Simulation of the Wave Phenomenon for the Near Surface Complexities in Extremely High Resolution

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Abstract

INTRODUCTION

Land seismic becomes the dominant method for oil and gas exploration, particularly with the rising of unconventional resources plays. Land seismic data processing therefore becomes more important. However, compared with processing of marine data, the issues with land data processing are dominated by the near-surface complexities. In Saudi Arabia, one of the near-surface complexities is due to the moving long-wavelength sand dune which is unique compared with other parts of the world. To design appropriate processing procedures and algorithms for land data, it is necessary to understand the physics of the wave propagation acquired in sand dune environments.

THE NEW ALGORITHM

In this paper, we design a new algorithm for the modeling of wave propagation in land environment with sand dune. The input parameters are elastic velocity models and subsurface geological structures. To simulate the wave phenomenon with high accuracy, we use high order finite difference for both time and space. The grids used for the numerical procedure are much smaller than conventional modeling. Therefore, the implementation is realized in high performance parallel computing which is important for repeated modeling for changing sand dunes. Particle velocity components are output from modeling. Output also includes the stresses and strains. The latter are useful for distributed optical fiber (DAS) application.

THE SIGNIFICANCE OF THE OUTPUT

The simulated land seismic data clearly demonstrates the significant impact of near surface elastic structures and sand dunes. The solid and air boundaries cause strong ground rolls which is enhanced by the low velocity and thin structures of the sand dune. Due to the irregular topography of the sand dune, traditional processing may need reimplemented. The simulated results and data are used for the test of new algorithms for land processing such as short- and long-wavelength statics correction, imaging and shallow velocity model building.

APPLICATION IN IMAGE ENHANCEMENT

The modeled data are used for understanding the impacts of changes of the compactness of the sand dune, the lateral gradients of the topography, and the contrasts of the solid and air boundaries. We also applied the data for preliminary imaging. Results show that increasing density of data acquisition can partially mitigate the impacts of the limitations of processing procedures.