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Multimode prestack migration of scattered teleseismic waves and local earthquake sequences for the imaging of crustal structure

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The deep geometry of active faults and the mid-crustal detachment at the base of seismogenic layer is important for understanding active tectonic process and accessing the risk of destructive earthquakes. The detailed image of source fault and subducting slab have been delineated by the controlled-source reflection profiling with the dense array of wide-angle seismic line through the combination of telemetry and independent recording system. Over the past few years, the deployment of a dense seismic array of portable broadband seismometers with 0.5 - 2.0km station interval has presented a number of imaging opportunities using scattered teleseismic wave and local-earthquake sequences, and provided the complementary data for the structural interpretation of lithosphere beneath the seismogenic layer.

Passive seismic imaging methods using scattered teleseismic wave and local-earthquake sequences include receiver function analysis (RFA), interferometric seismic imaging (ISI) and reverse-VSP approach (RVA). We summarized the potential applicability of these imaging methods, regarding migration artifacts due to irregular spatial sampling, prerequisite for azimuth distribution, removal of source-time function and error estimation of origin time and focal depth. Further, we discussed spatial and temporal resolution of seismic profiles obtained by these imaging methods.

Synthetic seismograms simulated by the elastic pseudospectral method for a simple 2D and 3D crustal model are given to investigate the application of RFA, ISI and RVA approach. The numerical modeling results demonstrate that dense spatial sampling less than 2.0km station interval is required to assure the spatial resolution comparable to controlled-source profile, and that migration artifacts and spurious events due to irregular passive-source geometry can be reduced by the multi-mode imaging of various forward and backward scattered phases. Further, we have estimated the earthquake source-time function by event-consistent predictive deconvolution based on the minimum-phase assumption in the application of ISI and RVA. In ISI, the Green's function between two stations for any inhomogeneous medium can be retrieved from deconvolution rather than the causal part of the cross-correlation of these two records. We derived the multi-dimensional deconvolution process to compensate the earthquake source-time function for the estimation of the Green's function. In RVA, the precise estimates of origin time and focal depth substantially improve the resolution of seismic profile. We investigated the simultaneous approach to compensate the estimation error of origin time and focal depth based on the focusing criteria of prestack migration image.