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Ground Roll and Random Noise Attenuation Using Common Offset Common Reflection Surface Stacking

Seyed Ali Fa'al Rastegar[1], Abdolrahim Javaherian*[1,2], Naser Keshavarz Farajkhah[3], Mehrdad Soleimani Monfared[4], and Abbas Zarei[5]

1. Department of Petroleum Engineering, Amirkabir University of Technology, Tehran, Iran

2. Institute of Geophysics, University of Tehran, Tehran, Iran

3. Exploration and Production Research Center, Research Institute of Petroleum Industry (RIPI), Tehran, Iran

4. Department of Mining, Petroleum and Geophysics, Shahrood University of Technology, Iran

5. Department of Geophysics, Exploration Directorate of National Iranian Oil Company, Iran

javaherian@aut.ac.ir

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Abstract

Seismic noise can be divided to random and coherent in reflection survey. The ground roll is a coherent noise in land seismic data that has high energy, high amplitude, low frequency and low velocity. It usually masks the reflections. Therefore, it must be attenuated in the seismic data processing. In this paper, we proposed a modification on the common offset common reflection surface method to attenuate ground roll and random noise. The CO CRS stacking operator is a hyperbola; therefore, it fits the hyperbolic reflections in the prestack data. Ground roll and random noise has linear and uncorrelated traveltime respectively. When the CO CRS operator is applied to the data, the reflection events can be detected by the coherency analyses. High coherency values belong to the reflection events, and low values indicate that no events with hyperbolic traveltime are detected. As a result, when the events are distinguished, any event with non-hyperbolic traveltime can be muted. We applied the proposed method on two real land data sets. The new method was compared with the f-k filtering and conventional CO CRS stacking after the f-k filtering. Results showed that the proposed method attenuated aliased ground roll better than the f-k filtering and conventional CRS. Further investigation was the effect of reflection amplitudes on ground roll attenuation by the CO CRS stacking. For a better attenuation, the minimum coherency of reflections had to be higher than the maximum coherency of the ground roll. Therefore, the intersection of the minimum reflections coherency and the maximum ground roll coherency is an SNR threshold (dB) for ground roll attenuation with FO CRS stacking.

Keywords: Common Reflection Surface, Common Offset, Attenuation, Random, Ground Roll.

Introduction

Ground roll is a surface wave with high amplitude, high energy, low velocity and low-frequency [1]. It often covers reflections in the near offset traces and must be attenuated in the seismic data processing [2]. In this paper, the common offset common reflection surface (CO CRS) stacking was modified in order to attenuate the aliased and non-aliased ground roll. We search the dip and curvature of reflections in CS gathers prior to CO section. It is also desired to have a minimum damage to reflection amplitudes, so we only stack the multi-coverage data in the ground roll areas. Searching the CS gathers before CO section is another change with respect to the conventional CO CRS. The validity of the proposed method is tested on real oilfield shot records from the west of Iran. The modified CO CRS stacking attenuated the aliased and non-aliased ground roll well, whereas the conventional methods like f-k filtering could not attenuate the aliased ground roll.

Methodology

The CO CRS operator describes a hyperbolic surface [3]; therefore, fitting any event with a hyperbolic traveltime like a reflection event in the prestack data. Conversely, the ground roll, as well as diffractions, are linear in the common-midpoint (CMP) and common-shot (CS) gathers and can be distinguished and attenuated by the CO CRS operator. Therefore, we applied searching for parameters (i.e., dips and curvatures) and attenuating of the ground roll first in the CMP gathers, then in the CS gathers prior to curvature searching in the CO sections. This means that we first attenuate the ground roll in the CMP gather, and afterwards we attenuate the remaining ground roll re-sorting the data to CS gathers. Before applying the CO CRS operator to the data, the ground roll and reflections had low and high coherency values, respectively. After the algorithm was specified, any event with non-hyperbolic traveltime, like the linear traveltime ground roll can be muted.

Example

We applied our proposed method on the field data that is a split-spread survey from an oilfield in the west of Iran. The sampling interval and trace spacing are 4 ms and 60 m respectively. Figures 1 c and 1 d show the field shot before and after attenuating the ground roll, respectively. Figures 1c-d display the results of the ground roll attenuation using the f-k filtering and conventional CO CRS in the f-k filtered data. As it can be seen, the conventional CO CRS amplifies the remained aliased ground roll after the f-k filtering. By making a companion between Figure 1 b with Figures 1 c and 1 d, it is revealed that the modified CO CRS stacking method can attenuate the aliased ground roll better than the other two methods. Figure 2 represents the f-k spectra of Figure 1. Ellipses in Figures 2 c and 2 d show the remained aliased ground roll after the f-k filtering and conventional CO CRS stacking in the f-k filtered data. Comparing Figure 2b with Figures 2 c and 2 d, also verifies that the modified CO CRS stacking attenuates the aliased ground roll better than the f-k filtering and conventional CO CRS stacking in the f-k filtered data.

Conclusions

In this article, the CO CRS stacking was modified to attenuate the ground roll in multi-coverage data. The CO CRS operator is based on a hyperbola; therefore, it can be used to separate hyperbola reflections from the linear ground roll.

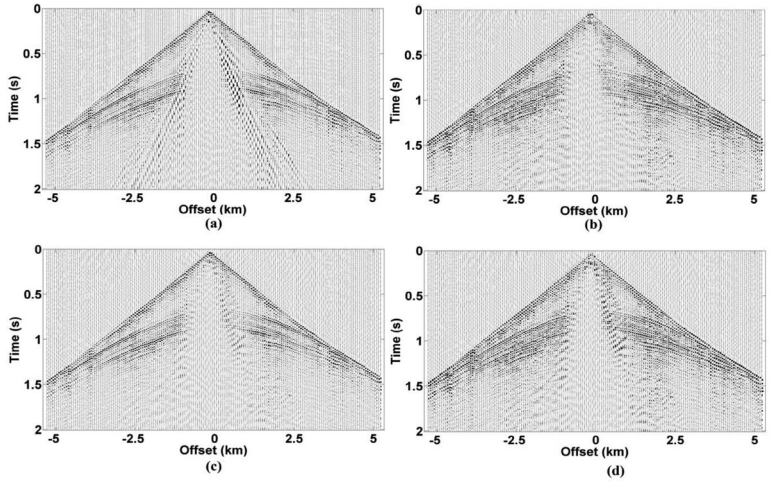

Figure 1: (a) A shot record with sampling interval and trace spacing of 4 ms and 60 m. (b) After attenuating the ground roll using the modified CO CRS stacking. (c) After attenuating the ground roll using the f-k filtering. (d) After applying traditional CO CRS stacking to (c).

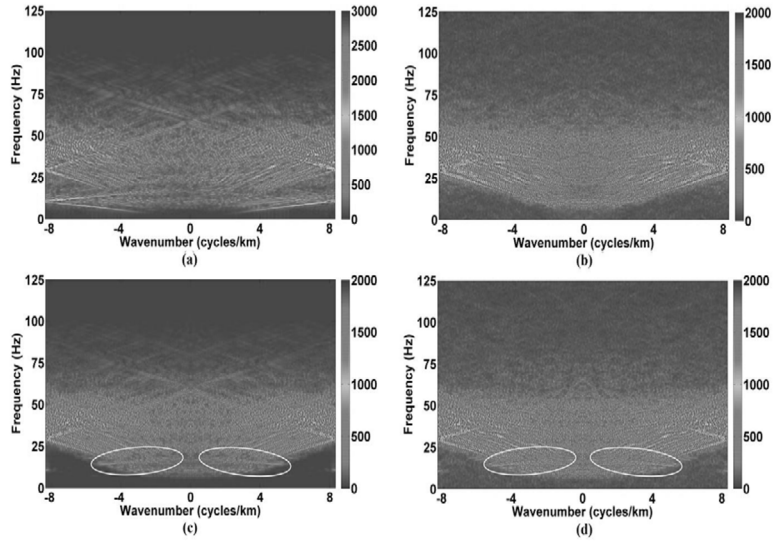

Figure 2: The f-k spectra of Figure 1. Ellipses on (c) and (d) show the remained aliased ground roll. Comparing Figure 2b with Figures 2 c and 2 d verifies that the modified CO CRS stacking attenuates the aliased ground roll much better than the f-k filtering and conventional CO CRS stacking.

We applied the proposed method on the field data and compared it with the f-k filtering. The result showed that the modified CO CRS stacking attenuated the aliased and non-aliased ground roll well, whereas the f-k filtering could not attenuate the aliased ground roll. The modified CO CRS did not make artificial events.

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