



4D tomography images reveal migration of magma chambers beneath Kluchevskoy volcano (Kamchatka)

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The data used in this study contain more than 500 000 travel times of P and S seismic waves from about 80 000 earthquakes occurred in the time period from 1999 to 2009 which were recorded by 14 permanent stations in the area of the Kluchevskoy volcano group (Kamchatka, Russia). Most of the events are located at depths of more than 25 km that is favorable for performing the tomographic inversion. These data were used to reveal temporal variations of seismic structure beneath the Kluchevskoy volcano. Simultaneous inversion of the entire dataset, although using the data from the best recorded events, brought to much weaker variance reduction than in cases when the inversion performed for shorter time windows. For the inversions performed in one-year intervals, the maximal variance reductions occurred in stable periods between eruptions. On the other hand, relatively low variance reductions were obtained in years of eruptions, when maximal temporal variations of seismic properties were expected. All these facts can be used as evidences for strong variations of seismic properties beneath the volcano related to the eruption activity. We performed the tomographic inversion in separate time windows with applying both spatial and temporal smoothing and obtained 4D models of the distribution of P and S velocities, as well as V_p/V_s ratio. The latter was used as a main indicator for tracing the locations of melts and fluids beneath the volcano. It can be seen that the major feeding chamber, where V_p/V_s ratio reaches 2.1-2.2, is located below 25 km depth. We observe also smaller intermediate chambers at depths of about 10-15 km. Just before the major eruptions of the Kluchevskoy volcano we see small shallow anomalies at depths around the sea level. A series of different tests were performed to prove the reliability of the obtained results.