Estimasi Porositas pada Reservoar Batugamping dengan Menggunakan Inversi Seismik dan Pendekatan Geostatistik

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Abstrak

Metode litologi seismik bertumpu pada amplitudo gelombang-gelombang seismik yang dipantulkan oleh bidang batas antar lapisan. Litologi seismik menghasilkan penampang pseudosonic log, pseudo velocity atau impedansi akustik yang merepresentasikan litologi lebih baik dari pada seismik struktur.

Amplitudo dari sinyal seismik terpantul tergantung pada variasi impedansi akustik yang merupakan hasil kali kecepatan dan densitas. Sehingga perubahan pada salah satu parameter tersebut, kecepatan atau densitas batuan akan berkontribusi pada variasi respon seismik dari reservoar.

Litologi dan ketebalan reservoar serta sejumlah sifat petrofisika batuan seperti porositas dan saturasi fluida dipengaruhi kedua parameter tersebut. Oleh karena itu untuk mengestimasi sifat-sifat petrofisika batuan dengan menggunakan data seismik harus mengkuantisasi kontribusi masing-masing parameter petrofisika pada pengukuran akustik.

Metoda ini digunakan untuk mengestimasi parameter petrofisika reservoar migas dari data seismik sehingga disebut sebagai 'Seismically guided reservoir characterization di luar sumur pengeboran.

Geostatistik merupakan framework yang mengkombinasikan sample yang terdistribusi secara spatial, berdasarkan atas data log sumur dan data seismik. Yang berguna untuk estimasi yang akurat dari reservoar properties dari ketidakpastian dari model reservoar.

Dalam geostatistik mapping teknik ini berdasarkan atas Kriging, Regresi Linear dan Cokriging untuk memberikan kontribusi berdasarkan informasi petrofisika batuan yang diperoleh dari log sumur dan arah spatial dari seismik attribute. Secara garis besar teknik geostatistik untuk mengkombinasikan informasi petrofisika dan data seismik.

Dengan geostatistik pada situasi dengan minimal kontrol data, dapat memprediksi karakteristik reservoar dengan lebih baik dibandingkan dengan mapping standard.
<hr><i>Seismic Lithology method was introduced in the 1970's was based on amplitude of the seismic waves reflected by the subsurface interfaces. Seismic lithology generates pseudo sonic log, pseudo velocity log or acoustic impedance time section which represents the lithology better than the seismic structure. By using this method it is possible to estimate the petrophysical properties of the reservoir rocks from seismic data. Furthermore it is possible to estimate the reservoir parameters from seismic data. This approach enables to implement a new method which referred to as seismically guided reservoir characterization in the zones outside the borehole.

The amplitudes of reflected seismics signals depend primarily on variations in acoustic impedance. Changes in either rock velocity or density will contribute to variations in the seismic response of the reservoir. A number of petrophysical properties, such as porosity, fluid saturation affect both rock velocity and density. To estimate reservoir properties using seismic data it is necessary to quantify the respective contribution of each petrophysical parameter to the acoustic measurements.

A series of laboratory P wave and S wave measurement has been conducted on limestone core samples from Baturaja limestone reservoir. By using the laboratory acoustic measurement data to support seismic derived porosity and fluid saturation determination in the reservoir. Several parameters have been derived from transit time data such as P and S wave velocities, Poisson ratio. To provide relationship between fluid saturation, porosity, P wave velocity and Poisson ratio, and modify acoustic impedance, crossplots between the parameters have been generated using a combination of laboratory acoustic measurement on core samples and mathematic modelling.

A geostatistical technique integrating well and seismic data has been studied for mapping porosity in hydrocarbon reservoirs. The most important feature of the cokriging method is that it uses spatial correlation functions to model the lateral variability of seismic and porosity measurements in the reservoir interval.

Cokriging was tested on a numerically simulated reservoir model and compared first with kriging, then with a conventional least squares procedure relying only on local correlation between porosity and acoustic impedance. As compared to kriging, the seismically assisted geostatistical method detects subtle porosity lateral variations that cannot be mapped from sparse well data alone.

As compared to the standard least squares approach, cokriging provides not only more accurate porosity estimates that are consistent with the well data. Using seismically derived acoustic impedances, cokrigging also was applied to estimate the distribution of porosity in limestone reservoir.</i>