CHAPTER 1

Introduction

One of the exploration geophysics is seismic reflection. To estimate the properties of the subsurface from reflected seismic waves, the principles of seismology is required. The seismic source is required for seismic migration method (Sheriff and Geldart, 1995)

Seismic migration (Yilmaz, 1987) is the process which the locations of seismic events are geometrically changed in space or time to the location where the event occurred in the subsurface and record at the surface. Seismic migration moves dipping reflectors to true subsurface locations and collapses diffractions. After migration, image section has increased spatial resolution. There are two migration methods which are 15-degree Finite difference and Gazdag have been run in the testing data sets.

Cartesian coordinate system is a conventional coordinate method that has been applied in the migration processing. Even though, migrating seismic data with the Cartesian coordinate system can handle the models with lateral velocity variations that occur in the complex geologic structure, it still has limitations in the vertical direction (Claerbout, 1985). The larger angle between the extrapolation axis and the wave propagation direction causes the loss of high angle reflection energy. The applied migrations in Cartesian coordinate system cannot correctly image steeply dipping events (Naghadeh and Riahi, 2013a).

By converting the coordinate system from Cartesian to log-polar (Naghadeh and Riahi, 2013a) inexpensive extrapolation operators for imaging subsurface by utilized. By using extrapolation operator in log-polar coordinate systems, wave equation migration can image steeply dipping events using wide-angle waves. Because the extrapolation step size in log-polar coordinate system changes exponentially, the origin of log-polar coordinate system can be located to emphasize areas of complex geological structures.

As a result, structures can be imaged with high accuracy and without amplitude attenuation at great depths. The dip limitation of one-way wave equation migration has been removed by changing the coordinate system from Cartesian to log-polar coordinate systems.

Migration in log-polar coordinates appears to be more efficient in steeply dipping and complex geologic structures in the area of interest. This hypothesis was tested within the seismic data of an area interpreted to have steeply dipping reflectors. In this study, the structurally complex region of Shelikof Strait and Norton Sound was selected to compare the post-stack migration process in both Cartesian and log-polar coordinate systems.

1.1 The objective of study

1.1.1 To use one-way wave equation migration in log-polar coordinate system to image steeply dipping reflectors following Gazdag and Finite-difference methods.

1.1.2 Comparing migration results of post-stack seismic data between one-way wave equation migration in Cartesian and log-polar coordinate systems including the limitations of the methods.

1.2 Literature review

In order to decrease the limitation of downward continuation method, Naghadeh and Riahi (2013a) obtained acoustic wave and wavefield extrapolation equations in log-polar coordinates (LPCs). Wave equation migration in the log-polar coordinate system can clearly image varied (horizontal and vertical) events in complex geologic structures using wide-angle and turning waves. The migration result of synthetic data (Marmousi model), clearly shows the priority of migration in LPCs than Cartesian.

Plane-wave migration in tilted coordinates (Shan and Biondi, 2008) shows the ability to image steeply dipping reflector by using one-way wave equation in tilted coordinate system. In the tilted coordinate system, extrapolation direction close to wave propagation direction by choosing the location of each plan wave source. Steeply dipping reflector was imaged in this method very well.

Riemannian wavefield extrapolation (Sava and Fomel, 2005) using one-way wave equation in semiorthogonal Riemannian coordinate imaged over turning waves efficiently. In this method, wave propagating in arbitrary direction. Mostly, wavefield propagates along extrapolation axis in this method allow them to use Finite-difference of mixed-domain extrapolator image high angle.

Pre-stack wave-equation depth migration in elliptical coordinates (Shragge and Shan, 2008) Remannian wavefield was extended to pre-stack migration in Elliptical coordinate systems. High quality migration image was generated by pre-stack Remannian wavefield algorithm obtaining the migration result more accurate than Cartesian coordinate systems.

In Cartesian coordinates, pre-stack and post-stack migration results of the Marmousi model use the 45° equation to demonstrate that it cannot image events with dip more than ±45° due to dip filtering (Naghadeh and Riahi, 2013a).

In areas of complex geology, defining an optimal tilt angle for the extrapolation grid is not straightforward. The 45° wave equation migration in tilted coordinates can image events with dips from −70° to 70° but reduces the accuracy in other regions of the model and it cannot image dips more than ±70° (Naghadeh and Riahi, 2013b).

The WEM in elliptic coordinate systems needs to consider the correct definition of the foci locations and the stretch parameter controlling coordinate system breadth. An inexpensive operator cannot image dips more than ±75° (Naghadeh and Riahi, 2013b).

Comparing results of pre-stack and post-stack migration for Marmousi dataset in elliptical and log-polar coordinates (Naghadeh and Riahi, 2013b) show that steeply dipping events can be better imaged in the log-polar coordinate system than the elliptic coordinate system.

Turning wave migration by horizontal extrapolation uses the wave equation to image the turning waves (Zhang and McMechan, 1997), in contrast the extrapolation axis is rotated 90 degree to also image the turning wave energy. In this study, the vertical extrapolation axis and horizontal extrapolation axis were used to image near horizontal and near vertical reflectors and resultant images were then combined.