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AVO Application in a Carbonate Offshore Oil Field, U.A.E.

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SUMMARY

We will present fluid substitution well log modeling results based on Gassmann's equation and application of conventional AVO and other techniques such as Elastic Impedance and Simultaneous Inversion followed by lambda-rho mu-rho (LMR) techniques in a pilot area of interest. The results of the pilot study were validated with the known well fluid status in the pilot area. Mapping of the different water-oil-gas fluid response using the LMR technique shows a reasonably good agreement with currently known well saturations. It is, however, difficult to discriminate reservoir sub-layer water-cut percentages due to data resolution limitations. Generally, the results of the analysis indicate potential to identify hydrocarbon to water fluid contents, with the above constraints.

Amplitude Variation with Offset (AVO) is a well known technique as a direct hydrocarbon indicator in clastic gas fields. Carbonate reservoirs usually have a more rigid rock framework making them more difficult to see the changes in elastic parameters based on differing types of fluid saturation. An AVO Pilot Study has been conducted in 2007 to investigate the ability to detect fluid fronts in a producing Lower Cretaceous carbonate oil field, using pre-stack seismic data acquired in 2001. Assessing the position of injected water is a critical factor for future in-fill well location optimization and provides additional support for reservoir fluid movement prediction when coupled with reservoir surveillance and simulation data. The study was conducted in a small pilot area that includes a recently drilled well, where necessary data were available for a modeling. The modeling study was performed utilizing log data to assess the degree of seismic change (Table.1 and Fig.1) due to fluid substitution based on Biot-Gassmann equation and synthetics have been generated to compare with actual seismic response. In addition to the conventional AVO technique, other techniques have also been tested such as Elastic Impedance and simultaneous AVO inversion followed by Lambda Rho / Mu Rho(LMR) transforms. The results of the pilot study were validated with the known well fluid status in the pilot area. Mapping of the different water-oil-gas fluid response using the LMR technique shows a reasonably good agreement with currently known well saturations. It is, however, difficult to discriminate reservoir sub-layer water-cut percentages due to data resolution limitations. Generally, the results of the analysis indicate potential to identify hydrocarbon to water fluid contents, with the above constraints.

		ϕ (%)	Vp (m/s)	Vs (m/s)	ρ (g/cc)	Zp (m/s ² /g/cc)	Zs (m/s ² /g/cc)	Vp/Vs	σ	$\lambda\rho$ (GPa ² /g/cc)
Well A	Brine	24	4013.80	2056.89	2.31	9391.33	4596.55	1.95	0.32	42.79
	Oil		-6	2	-3	-9	-2	-7	-14	-31
	Gas		-6	5	-9	-14	-4	-10	-20	-43
Well B	Brine	19	4148.52	2100.03	2.40	10077.76	5124.45	1.97	0.33	49.79
	Oil		-6	1	-3	-8	-1	-7	-13	-30
	Gas		-7	4	-7	-13	-3	-10	-19	-42

Table.1 Fluid substitution effects on properties. Brine row displays the base properties. Oil and Gas (95% saturation) cases are relative changes from the Brine case.

Fig.1 Crossplots of original log and fluid substitution results in different domain. Blue is well B and dark green is well A original log data assuming with mud invasion effect. Brown arrow indicates porosity increasing effect and green arrow is for hydro-carbon increasing effect.