using seismic 3D Post Stack Time Migration data (the year 2014), well correlation, petrophysical analysis and core analysis. Core analysis seen in Table 1. Then next seismic interpretation is doing acoustic impedance inversion and sweetness attribute.

The results of the processing conducted are the conceptual geological model built from acoustic impedance volume and sweetness. Acoustic impedance inversion can show carbonate characteristic associated with the porosity of reservoir. Sweetness succeeds to confirm stratigraphy feature. The high magnitude of amplitude envelope can describe the character of geometry distribution of carbonate reservoir. Instantaneous frequency expected to describe fluid distribution that trapped in the carbonate reservoir. The relation between acoustic impedance and sweetness used for creating a conceptual geological model of carbonate build up that refers to Bubb & Hatlelid concept [2].

## 2. Methodology

### 2.1. Seismic Inversion Acoustic Impedance

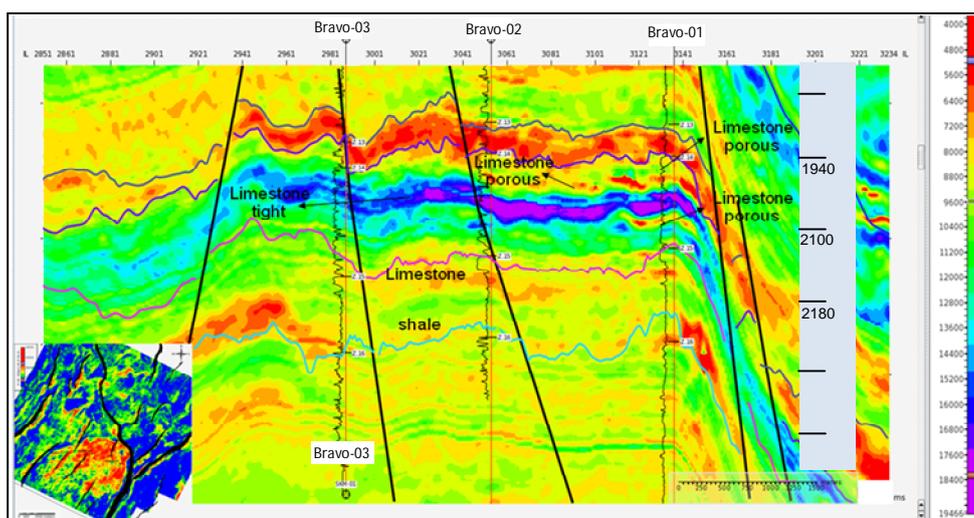
Acoustic impedance inversion is a process to get reflection coefficient value from the seismic record that will be used to determine quantitative rock property such as acoustic impedance value. Inversion method for this study is the model based. It needs an early impedance model (initial model) from well log data, which are velocity log and density log [3, 4]. Parameters used for inversion are background value 14,806 gr/cc.m/s, 40% model weight and 40x iteration in the inversion process.

### 2.2. Sweetness Attribute

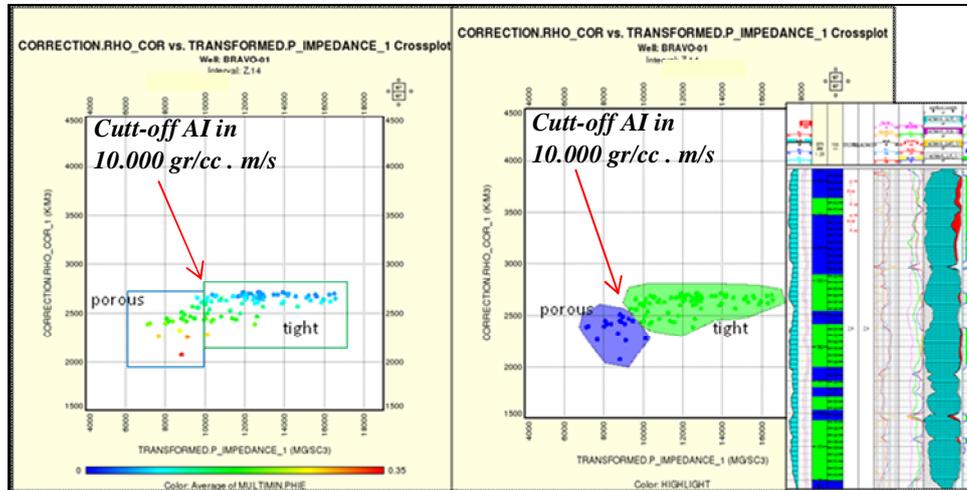
Sweetness attribute is the empirical algorithm to identify reservoir existence in an area based on seismic data that can reveal high amplitude value and low frequency. The ratio between amplitude envelope and the root of instantaneous frequency can build it. This attribute will identify feature which has general energy change of seismic data [5].

## 3. Results and Discussion

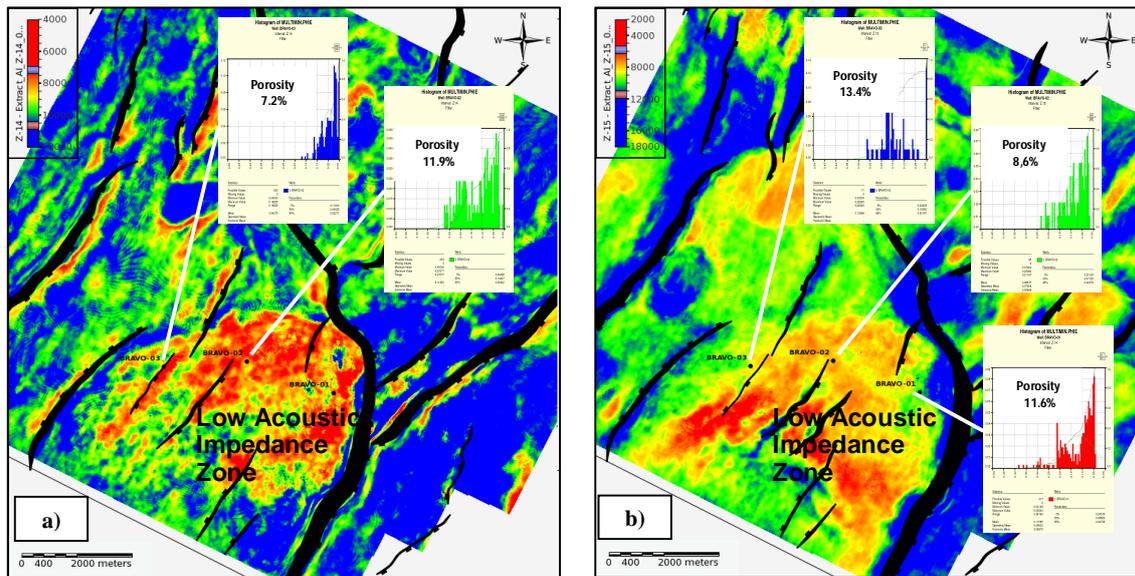
Figure 2 shows carbonate reservoir characteristic, where deposited carbonate Z-14 above carbonate Z-15. Porous carbonate distribution is presented by low acoustic impedance value for carbonate Z-14 at 1935-1960 m and shows up again in carbonate Z-15 at 2080-2120 m. The evenly spread of high acoustic impedance value associated with tight carbonate occur at less than 1960 m to 2080 m. The area on those depths is the platform of carbonate Z-14 growth. Finding out acoustic impedance cut-off value that separates porous zone and tight zone shown in cross plot between acoustic impedance log and density log (Figure 3)



**Figure 2.** Acoustic impedance inversion shows that low acoustic impedance value (red color) associated with porous carbonate, whereas high acoustic impedance value (blue-violet color) associated with tight carbonate

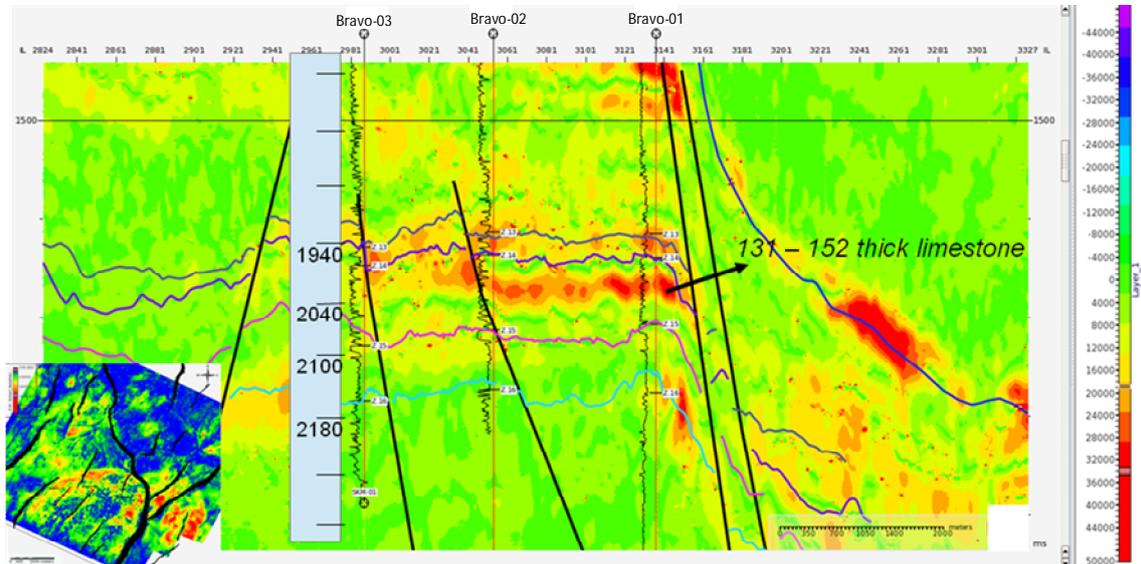


**Figure 3.** Sensitivity analysis with cross plot between acoustic impedance log and density log using effective porosity log as the color scale.



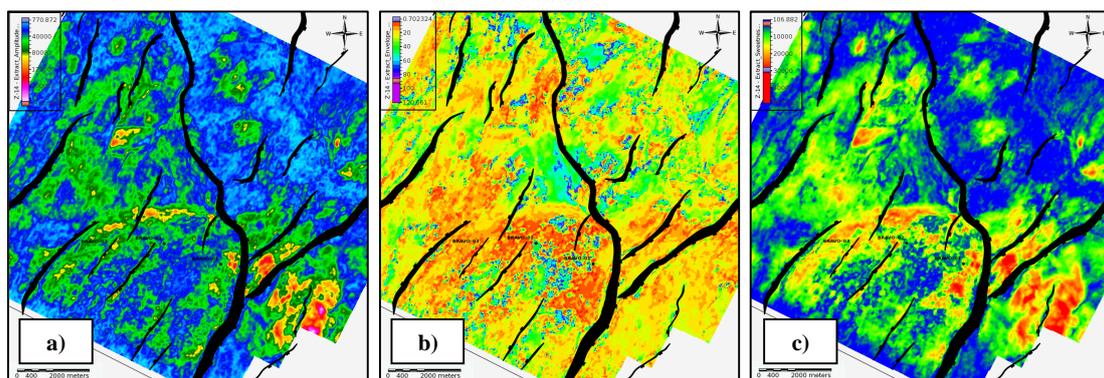
**Figure 4.** Carbonate reservoir properties distribution derived from acoustic impedance using window 10ms; a) Carbonate Z-14; b) Carbonate Z-15

To acquire acoustic impedance value distribution pattern laterally for carbonate Z-14 and Z-15, slicing with window width 10ms along the horizon Z-14 and Z-15 is done (Figure 4). The result can be used for facies interpretation of build up carbonate depositional environment based on rock property value, which is porosity. Low acoustic impedance value distribution that relates with porous carbonate has porosity value around 7-11% for Z-14 and 8-13% for Z-15. Refers to core analysis data (Table 1), depth 1935.5 m (Z-14) and depth 2080 m (Z-15), lithology description shows that carbonate facies is packstone with coral, algae, and foram contains. So that interpreted low acoustic impedance zone associates with shelf-margin facies (Figure 7).



**Figure 5.** Comparison between sweetness attribute and gamma ray on well, sweetness applied to predict reservoir carbonate. High sweetness can show 131-152 m thick of carbonate at 1935 m depth, while carbonate under depth 2080 m can't present good correlation with sweetness

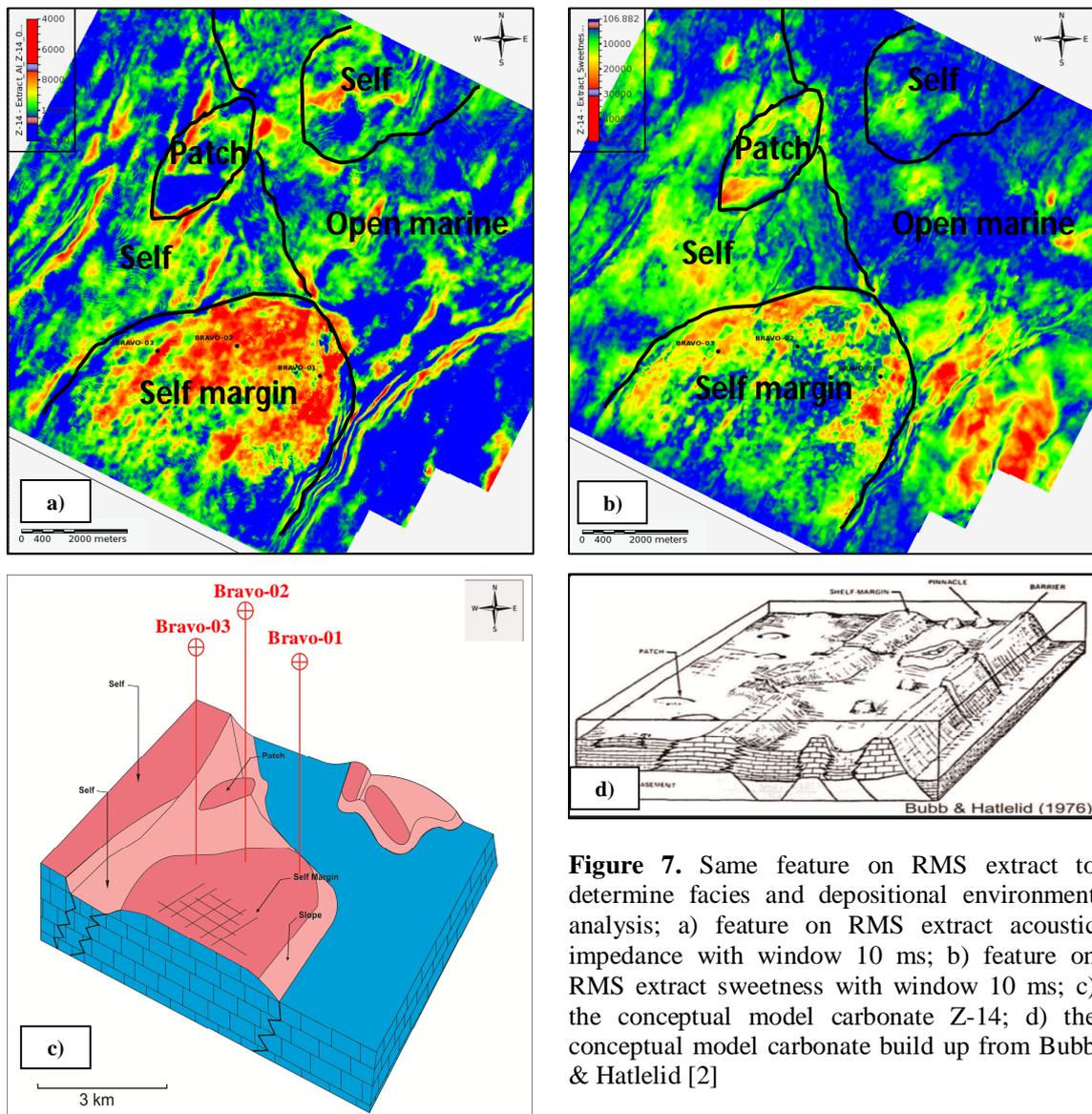
Figure 5 shows high sweetness can describe 131-152 m thick of carbonate at depth 1935 m (Z-14), while carbonate under 2080 m can't show good correlation with sweetness. Sweetness distribution pattern laterally is sliced along the Z-14 top horizon with window width 10 ms, and supported by frequency and envelope amplitude slicing with the same window (Figure 6). The high magnitude of envelope magnitude can show the body of carbonate Z-14 associates with lithological change among rock beds around or boundary depositional environment change of carbonate Z-15. Then low-frequency distribution can show carbonate Z-14 trap that contains fluid (gas). The relation between them generates high sweetness value that can describe stratigraphy feature as a patch reef and shelf-margin. Facies open marine clearly presented with low sweetness value (Figure 7).



**Figure 6.** Same feature on RMS extract to calculate Sweetness attribute; a) feature on RMS extract amplitude envelope attribute with window length 10 ms; b) feature on RMS extract instantaneous frequency attribute with window length 10 ms; c) feature on RMS extract sweetness with window length 10 ms.

Finally, interpretation result using acoustic impedance value and sweetness distribution, the conceptual geological model built for describing the geological condition (Figure 6). Acoustic

impedance value distribution overlaid with sweetness distribution supported by porosity data from petrophysical analysis and core analysis in the model while building that model. Shelf-margin facies generated based on acoustic impedance value distribution, petrophysical analysis, and core analysis. Then patch reef, shelf and open marine facies produced by sweetness distribution. Conceptual geological model refers to carbonate build up conceptual geological model belongs to Bubb & Hatlelid [2]



**Figure 7.** Same feature on RMS extract to determine facies and depositional environment analysis; a) feature on RMS extract acoustic impedance with window 10 ms; b) feature on RMS extract sweetness with window 10 ms; c) the conceptual model carbonate Z-14; d) the conceptual model carbonate build up from Bubb & Hatlelid [2]

#### 4. Conclusions

Based on dynamic data correlation and seismic characterization, we can build the new concept facies, diagenesis, and also environment depositional carbonate. Acoustic impedance inversion can explain reservoirs character of carbonate Z-14 and Z-15. Porous carbonate shown by low acoustic impedance at 1935-1960 m depth and 2080-2120 m depth. While at 1960-2080 m depth, interpreted as the platform of carbonate Z-14 growth because it is tight that shown by high acoustic impedance.

Sweetness attribute can describe a carbonate trap that contains fluid (gas) at 1935 depth with reservoirs thickness around 131-152 m.

Acoustic impedance distribution, sweetness, petrophysical analysis and core can build a conceptual geological model of carbonate Z-14. Shelf-margin facies generated from acoustic impedance value distribution, petrophysical analysis, and core, whereas patch reef, shelf, and open marine facies determined by sweetness value distribution.

### **Acknowledgements**

We would like to thanks to PT. Pertamina EP Asset 3 as the company that owns Bravo structure

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