

Upper-crustal Velocity Structure Along 150 km of the Mendeleev Ridge From Tomographic Inversion of Long-offset Refraction Data Collected During HLY0602

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Abstract

Mendeleev Ridge consisted of 14 instrument sites with 12 km spacing between instruments. On every site we deployed a Sea-Ice Seismometer (S-IS) especially designed for this experiment in the ice-covered part of the Arctic Ocean. Each S-IS contained a vertical component geophone that was buried in the ice and a hydrophone that was hanging from the ice edge in the water. From the 14 instrument sites, 10 contained useful data with refracted crustal arrivals up to offsets of 40 km. Because of extensive drifting of the receivers (40 km in 5 days and containing numerous loops), and because of the irregular geometry of airgun shots due to the problems of sailing through ice-covered seas, a 3D ray-shooting code was developed to calculate ray paths within a 3D velocity model that extends along 150 km in the X- direction and along 35 km in the Y-direction. Using the velocity model proposed by Lebedeva-Ivanova et al. (2006) we observe that the maximum depth of our calculated ray paths is 11 km below sealevel. Using all the available data, the Root Mean Square (RMS) difference between observed and calculated travel-times is of the order of 500 ms. Initially a simple 1D travel-time inversion was developed to constrain the velocity structure of the basement underneath a layer of water (3D) and a layer of sediment (1D). This inversion was carried out on 2 pairs of receivers: one pair in the NNE and one more towards the SSW part of the line. Inversion of S-IS 45N-42 (NNE) results in a model with a velocity of 5.5 km s^{-1} at the top of the basement, slowly increasing to a velocity of 5.7 km s^{-1} at 3 km below the top of the basement (RMS = 117 ms). Inversion of S-IS 49-45S (SSW) results in a model with a velocity of 4.8 km s^{-1} at the top of the basement, increasing to a velocity of 5.9 km s^{-1} at 3 km below the top of the basement (RMS = 67 ms). The two resulting crustal velocity models suggest that there is a significant change in velocity along the Mendeleev Ridge: $>0.5 \text{ km s}^{-1}$ difference between the final models from S-IS 45N-42 and S-IS 49-45S. Rays in both models penetrate to a depth of 6.5 km. These results indicate that the Mendeleev Ridge has different crustal velocity structure in the northern and southern parts. It might also provide first proof that the Arlis plateau has a different origin and is separate from the Mendeleev Ridge. A 2D inversion is being developed which will allow inverting all the data along the Mendeleev Ridge simultaneously and which will provide us with a 2D upper-crustal velocity model along 150 km of the Mendeleev Ridge. Comparison of the resulting velocity model with the velocity structure of continental crust, thinned continental crust, oceanic crust, and other oceanic ridges will allow us to interpret the upper-crustal velocities along the Mendeleev Ridge in terms of crustal lithology and tectonic history.

References

N.N. Lebedeva-Ivanova, Y.Y. Zamansky, A.E. Langinen, M.Y. Sorokin (2006). Seismic profiling across the Mendeleev Ridge at 82°N : evidence of continental crust. *Geophys. J. Int.* 165(10), 527-544.

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