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CLASSIFICATION OF HIGH-SPEED DEFORMATION OF THE OCEANIC CRUST

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Keywords: aseismic geodeformation, tsunamis, oceanic crust, waterworks, pipelines destructions.

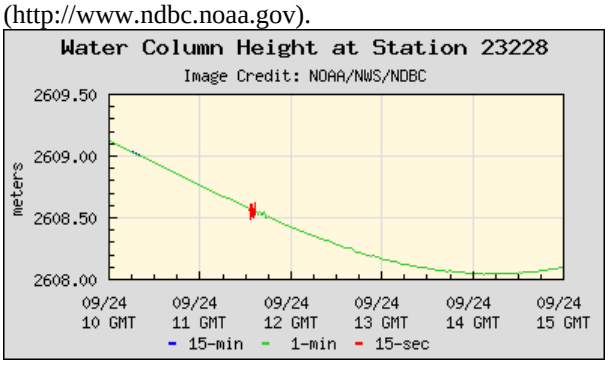
Statement of the problem. State of the art geodynamic monitoring land including regional geodetic permanent GPS network, global and regional seismometric networks, satellite gravity, altimetry and interferometric system, accumulated a considerable amount of data on high-amplitude reverse aseismic geo deformation timescale minutes - weeks [1]. Measurements of this type of geodeformation areas for ocean areas did not exist. At the same time, these destructive properties geodeformatsy, as a new type of tectonic movements [2] may occur both on land and in the ocean area. Importantly, the oceanic crust is different geological structure of the continental crust, it is several times thinner. In this regard, have reason to believe and differences in geodynamics of the oceans and continents. The most relevant is the determination of the dangers of this type of movement for marine pipe sections and waterworks on the ocean floor.

Connection with important scientific and practical tasks. Global character the high-amplitude aseismic geo deformation property of their spatial localization in terms of short duration geodeformation process greatly limit the use of of existing methods of geodynamic monitoring. Such geo deformation may be accompanied by cracks, dips, vibratory ground motion (amplitude up to 30 cm), including in the areas considered seismicity. For oceans area information about the of the amplitude-frequency characteristics of specified type aseismic geodeformatsy still lacking.

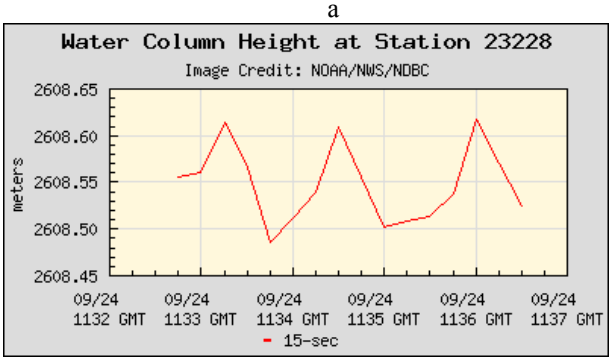
Analysis of recent achievements and publications. Known cyclic aseismic geo deformations global scale with periods 28 days, 14 days, 7 days, 3.5 days [2,3]. Using data from the EUREF Permanent GNSS Network Monitoring (averaging daily data), we have examined such geodeformation [3]. According to the data placed on land broadband seismographs analyzed the amplitude-frequency characteristics of high aseismic geodeformations [3].

Formulation of the problem. Continental differs from oceanic crust thickness, composition, saturation water, gases and other parameters. Character deformability of the oceanic crust, the dynamics and kinematics of this process has not yet been studied. The purpose of this study was to examine prospects for the use of existing marine monitoring systems for the study of geodeformation of the ocean floor. As a study object selected modern tsunami early detection system, complete with bottom sensors located on the oceanic crust. Total installed in the ocean more than 50 benthic systems performing measurements of vertical displacement of the ocean floor with 15 seconds discreteness. This allows you to measure geodeformations with period longer than 1 minute. Vertical displacement measurement accuracy better than 5 mm. Measurements of this system include measurement of deformations of the ocean floor.

Basic material of research. For further separation and exclusion from the analysis of seismic Rayleigh waves measured tsunami early detection system, we studied the data of their registration in the ocean after a strong earthquake with its epicenter on the continent. As an example, choose between a continental earthquake 24.09.2013 on 11:29:47 UTC, with M=7,7 in Pacistan (26.951°N 65.501°E). Rayleigh waves from earthquakes were measured bottom station registered tsunami Indian Ocean, number 23228, installed at a depth of 2611 m at latitude 20.799 ° N 65.347 ° E. Fig. 1 shows a record bottom station number 23228 of the Rayleigh waves from an earthquake. Rayleigh wave velocity was 3 km / s, which corresponds with the theoretical estimates. Rayleigh wave was characterized by a train of of three oscillations with a period of 75-90 seconds and amplitude of up to 14 cm. We shall assume Fig. 1 test schedule seismic Rayleigh waves after a strong earthquake. All kinds of movements the bottom surface, which differ from the test schedule will classify geodeformations. Due to the fact that the oceanic crust geo deformatsii analyzed for the first time, you must perform an important stage of research - their classification. For the analysis of the database was attracted measurements of bottom measuring stations tsunami (http://www.ndbc.noaa.gov).



a



b

Fig. 1 Record the bottom station of the Rayleigh wave tsunami registration number 23228 (a) and an

enlarged fragment of this entry 11:00 32 minutes up to 11 hours 37 minutes of 09.24.2013 (b).

The analysis of the measurement data 58 bottom stations in the last 7 years, succeeded in the execute classification geodeformatsy oceanic crust with periods from one minute to several hours. Fig. 2 shows a a quick uplifting bottom surface 10 cm and returned to its previous position with the duration of elevated phases of deformation up to one minute.

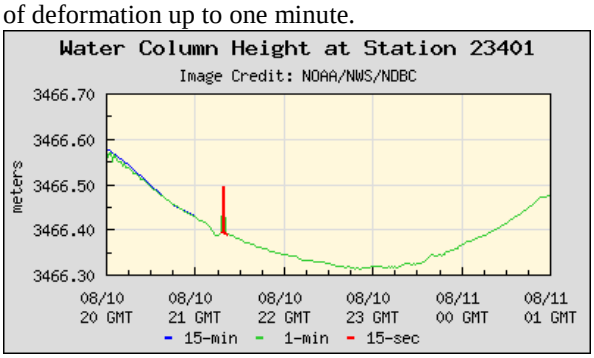


Fig. 2 The results of measurements station registration of tsunami №23401.

Fig. 3 shows examples of prolonged 30 minute (s) and hour and a half (b) subsidence the bottom surface 10 cm (a) and 25 cm (b), and a quick return to its previous position.

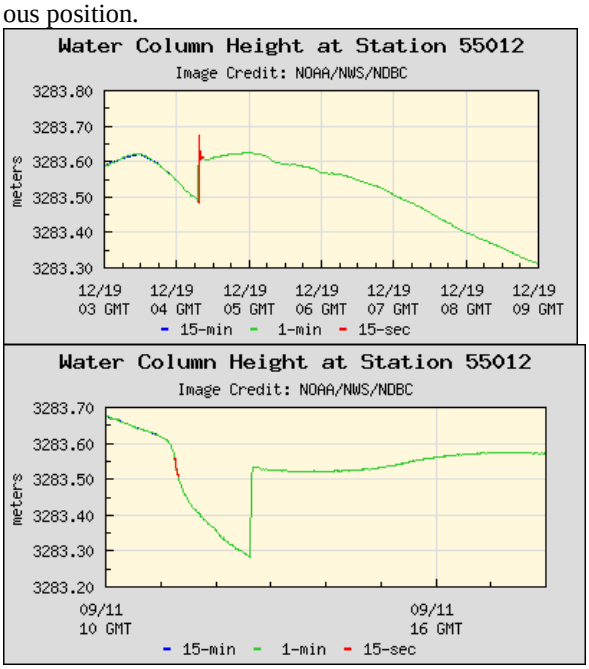


Fig. 3 Results of measurements station registration tsunami №55012.

Fig. 4 shows an example of a rapid subsidence to the bottom surface 15 cm and a relatively smooth 20-minute return to its previous position.

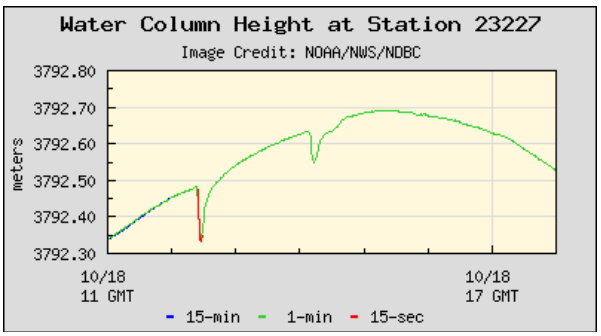


Fig. 4 The results of measurements station registration of tsunami №23227.

Fig. 5 shows an example of a 2-hour raise the bottom surface 30 cm and a quick return to its previous position.

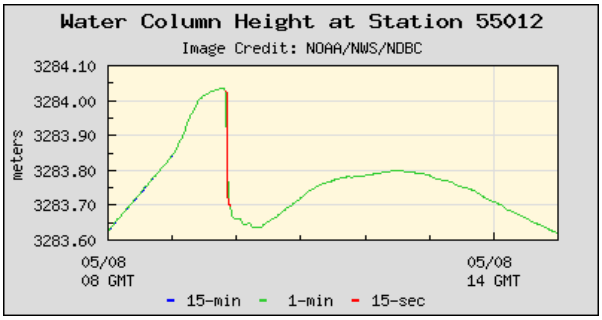


Fig. 5 The results of measurements station registration of tsunami №55012.

Fig. 6 shows an example of seafloor subsidence and return to its previous position with an amplitude of more than 4 meters and a length of about an hour.

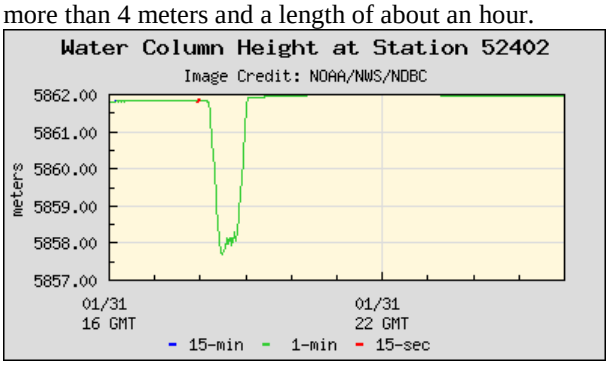


Fig. 6 The results of measurements station registration of tsunami №52402.

Fig. 7 shows an example of vertical movement complicated seafloor amplitude of 20-30 cm and a length of about an hour.

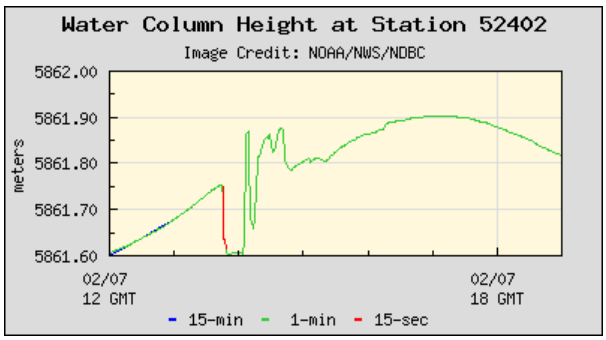


Fig. 7 The results of measurements station registration of tsunami №52402.

Fig. 8 shows an example of a 5-minute rise at the bottom surface of 12 cm.

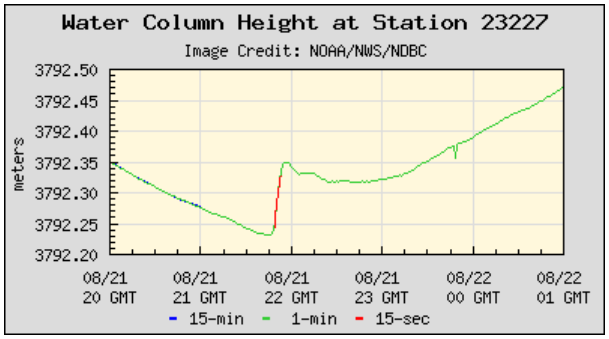


Fig. 8 The results of measurements station registration of tsunami №23227.

Analysis executed classification geodeformation shows that the frequency characteristics of fast geodeformations oceanic crust is consistent with the geometry deformations registrable within the continental crust [3], and the amplitude of the vertical displacement of the oceanic crust may be much higher. Extreme amplitude geodeformation measured the meter, and even tens of meters, is unique within the continental crust and requires additional analysis and study.

Conclusions. An analysis of methodological solutions on the measurement geodeformation on land (continental crust conditions) are shown the possibilities of complex use of permanent networks of satellite geodesy, global seismological network of broadband seismic and other techniques for measuring geodeformations a wide frequency range. For Ocean (thin oceanic crust conditions) methods for studying geodeformation not been proposed. We have proposed to use the measurement technology tsunami that allows to measure the vertical component geodeformations centimeter accuracy and periods longer than one minute. As a result of the research carried out classification geodynamic movements of the oceanic crust and found that the frequency of fast geodeformations oceanic crust is consistent with the frequency geodeformations recorded within the continental crust and oceanic crust deformation amplitude is much higher.

Literature

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Classification of high-speed deformation of the oceanic crust

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The classification geodynamic movements of the oceanic crust. Found that the amplitude of the high-speed deformation of the oceanic crust is much higher than that of the continental crust.