The stress state of the Kuril-Kamchatka subduction zone after the 2006–2007 Simushir earthquakes

Polets A.Y.

The Institute of Marine Geology and Geophysics Far East Branch of the Russian Academy of Sciences, Yuzhno-Sakhalinsk, Russia

e-mail: polec84@mail.ru

The Central Kuril Islands segment of the Kuril-Kamchatka seismic focal zone has long been characterized by low seismic activity. For many decades, the possibility of earthquakes with moment magnitude Mw≥7.7 within the Middle Kuril Islands has remained debatable [3].

On November 15, 2006, the first strong earthquake, Mw=8.3, occurred in the central part of the Kuril zone, due to subhorizontal compression typical for island-arc earthquakes, the earthquake focal mechanism – thrust fault. An event of such magnitude was recorded in this area for the first time in the history of seismological observations. The November event was followed by the second earthquake on January 13, 2007, Mw=8.1.

The 2006–2007 earthquakes occupied a special place in the seismic history of the Kuril-Kamchatka subduction zone. They significantly changed the prevailing ideas about the seismic potential of its central part and the duration of the seismic cycle and could lead to a noticeable change in stresses both in the vicinity of the earthquake source and beyond it.

The method of cataclastic analysis of discontinuous Displacements was used for the reconstruction of modern tectonic stresses field in the Kuril-Okhotsk region after the largest 2006–2007 Simushir earthquakes. The method makes it possible to carry out a consistent calculation of the tensors principal stress axes orientation, the increments of seismotectonic deformations and the coefficients that determine the form of these tensors [2]. In the calculations, the earthquake focal mechanisms in the magnitude range from 4.7 to 6.5 were used. Processing of initial seismological data was carried out for different depth and time intervals.

The area of lateral extension at depths of 0–30, 30–60, and 60–120 km was revealed according to the tectonic stresses reconstruction results that acted before the 2006–2007 Simushir earthquakes [1]. It was also shown that this extension area was formed not during the first Simushir earthquake on November 15, 2006, but existed long before it.

The stress reconstruction performed after the Simushir earthquakes has showed the presence of an extension area at depths of 0–30 km only in the aftershock period and its absence after 2009. At depths of 30–60 km, for all considered time intervals, a horizontal extension area was not identified, the predominant geodynamic regime was horizontal compression. At depths of 60–120 km, the area of horizontal extension is still preserved.

At the second stage of the stress reconstruction, the relative values of the spherical and deviatoric components of the stress tensor were determined. Domains with increased values of the relative confining pressure are concentrated to the aftershock zones boundaries of the 2006 and 2007 Simushir earthquakes. Such distribution is consistent with the idea of increased stress values near the fault boundaries, which in this case are identified with the aftershock zones boundaries [Rebetsky, 2007].

The performed stress reconstruction showed that the stress field is most inhomogeneous during aftershock processes. During the period of intense activation after the large earthquakes, a sharp restructuring of the geological environment occurs, which manifests in the spatial variability of the stress field.