Geophysical Research Abstracts
Vol. 15, EGU2013-6839, 2013
EGU General Assembly 2013

Comparison of advanced seismic migration techniques using the CCSS2003 benchmark dataset

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The principal goal in reflection seismics is to obtain a high quality image of the structures in the subsurface. The main purpose in hydrocarbon exploration is to characterize the reservoir, whereas in deep seismic soundings it is e.g. to image fault zones at transform or convergent plate boundaries or even the crust-mantle boundary.
Kirchhoff prestack depth migration (KPSDM) is widely considered as a state-of-the-art imaging technique to obtain a high quality image of the reflectivity distribution in the crust and mantle. In KPSDM the amplitudes of the reflected wavefield are smeared along the corresponding two-way traveltimes of the reflected wave, and constructive interference leads to an image of the reflector.
Fresnel volume migration (FVM) uses the emergent angle at the receivers to propagate a ray back into the subsurface and restricts the migration operator to the Fresnel volume along this ray. Thus the migration is focused to that part of the reflector which is physically contributing to the reflection. This procedure reduces migration noise and enhances the image quality compared to KPSDM.
Here, we compare both imaging algorithms for their application in deep seismic soundings using the CCSS2003 benchmark data set. This data set resembles a very heterogeneous crust with varying character of the crust-mantle (Moho) transition zone. Comparing the images of both algorithms along the Moho, Fresnel volume migration yields a significantly better resolution as well as less migration noise and enhances the contrast between the highly reflective lower crust and the underlying part of the upper mantle. This effect is particularly evident in areas where the Moho is not a first order discontinuity but rather a transition zone, which in turn allows a better distinction between the crust and the mantle in such areas.