Influence of volcanism on changes in the stress state in the crust of subduction zones

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Numerous reviews show that the periods of volcanic activation do not coincide with the periods of occurrence of the most severe earthquakes in these regions. It is also known that the stress state is heterogeneous across subduction zones coexisting with areas of active volcanism . It is known that in subduction zones, the main mode is horizontal compression, which operates throughout the seismic range of the crust. It is important to note that after the Tohoku earthquake M = 9.1 (2011), there were drastic changes in the stress state in the upper part of the crust of the focal area. Our research has shown that for more than 10 years there has been a horizontal stretching regime here, which is a consequence of earthquakes occurring with discharge-type mechanisms. A change in the horizontal compression mode, which affects horizontal tension in subduction zones, is a very rare phenomenon even for mega-earthquakes. So, after the Sumatro-Andaman M = 9.0 (2004) and the Chilean –Maule M=8.8 (2010) megasemmetric earthquakes, such a phenomenon did not occur in large volumes of the crust. At the same time, of course, as a result of these earthquakes, the level of horizontal compression decreases in comparison with the lithostatic pressure.

The problem of volcanism in terms of the mechanism of formation of conditions conducive to the movement of magma along the subvertical stocks is close to the problem of the development of dikes. According to the results of a large number of studies, it is known that the subvertical flat dikes are located orthogonally to the axis of the smallest horizontal compression. It should also be added here that the progress of the dikes is observed in the direction of the action of the greatest compression stress. These provisions allow us to predict the development of stages of volcanism developing in subduction zones from tectonophysical positions. The beginning of activation of volcanic activity should occur after the weakening of horizontal compression stresses acting orthogonally to the strike of the subduction zone. This usually occurs as a result of strong earthquakes of the interplate type. Depending on how the stress state of the crust changes, magma gets the opportunity to rise up either from crustal or mantle magmatic foci.

The tectonophysics of volcanic activation determines that the magma pressure in crustal and mantle foci is close to the level of the average isotropic pressure. In the front of the advancing magma, its pressure should be higher than the lateral compressive stress. Thus, below the magma front in the rocks surrounding the channel or magma-producing fault, the level of horizontal compression stresses increases to the level of magma pressure.

When the difference between the compression stresses in the horizontal and vertical direction is small, an increase in the level of horizontal compression from certain depths will lead to a change in the geodynamic mode of the stress state from horizontal tension to horizontal compression.