Estimating subsurface petro-physical properties from raw and conditioned seismic reflection data: A comparative study

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ABSTRACT

The data conditioning plays an important role in simultaneous seismic inversion process as in some cases, it improves the resolution of the inverted results, while in other cases, it degrades the solution dramatically. Therefore, it needs to be studied carefully. The objective of the present study is to quantify the advantages of performing pre-stack data conditioning, prior to estimation of subsurface petro-physical parameters. In present study, a very simple and straight forward method of testing the effects of data conditioning on simultaneous inversion, have been chosen and inversion is performed over the original processed gathers, as well as the conditioned gathers to measure the difference in intermediate steps of the workflow. In this regard, initially, one trace is inverted and compared with original curve from well log to test the algorithm. The correlation between the two is estimated to be 0.82 for raw gather and 0.87 for conditioned gather. Further, the entire seismic volume is inverted for impedance, density and lamé parameters in inter well region, thereafter, and the cross plots between inverted section are computed. The results of the analysis indicate that the reservoir is devoid of hydrocarbon. The analysis depict that the inversion of conditioned data produces a result, which is of more valuable to an interpreter as compared to the inversion of raw gather.

Keywords: Acoustic Impedance, Seismic Processing, Data Conditioning, Hydrocarbon, Scotian Basin (Canada)

INTRODUCTION

Seismic inversion methods have been widely used to locate potential oil and gas reservoirs, as well as to provide information on the physical properties of the reservoir rocks. Changes in physical properties of the rock such as density, seismic acoustic impedance, cause a significant influence that could be observed in a high quality seismic data. Earlier, only post-stack seismic inversion method was used routinely to estimate acoustic impedance (P- impedance) and characterize the reservoir. However, this approach gives insufficient information about the reservoir, since P- impedance alone is unable to distinguish the effects between lithology and fluid content. Fortunately, this limitation has been overcome by extracting information from the shear impedance (S-impedance) seismic data, to describe the fluid content of the area in a precise manner (Maurya et al., 2018, 2019).

Presently with the advent of new technologies, the prime aim is to increase the resolution of seismic inversion by increasing the signal to noise ratio of seismic gather. Therefore, some researchers tried to use pre-conditioning of gather for improving the signal to noise ratio. However, some other researchers (Chopra and Sharma, 2016; Singleton, 2009) have shown that the pre-conditioning technique degrades inversion results significantly. Therefore, the present study is aimed to demonstrate the effect of data conditioning on simultaneous inversion method for the seismic data from Penobscot, Canada.

The simultaneous inversion method estimates P-impedance, S-impedance, density, V_P/V_S ratio by inverting each partial angle stack data simultaneously, using the extracted wavelet from each angle stack. The inversion results such as Density (ρ), Lambda-rho ($\lambda\rho$) (Incompressibility), and Mu-rho ($\mu\rho$) (Rigidity) are proven useful for reservoir characterization of the prospective area.

The purpose of pre-stack simultaneous inversion is to obtain reliable estimation of P-wave velocity (V_P), S-wave velocity (V_S), and density (ρ) for predicting the fluid and lithological property of Earth is subsurface.