Mass concentration of the earth's crust before strong earthquakes: direct and indirect data

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According to the hypothesis of elastic rebound, its main source is the accumulation of elastic deformations in a maturing seismic source. This process is facilitated by the presence of asperity of elements of tectonic seismogenic faults in the place of future release of accumulated elastic stresses. Such a mechanism requires the accumulation of masses in the region of the future hypocenter due to an increase in the density of the material of the earth's crust in a given local area and a corresponding increase in the acceleration of gravity. The release of elastic stresses as a result of an earthquake contributes to the deconsolidation of the volumes of the crustal material, which should be expressed in a decrease in the gravity at the epicenter after the earth's crust has been ruptured. This assumption is already beginning to be tested by direct gravimetric observations of changes in gravity in seismically active regions. The process of compaction of crustal material today can be tracked by means of GNSS observations. In regions of high seismic activity, such as the western coast of North America, Japan, and others, continuously operating geodynamic GNSS networks occur. Thus, the possibility of tracking the accumulation of deformations of the earth's crust at different stages of the seismic cycle is realized. Already before many strong seismic events, changes in the coordinates of GNSS points were determined, which is the basis for observing the evolution of deformation in connection with the maturing of earthquakes that occurred. According to the elastic rebound model, it is natural to assume that compressive deformations accumulate in the places of future strong earthquakes, which contribute to the compaction of the crustal material and the accumulation of elastic seismic energy. In order to test this assumption, special experiments were carried out. Before ten strong earthquakes in the USA, Japan, Turkey and New Zealand, digital models of horizontal displacements and deformations for every day for about a decade were determined in territories with a radius of about a hundred kilometers from their epicenters. Graphic visualization of each digital model was a frame of the corresponding synoptic animation, representing the evolution of the seismic-deformation process in connection with the fault tectonics of the area. Thus, it became possible to directly observe the seismic-deformation process before strong earthquakes. According to Reid's hypothesis, at the epicenters of future earthquakes, a region of minimal inner movements (deficit of displacements) of GNSS points should become, and at distances from the future epicenter, the speed of movements should be higher. This assumption is consistent with the area of seismic gap that occurs before future earthquakes. A heuristic analysis of the obtained kinematic visualizations confirmed the formation of zones of internal displacement deficiency before strong crustal earthquakes in all available cases. This result does not contradict the assumption of mass accumulation at the hypocenter of a future strong earthquake. The results obtained indicate that continuous GNSS observations make it possible to register the locations of future strong earthquakes.