Multiscale studies of Subduction zones based on seismic tomography

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In the talk I present an overview of main our results on studying deep structure beneath subduction zones using various tomographic schemes. Shape of subducting slab is studied with the use of regional tomographic scheme which is based on global seismological datasets, mainly on the ISC catalogue. As an example of regional study, I present the model of P and S velocity anomalies in the mantle beneath the Kurile-Kamchatka and Aleutian arcs (Koulakov et al., 2011a). These results show that the slab beneath the Kurile-Kamchatka ark varies its thickness and dipping angle (Figure 1). Beneath the southern Kuriles, the slab appears to be coupled and it can indicate to the eastward shift of the Subduction location. In addition, tomographic images of slabs beneath Sunda, Isu-Bonin and Marianna subduction zones are shown in the talk.

Structure of the upper part of the subduction complexes (down to ~100 depth and with the lateral size of first hundreds km) is studied based on local seismicity data recorded by local seismic stations. In the talk I shortly discuss the tomographic results corresponding to different subduction zones, such as:

1. Central Java, Merapi volcano (Koulakov et al., 2009a, Figure 2A). Based on anisotropic version of the local earthquake tomography code we revealed the paths of fluid and melt migration from the lab up to the volcanic arc. In the area of the Merapi volcano we found a low-velocity anomaly, unprecedented on its size and intensity, which apparently contains the material feeding the volcanoes of Central Java.
2. Toba Caldera, Sumatra (Koulakov et al., 2009b, Figure 2B). The obtained seismic model clearly reveals the locations of magma chambers beneath the active volcanoes of the arc. Vertical low-velocity anomaly links the seismicity cluster at 100 depth with the Toba Caldera.
3. Costa-Rica, Nicaragua (Rabbel et al., 2011). Based on results of anisotropic tomography we can propose the possibility of trench-parallel flow in the mantle wedge which is also supported by geochemical observations.
4. Central Andes. In tomography results we can clearly observe low-velocities beneath the volcanic arc which appear to be linked with two seismicity clusters in the slab at 100 and 200 km depth.

To illustrate small-scale tomographic studies of subduction zones, Ipresent one example with results of studying the accretion wedge structure at the Chilean margin along the marine DSS profile (Koulakov et al., 2011b). In the tomographic images, we can clearly see a low-velocity layer which marks the subduction channel composed of strongly fractured rocks with high water content.

References:

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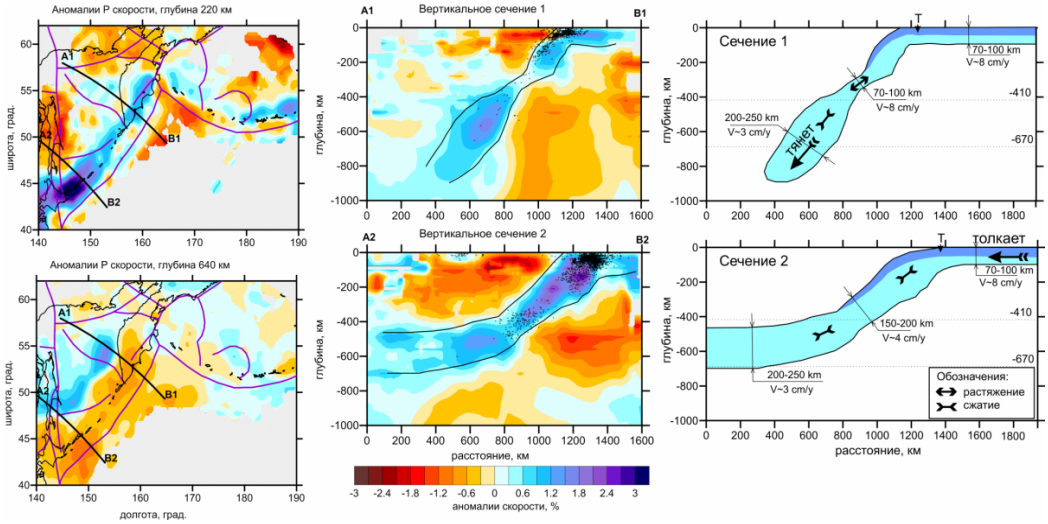

Figure1. Result of regional inversion for the Kurile-Kamchatka arc in horizontal and vertical sections (left and central columns). Right column depict force balance sin corresponding sections according to our interpretation.

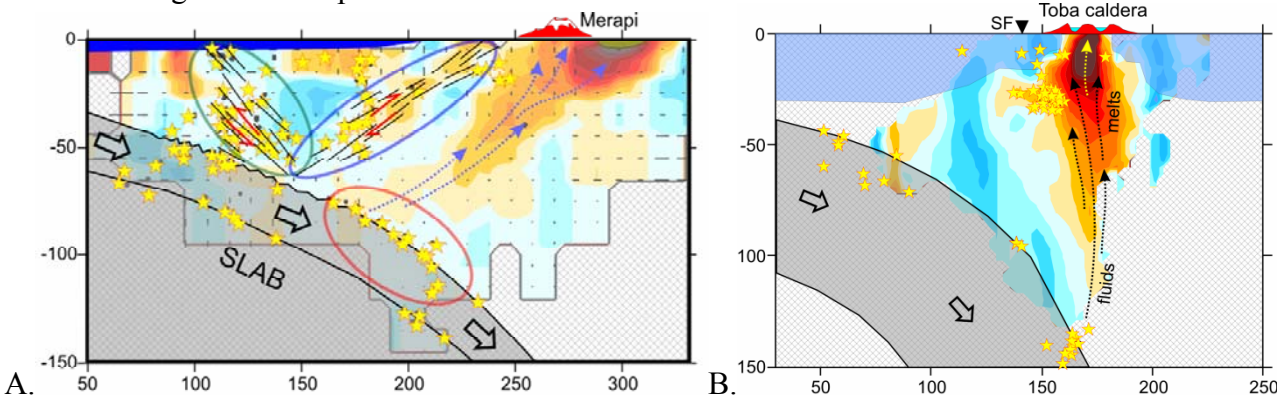

Figure2. Results of tomographic inversion in two Subduction zones: A.) Merapi (Cental Java) and B.) Toba Caldera (Sumatra). Arrow smark possible path soffluidand melt migrations, yellow stars depict location of the seismicity.