Geophysical Research Abstracts
Vol. 14, EGU2012-4236-1, 2012
EGU General Assembly 2012

New insights on shallow and deep crustal geological structures of BABEL line 7 marine reflection seismic data revealed from reprocessing

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The BABEL project (Baltic And Bothnian Echoes from the Lithosphere) was a collaboration among British, Danish, Finnish, German and Swedish geoscientists to collect deep-crustal reflection and wide-angle refraction profiles in Baltic Shield and Gulf of Bothnia. The acquisition of 2,268km of deep marine reflection seismic data was carried out in 1989. The BABEL line 7 runs in E-W direction in the Bothnian Sea, north of the Åland islands and east of the city of Gävle. Several authors presented the seismic results but with a main focus of imaging and interpreting deep crustal geological structures and the nature and the depth of Moho discontinuity along line 7. Based on this seismic data, several publications about velocity distributions within the crust, the depth and texture of Moho discontinuity and seismic reflectivity patterns in the crust were presented. Some evidence from the reflection seismic data was also presented to suggest Early Proterozoic plate tectonics in the Baltic Shield. Previous seismic images of the BABEL line 7 reflection data show a dramatic change in the reflectivity pattern from weakly reflective lower crust in the west to a more reflective lower crust in the east, which was attributed to a change from a rigid crust to a plastic crust from the west to the east.

The BABEL line 7 reflection data were acquired with a total profile length of 174km, a set of 48 airguns towed at 7.5m depth, and 3000m long streamer with 60 channels spaced with 50m intervals and towed at 15m depth. Seismic data were recorded for 25s using 4ms sampling interval and 75m shot interval. Seismic data is characterized by strong source-generated noise at shallow travel times and strong but randomly distributed spurious spikes at later arrival times.

In this study, we have recovered and reprocessed the seismic data along BABEL line 7. Using modern processing and imaging techniques, which were not available at the time, and with a focus on the shallow parts of the seismic data, we have managed to reveal reflections as shallow as 1s in the data. Some of these reflections appear to be a continuation of deeper reflections but now they appear to reach to the surface, allowing correlation with the near-surface geology. At least two major moderately dipping shear zones are visible in the reprocessed data in comparison with the previous results. Deeper reflections are also improved which together with the improvements in the shallow parts of the data should allow small-scale geological structures encounter along the BABEL line 7 to be refined.