Geophysical Research Abstracts, Vol. 7, 03946, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03946

High-resolution tomography application to Northern volcanic group in Kamchatka (Russia)

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The northern volcanic group (NVG) of Kamchatka, that includes Klyuchevskoy volcanic group (Klyuchevskoy, Bezymiannyi, Kamen), Sheveluch volcano and Tolbachik is the largest volcanic center of the active margins on earth. The NVG is located near the Kurilo-Kamchatkan and Aleutian trench junction and its unusual activity correlates with geophysical processes in deep lithosphere and subduction zone. In this study we investigate in details NVG deep structure using high-resolution seismic tomography methods.

Based on the complete EMSD GS RAS catalogue of volcano-tectonic earthquakes during time period from January 2000 to end of May 2004, we selected 11357 events that meet the following conditions: a gap less than 170 degrees, minimum 8 P phases for each earthquake with arrival time errors less then +/- 0.2 s. Thanks to the use of a Minimum 1D model calculated for NVG, data used in this study are highly consistent and more accurate.

Total number of phases used in inversions was 164196 and included 86893 P wave phases and 77303 S wave phases. The subsurface volume was parameterized with cells 10km x 10km x 5km allowing appropriate theoretical resolution of crustal structures and large magma chamber systems. We made synthetic calculations for resolution assessment and to appropriately tune (damping) the coupled inverse procedure. After several inversions we obtain 3D P and S velocity models that allow the following conclusions:

At depths 25-30 km there is a pronounced low velocity anomaly that we interpret as

low crustal magma source region. At the same depth we locally observe a decreasing of Vp/Vs ratio that shows material property change. Near surface low velocity zone (above which there are numerous earthquakes) likely corresponds to Klyuchevskoy volcano direct magma source. Results were compared with gravity data and geology maps.

This work is supported by grant RFBR N 03-05-64650.