Converted Wave Processing to Reveal Signal of Highly Noisy Single Sensor Data

Victor Dolgov, Bahaaeldin Kamel

Aramco

Abstract

Processing single sensor data is a challenging task which can become troublesome with the added complexity of the converted waves (PS). Without the customary array filtering for both the receiver and shot source to cancel linear and random noise, the processor has to be diligent when dealing with the extra noise level at every step of the processing flow. With the raw shot records being very chaotic and riddled with noise, we have to pay careful attention to the preconditionion of the data in order to reveal the signal which is masked by the noise. Although PS waves processing has additional layers of difficulties, it is still very similar to the processing of P-wave (PP) data. For example, the velocities obtained in conventional processing flows do not need to be re-picked instead we pick only Vp/Vs ratios. Also a important step in PS waves processing is the rotation from field coordinate system into radial and transverse components. In this study, the single sensor data was acquired in the Northern part of Arabia Peninsula utilizing 3-component geophones and a single sweep-vibrator recording. Both PP and PS processing modes were carried out on the data, and the work presented here will be limited only to imaging some aspects of processing PP and PS wave data to show that multicomponent recordings can generate complementary or augmenting images to improve PP data. In our processing, first step was to find a robust approach to apply and deal with noise within the PP dataset. The main idea was to apply a linear noise attenuation (LNA) method in the cross-spread domain then sort the data back into shot domain. LNA is then applied in the shot domain before sorting the data into the common receiver domain and apply the LNA algorithm again. Upon the first application in the cross-spread domain, the gathers seem to be clean but unfortunately sorting them to the shot domain (or any other domain) presented the same noisy looking gathers. Therefore, we had to apply LNA in 3 consecutive domains: cross-spread, shot, and receiver in order to achieve acceptable level of signal to noise ratio. After that we implemented supergrouping for PP data in order to estimate deconvolution operators. The derived operators were than applied back to the original input data. In the second step, we wanted to apply this approach to see if it would work for PS data. Unfortunately, supergrouping methodology requires NMO corrected gather to be flat. This in turn required us to change the workflow and utilize a Non-Linear Beam Forming (NLBF) technique which is more flexible in terms of flatness of the events. Also, NLBF gathers were very well pre-condition for the analysis of Vp/Vs ratios. In this case study we will go through the workflows and the results we obtained for both PP and PS datasets. The outcome of this robust workflow is a seismic image where PS data are bringing additional information to PP data despite of the high level of noise coming from the single sensor data.