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Estimation and separation between seismic wave attenuation modes in carbonate reservoirs by using new approach.

Fateh Bouchaala (1), Mohammed Y Ali (1), and Jun Matsushima (2)

(1) The Petroleum Institute, United Arab Emirates (fbouchaala@pi.ac.ae), (2) The University of Tokyo, Frontier Research Center for Energy and Resources, Japan.

Many methods for quantitative interpretation of seismic data are based on the analysis of amplitudes of seismic waves. Seismic attenuation along the ray path of wave significantly affects this amplitude information. As such, understanding of this phenomenon has a huge impact for seismic studies. The main sources of seismic attenuation are scattering and intrinsic attenuation. The former is an elastic phenomenon where the energy undergoes new redistribution due to subsurface heterogeneities, however the total energy of the wavefield is conserved [Wu 1982]. The intrinsic attenuation is an anelastic phenomenon where the energy is converted to heat due to fluid-solid friction [eg. Müller et al. 2010]. Therefore, seismic attenuation can potentially improve geophysical interpretation in saturated media, such as reservoir zones. Nevertheless, accurate estimation and separation between scattering and intrinsic attenuation is challenging due to misunderstanding of their mechanism and their high sensitivity to data noise.

The sum of scattering and intrinsic attenuation is called total attenuation [Schoenberger and Levin 1974]. This latter is usually estimated from field data by using widely used methods in the frequency domain such as, spectral ratio [Bath, 1974] and Modified Median Frequency Shift (MMFS) [Frazer et al. 1997]. The scattering is usually estimated by applying the same methods on synthetic data generated by using Goupillaud model [Goupillaud, 1961]. Then, the intrinsic attenuation is estimated by subtracting the scattering from the total attenuation. In this study we combine new signal processing flow and a novel method to estimate scattering and intrinsic attenuation separately. The signal processing flow is based on common midpoint (CMP) approach which increases the signal to noise ratio (SNR) of data. The novel method is a further improvement of MMFS method [Matsushima et al. 2016]. Numerical study showed that the proposed method provides better depth resolution attenuation profiles than MMFS method with a good accuracy.

The reservoirs of Abu Dhabi oilfields are known to be highly fractured and heterogeneous. This makes scattering and intrinsic attenuation are good candidates to investigate and understand the properties of these reservoirs. We apply our method on Vertical Seismic Profiling (VSP) data acquired from Abu Dhabi oilfields, to assess the potentiality of these two attenuation modes in fluid and fractures detection and characterization. The comparison of attenuation with reservoir lithology and petrophysical parameters, shows high potential of attenuation on characterization and detection of fluids and fractures. We also provide a new way to use attenuation in fractured reservoirs in order to enhance geophysical interpretation.