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SPATIAL REGULARITIES OF MANIFESTATION OF SHORT-TERM OCEANIC CRUST DEFORMATIONS

I.Uchytel, B. Kapochkin

Keywords: aseismic geodeformations, tsunamis, oceanic crust, waterworks, pipelines accident.

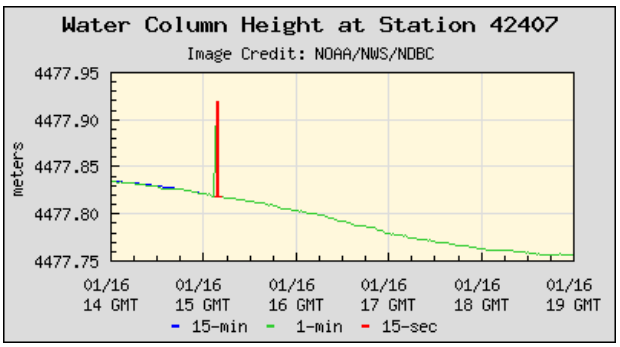
Statement of the problem. Aseismic rapidly occurring geodeformations studied on land based on the results of studies on the geodynamic testing [1]. Later this type of land geodeformations studied by other methods, and the results of these studies are summarized in [2]. In the ocean, where the oceanic crust is different in density and power rapidly occurring geodeformations may vary in amplitude-frequency characteristics and the character of manifestation. According to the data studies there, these deformations occur everywhere, but in fragments [2]. The purpose of this study is to investigate regularities manifestation in the space of fast deformations of the oceanic crust. As research instrument selected detection system of tsunami waves, complete with bottom sensors located on the ocean floor. 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 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.

Connection with important scientific and practical tasks. Global character the high-amplitude aseismic geodeformations, their spatial localization property in the conditions of short duration geodeformation process considerably limit the use of existing methods of geodynamic monitoring. According to the data measurements of global seismological network was found that high-amplitude aseismic geodeformations may occur synchronously in different parts of the globe. Duration is measured in hours of their manifestation. Just at the same time they expire. According to media reports, during the manifestation of these aseismic geodeformations, recorded in different areas of destruction engineering facilities associated with changes in the continuity of the geological environment. In the ocean, reversible aseismic geodeformations can be dangerous for pipelines, communication cables and hydrotechnical engineering structures.

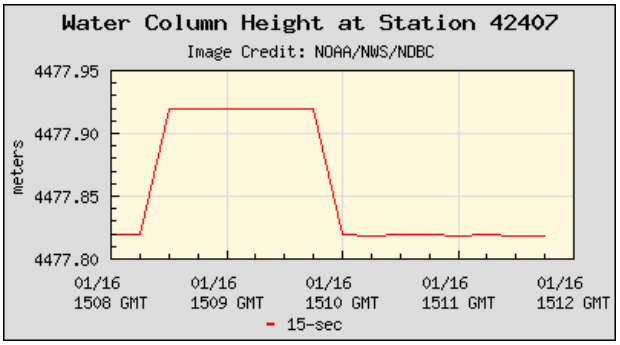
Analysis of recent achievements and publications. On land, episodically high-amplitude cyclic aseismic geodeformations global scale destructive considered in [2]. According to the data accidents pipeline network "Odessagaz" distributed over an area of about 200 km^2 with a total length of more than 4 thousand km pipeline network found that this type of deformation is shown on uplifting blocks and does not appear on the lower unit. For this reason, gets the impression that these geo deformations are manifested fragmentary. Described cases when deformation on the short time span entire block structures area 4 km^2 [2]. It has been established that deformation occurring in the three types described in [1].

Formulation of the problem. Continental crust 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 spatial patterns of manifestation of fast deformations of the oceanic crust.

Basic material of research. The analysis of the measurement data 58 bottom stations in the last 7 years, succeeded in the execute classification geodeformations oceanic crust with periods from one minute to several hours. Fig. 1 shows an example of measuring the most widespread type aseismic fast geodeformations in fast uplifting bottom surface 10 cm and return to its previous position, with the duration of elevated phases of deformation about one minute. An analysis of the database system tsunami detection (http://www.ndbc.noaa.gov) we discovered the time interval when the aseismic geo deformations specified type, manifested as on land, at the same time in different areas. This is the period 12-16 January 2009 are listed chronologically station tsunami detection system, which in this period were measured aseismic geodeformations by type, shown in Fig. 1. This station coordinates: №44401 (37°55'21"N 50°0'37"W); №46410 (57°38'5"N 143°47'8"W); №46413 (47°59'56"N 174°13'37"W); №52404 (20°46'57"N 132°20'54"E); №21418 (38°41'17"N 148°46'9"E); №44402 (39°23'58"N 70°56'30"W); №46404 (45°51'18"N 128°46'30"W); №46409 (55°18'1"N 148°30'55"W); №52401 (19°15'38"N 155°46'16"E); №51426(23°18'2"S 168°17'28"W); №41424 (32°55'18"N 72°27'57"W); №21413 (30°30'55"N 152°7'1"E); №43413 (11°3'54"N 99°51'12"W); №46407 (42°39'52"N 128°48'24"W); №51425 (9°30'37"S 176°14'26"W); №46403 (52°38'59"N 156°56'34"W); №32411 (4°59'58"N 90°50'27"W); №46419 (48°45'59"N 129°37'57"W); №52406 (5°17'36"S 165°0'6"E); №21418 (38°41'17"N 148°46'9"E); №21413 (30°30'55"N 152°7'1"E); №42407 (15°17'22"N 68°12'54"W); №46411 (39°20'55"N 127°1'15" W).



a



b

Fig. 1 Record aseismic geodeformations bottom station registration tsunami number 42407 (a) 16.01.2009 and enlarged fragment of this record with 15 hours 08 minutes to 15 hours 12 minutes (b).

For a comprehensive analysis of geodynamic conditions during the second decade of January 2009 were attracted seismological data and tide of forces in the solid Earth. An analysis of seismological information was found that the aseismic geo deformations began before and continued after a heavy sea (46.862 ° N, 155.156 ° E) M = 7.4 earthquake, recorded 15.01.2009 at 17:49:39 UTC. Earthquake coincides with the time of occurrence of the daily episodic aseismic geodeformations of 12-16.01.2009. Global geodynamic conditions in January 2009 was characterized by strong external influences gravitational nature. Geodeformatsii have occurred on the eve of Sunny (26 January 2009) and Moon (9 February 2009) eclipses. Cause geodeformatsy 12-16.01.2009 can be considered dynamic factors determining the superposition January 11 spring tides (Sunny - the annual fashion and Moon - fortnightly fashion) coincident with a perigee Moon (10.01.2009) and perihelion (03.01.2009). Thus we can assume, the geodynamic geo deformatsii 12-16.01.2009. The presence of dynamic factor does not always lead to kinematic effects. To confirm the causal relationships between gravity, external influence, and global of the oceanic crust manifestation geodefrmations give dates (Fig. 2) due to changes in measurement geodynamically tide-free component of the Earth's angular velocity (zonal tides in the solid Earth filtered). The graph shows that in the first ten days of January 2009 the trend of increasing the angular velocity of the Earth's rotation is reversed and started to recover since 12.01.2009 These data give reason to believe that the facts of abnormal external dynamic influence resulted in global kinematic effects.

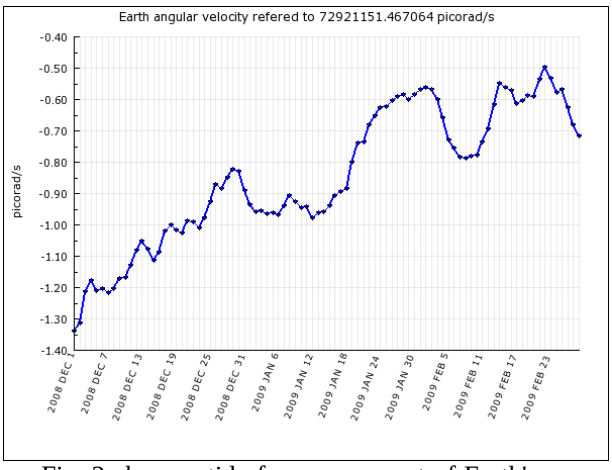


Fig. 2 changes tide-free component of Earth's angular velocity (zonal tides in the solid Earth filtered)

Traditionally, consider the the character of global geodynamics controlled in Odessa according to spatial and temporal variability pipeline accidents "Odessagaz." Fig. 3 shows the changes in time in Odessa pipeline accidents (green), filtered week harmonics of these strains (red) and pipeline accidents caused by horizontal displacements of the surface (purple). Weekly cycle discontinuities geological environment began with the onset 12.01.2009 geodeformations oceanic crust and ended 15.01.2009, almost simultaneously with the termination of the deformation of the oceanic crust. Stretching conditions change compression 10-11.01.2009 and 16-18.01.2009 completed under compression (geodynamically due to accident pipelines on these dates did not happen). 12-16.01.2009, the fixed horizontal displacements forming specific accident pipeline shown in Fig. 3 purple [2].

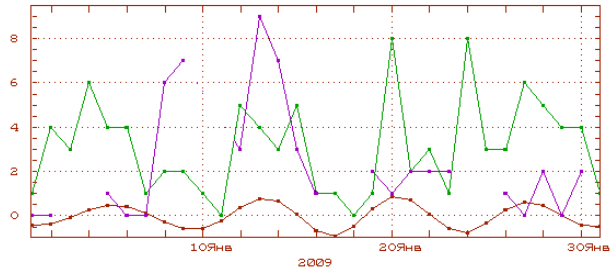


Fig. 3 Changes in pipeline accidents in Odessa (green), filtered week harmonics of these strains (red) and pipeline accidents caused by horizontal displacements of the surface (purple).

Are executed the analysis geodeformations oceanic crust during this period. Table 1 presents data on daily rent time of aseismic geodeformations.

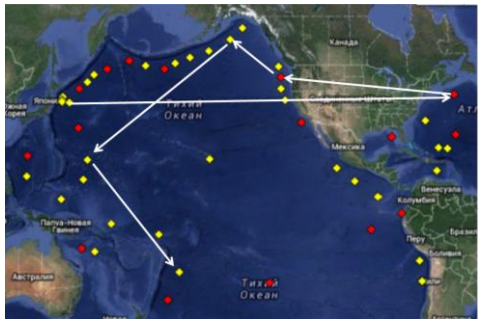
Table 1

Data on the time and place of manifestation aseismic geodeformations oceanic crust

Data	№ st.	Time	Depth (m)
12.01.2009	44401	16:47-16:50	5357
	46410	16:53-16:55	3782
	46413	17:52-17:55	5614
	52404	18:02-18:04	5956
13.01.2009	21418	16:08-16:10	5662
	44402	16:17-16:19	2443
	46404	16:23-16:26	2793
	46409	16:32-16:34	4200
	52401	17:08-17:10	5578
	51426	17:17-17:19	5659
14.01.2009	41424	15:17-15:19	5284
	21413	15:25-15:23	5822
	43413	15:32-15:34	3380
	46407	15:47-15:49	3322
	51425	16:02-16:05	4960
	46403	16:23-16:25	4512
15.01.2009	32411	15:38-15:41	3312
	46419	15:54-15:56	2775
	52406	16:54-16:56	1826
	21418	18:39-18:41	5662
	21413	18:54-18:56	5822
16.01.2009	42407	15:08-15:10	4499
	46411	15:18-15:19	4259

The table shows that the deformation occurred daily from 15 to 18 hours. During the sea earthquake 15.01.2009 deformation were interrupted and then continued that corresponds to the theoretical development of the provisions of plastic explosive and geodeformations [2]. Fig. 4 shows the sequence of manifestations geodeformations oceanic crust.

a



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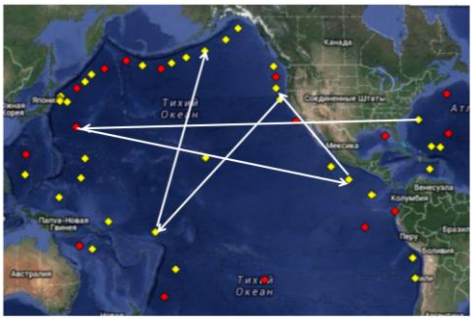

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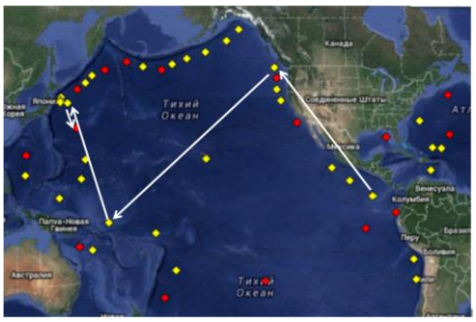

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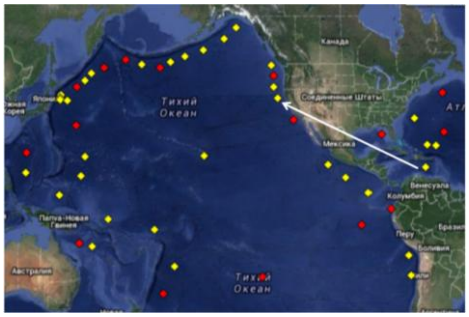

e

Fig. 4 Map directs geodeformations 12.01.2009 r (a), 13.01.2009 r (b), 14.01.2009 r (c), 15.01.2009 r (d), 16.01.2009 g (e)

Found that along with the trend spread geodeformations against the direction of rotation of the Earth, there are other features that appear immediately before the discontinuous geodeformations oceanic crust 15.01.2009

Fig. 5 shows the changes in time geodeformations aseismic oceanic crust of 12-16.01.2009

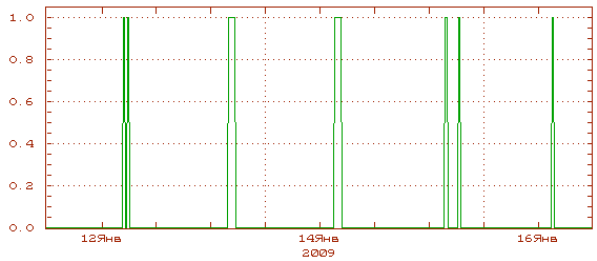

Fig. 5 Changes in aseismic geodeformations oceanic crust of 12-16.01.2009

Analysis of the data shows a direct analogy to the spatial variability of aseismic reverse geodeformations oceanic and continental crust, set out in [2]. Research covered geodeformations caused process compression-tension, in the conditions of the block divisibility lithosphere, accompanied by reversible vertical displacements along the inclined faults. Two other types of

aseismic reverse geodeformations requires additional analysis and study.

Conclusions. An analysis of data on global manifestations geodeformatsy oceanic crust found that boundary oceanic-continental crust is not an obstacle to the spread geodeformatsy oceanic crust. Geodeformatsii oceanic crust in the form of a short uplifting bottom surface with an amplitude of about 100 mm and a length of about a minute occur globally, but fragmentary. The deformation process of 12-16 January 2009 momentary activation manifested in the same time of day. Aseismic geo deformations continental and oceanic crust occur synchronized in time and obey the laws.

Literature

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Spatial regularities of manifestation of short-term oceanic crust deformations

Uchytel I., Kapochkin B.

An analysis of the data revealed that the aseismic geodeformatsii oceanic crust in the form of a brief uplifting bottom surface with an amplitude of 100 mm and the length of the minute appear globally, but fragmentary. The deformation process 12 - 16 January 2009 Momentary activation manifested in the same time of day. Aseismic geodeformatsii continental and oceanic crust happen are synchronized in time and obey the common laws.