Research plan under the Post-doctorate program at xx University

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Contents

1 Research Title

Crustal seismic anisotropy in the xx using Moho P-to-S converted phases.

2 Research Background & Purposes

Shear-wave splitting analyses provide us a new way to study the seismic structure and mantle dynamics in the crust and mantle. The crustal anisotropy is developed due to various reasons including lattice-preferred orientation (LPO) of mineral crystals and oriented cracks.

Traditionally, the earthquakes occurring in the curst and the subducting plates are selected to determine the seismic anisotropy of the crust. However, none of these methods can help us to assess the anisotropy in the whole crust. Because crustal earthquakes mostly are located in the upper crust, they do not provide information of lower crust. On the other hand, earthquakes in the subducting plates provide information of the whole crust but combined with upper mantle. However, its difficult to extract the sole contribution of the crust from the measurement. Fortunately P-to-S converted waves (Ps) at the Moho are ideal for investigation of crustal seismic anisotropy since they are influenced only by the medium above the Moho. Moho. Figure 1 schematically shows the effects of shear wave splitting on Moho Ps phases. Initially, a near-vertically incident P wave generates a radially polarized converted shear wave at the crust-mantle boundary. The phases, polarized into fast and slow directions, progressively split in time as they propagate through the anisotropic media. Here, the Ps waves can be obtained from teleseismic receiver function analysis.

The Korean Peninsula is composed of three major Precambrian massifs, the Nangrim, Gyeongii, and Yeongnam massifs(Fig.2). The Pyeongbuk-Gaema Massif forms the southern part of Liao-Gaema Massif of southern Manchuria, and the Gyeonggi and Mt. Sobaeksan massifs of the peninsula are correlated with the Shandong and Fujian Massifs of China.

Our purpose of the study is to measure the shear wave splitting parameters in the crust of the Korean Peninsula. The shear wave splitting parameters include the splitting time of shear energy between the fast and slow directions, as well as fast-axis azimuthal direction in the Korean Peninsula. These two parameters provide us constraints on the mechanism causing the crustal anisotropy. From the splitting time, the layer thickness of anisotropy will be estimated. Whether crustal anisotropy mainly contributed by upper or lower crustal or both will be determined. Based on the fast-axis azimuthal direction, the tectonic relation between northeastern China and the Korean peninsula will be discussed.

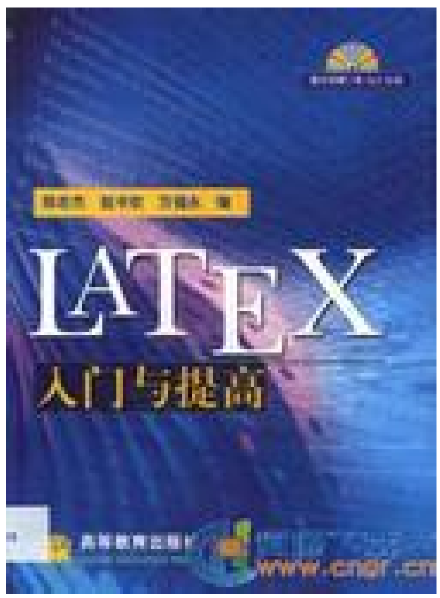

Figure 1: The effects of shear wave splitting in the Moho P to S converted phase. Top shows a schematic seismogram in the fast/slow coordinate system with split horizontal Ps components.(cited from: McNamara and Owens, 1993)

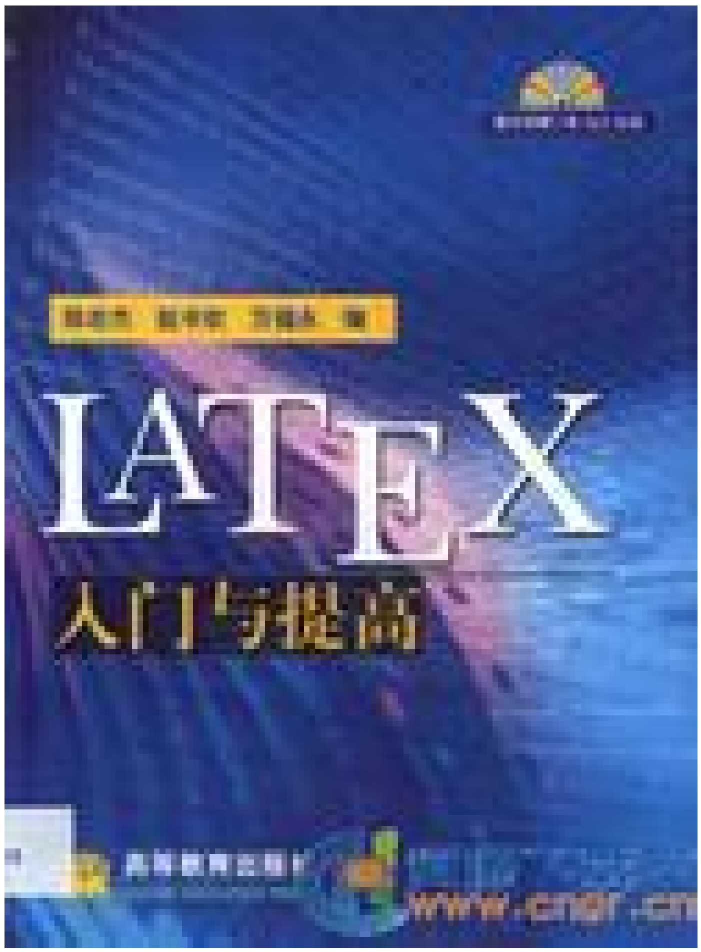

Figure 2: Simplified geologic map. NCB: North China block; SCB: South China block.(cited from: Choi et al., 2006)

3 Research Methods

Several methods have been introduced for calculation of receiver functions. An iterative deconvolution technique may be useful for this study since it produces more stable receiver function results than others. The foundation of the iterative deconvolution approach is a least-squares minimization of the difference between the observed horizontal seismogram and a predicted signal generated by the convolution of an iteratively updated spike train with the vertical-component seismogram. First, the vertical component is cross-correlated with the radial component to estimate the lag of the first and largest spike in the receiver function (the optimal time is that of the largest peak in the absolute sense in the cross-correlation signal). Then the convolution of the current estimate of the receiver function with the vertical-component seismogram is subtracted from the radial-component seismogram, and the procedure is repeated to estimate other spike lags and amplitudes. With each additional spike in the receiver function, the misfit between the vertical and receiver-function convolution and the radial component seismogram is reduced, and the iteration halts when the reduction in misfit with additional spikes becomes insignificant.

For all measurement methods of shear-wave splitting, time window of waveform should be selected. Conventionally the shear-wave analysis window is picked manually. However, manual window selection is laborious and also very subjective; in many cases different windows give very different results.

In our study, the automated S-wave splitting technique will be used, which improves the quality of shear-wave splitting measurement and removes the subjectivity in window selection. First, the splitting analysis is performed for a range of window lengths. Then a cluster analysis is applied in order to find the window range in which the measurements are stable. Once clusters of stable results are found, the measurement with the lowest error in the cluster with the lowest variance is presented for the analysis result.

4 Expected results & their contributions

First, the teleseismic receiver functions(RFs) of all stations including radial and transverse RFs can be gained. Based on the analysis of RFs, the crustal thickness can be estimated in the Korean Peninsula. Then most of the expected results are the shear-wave splitting parameters from RFs analysis in the crust beneath the Korean Peninsula. The thickness of anisotropic layer will be estimated in the region when the observed anisotropy is assumed from a layer of lower crustal material.All the results will help us to understand the crustal anisotropy source.

Crustal anisotropy can be interpreted as an indicator of the crustal stress/strain regime. In addition, since SKS splitting can offer the anisotropy information contributed by the upper mantle but combined with the crust, the sole anisotropy of the upper mantle can be attracted from the measurement of SKS splitting based on the crustal splitting result.

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