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On a System of Earthquake Prevention in Tiberias

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Abstract: ***The article analyzes physical models of an earthquake at a shallow depth: an explosive earthquake model and a steam model of an earthquake that arose when water was pumped. A system for preventing earthquakes at shallow depths, which occurred in Tiberias, is suggested, by analogy with the previously proposed system for the prevention of volcanic eruptions. The system of earthquake prevention at shallow depth will save citizens from death in future medium and strong earthquakes and save houses and infrastructure from destruction and from causing damage to them. The article is intended for researchers and the widest circle of readers, and contains useful information for governments (Israel, etc.), municipalities (Tiberias, etc.) and companies producing equipment.***

Keywords: prevention of earthquake prevention at shallow depth, explosive earthquake model, a steam model of the earthquake that arose when water was injected.

1. Introduction

From 4 to 9 July 2018 in the Tiberias (Israel) area, earthquakes were registered 30 times. Only in a few cases the magnitude of the earthquake exceeded 3. The first earthquakes of magnitude 4.1 were recorded in the north of Israel at 4:50 am on July 4 on Wednesday. Epicenter was 6 km north-west of Tiberias, the focus was at a depth of 15 km. The shocks continued at 6:52 am. The European-Mediterranean Seismological Center reported that the epicenter of the earthquake this time was 2 km west of the village of Ilabun. The heath lay at a depth of 2 km. At 7:19 a weak underground earthquake of magnitude 2.8 was recorded. The epicenter is 8 km to the north-east of Tiberias. The hearth lay at a depth of 1 km. On the night of Thursday, July 5, around 01:00, a second earthquake occurred in the north of Israel. According to the Israeli Institute of Geophysics, its magnitude was 3.2. About 22:40 Wednesday in the north and in the center of the country there were tremors. The European-Mediterranean Seismological Center reported that in Israel earth tremors with a magnitude of 4.3 were recorded. Epicenter was located three kilometers to the north-east of Tiberias, the hearth lay at a depth of 10 km. According to the Institute of Geophysics of Israel, the magnitude of the earthquake was 4.6, and the epicenter was in the region of the Kinneret [1]. An earthquake with a magnitude of 3.4 was recorded in the Kinneret area on Sunday, July 22. This was reported by experts from the Geophysical Institute of Israel. According to the world classification, an earthquake of up to a magnitude 5 is considered weak, up to a magnitude 7 - average, above a magnitude 7 - strong or destructive. For Israel, weak earthquakes are common, they occur several times a year. We will present information on medium and strong earthquakes in the Tiberias region, as described in the publication of A. Griber [2] (EARTHQUAKES IN THE HISTORY OF ISRAEL).

On January 18, 749, an earthquake occurred in the Golan region with a a magnitude of 5-6. As a result, the territory of Umm el Canter became an unoccupied area. Researchers claim that about 30 Tiberias synagogues collapsed that day, and Beit Shean and Susita also suffered. About 20 thousand people died. The synagogue in Arbel, the church in Kursi, Hamat Gader, Beit Shean and Jericho were damaged. Destroyed by Jerash (Jordan). The Al-Aqsa Mosque in Jerusalem was damaged. The earthquake completely destroyed the rich Skitopolis (Beth Shean), after which the city never reborn in its former power.

On January 14, 1546, with the earthquake occurred of a magnitude 5-6, the cities of Safed, Shechem, Ramallah, Hebron and Gaza were affected. In Jerusalem, the mosque of Omar collapsed, the dome of the Church of the Holy Sepulcher and the fortress wall near the Golden Gate. Shift of soil in the mouth of the Jordan River in the north of the Sea of Galilee stopped the flow of the river for 2 days. About five hundred inhabitants of Shechem were buried under the rubble of houses.

October 30, 1759 during an earthquake occurred of more than magnitude 6, according to some reports, up to 40 thousand people died. The north of the country was especially affected: the cities of Tiberias, Safed, Sasa, Gush Halav, and Akko. Earthquakes lasted another 3 months. November 25, 1759, a strong second earthquake was in Safed.

On January 1, 1837, with an earthquake occurred of more than magnitude 5-6, the city of Safed (5000 dead) and the villages around (2158 dead) suffered very much. Most of the buildings in Safed and surrounding villages are destroyed. In the city of Tiberias, the fortress walls collapsed. In Tiberias and its environs. 17 villages killed about 1000 people. 143 people were killed in the village of Lubiya (Tsomet Golani). Suffered the city of Nazareth, Acre, Haifa.

March 20, 2010 in the evening in the Kinneret area was recorded an earthquake with a magnitude of 3.6. The epicenter of the earthquake was in the area of the Arik bridge north of the Sea of Galilee, at a depth of 14 kilometers. There are no victims or devastation, but the local population felt the concussion of the earth. Specialists note that this is the most severe earthquake in the area in the last 10 years.

Thus, information on earthquakes in Tiberias made the writing of this article relevant; this paper is based on [3-5] and devoted to the creation of an earthquake prevention system in Tiberias.

2. Thermal springs Khamei Tiberias

Thermal springs of Khamei Tiberias (Israel) are located on the shores of the Sea of Galilee near the southern entrance to the city of Tiberias: on one side you can see the Sea of Galilee, on the other side you can see the Golan Heights. The baths function on the basis of 17 mineral springs, coming from the depth of the earth with a temperature of 60-62 degrees. Thermal waters of the Khamei Tiberias rise to the surface from an almost 2-kilometer cracks in the earth's crust. The Syrian-African rift passes through Tiberias and stretches from the Sea of Galilee to the Eilat Gulf itself. Another healing component of this place is the natural mud (papiloma)- which is a volcanic sediment released on the surface. They extract it from the shores of the Sea of Galilee, and then within a year insist on mineral waters. [6]

3. Physical Model of Earthquakes at Shallow Depth

To clarify the physics of earthquake prevention measures at shallow depth, we need to analyze the physical models of earthquakes.

3.1. Explosive earthquake model

The cause of the earthquake is the explosion of primary explosive gases unstable at low pressures of chemical compounds of helium with hydrogen and other elements; the eruption of a volcano is regarded as an earthquake whose hypocentre emerges on the earth's surface.

Let us quote the opinions of two very respected researchers: First, Charles Darwin, educated geologist and author of numerous geological studies. Darwin wrote in his diary: "The earthquake and volcano are parts of one of the greatest phenomena that command this world." Returning to London, he read on March 7, 1838 at a meeting of the Royal Geographical Society lecture, the title of which speaks for itself: Charles Darwin (Read March 7th, 1838). On the Connexion of certain Volcanic Phenomena in South America, and on the Formation of Mountain Chains and Volcanoes, as the effect of the same. Transactions of the Geological Society.5 1842-46, Chapter XLII, p. 601-631. ("On the intimate connection of a volcanic phenomenon in South America, the formation of mountain ranges and volcanoes as a result of the same energy that raises the continents") [9].

The second opinion is "the father of modern geology," and Charles Darwin's teacher, Sir Charles Lyell: "The root cause of volcanoes and earthquakes is the same, associated with the release of heat and chemical reactions at various depths of the interior of the globe" ("The primary causes of the volcano and the earthquake are to the great extent the same, and connected with the development of the heat and chemical action at various depths in the interior of the globe. "; p. 242, in: Sir Charles Lyell, Bart. MAFRS, 1875. Principles of Geology, Or the Modern Changes of the Earth and its Inhabitants, Considered as Illustrative of Geology, Twelfth Edition in Two Volumes, London John Murrey, Albemarle Street (1875), Vol. I, 655 pp.

The level of development of physics and chemistry of the XIX century did not then allow the construction of an acceptable theory, and after the strongest earthquake in 1906 in San Francisco, the mechanistic hypothesis of H.F.Reid was adopted and turned into a paradigm. Its main advantage was simplicity and clarity of explanation: the plates on opposite sides of the fracture undergo pressure and accumulate a voltage reaching a certain critical value until a "breakdown" occurs, at which the accumulated energy of elastic recoil is released, partly in the form of heat, and partly in the form of elastic waves, representing an earthquake.

The paradigm of H.F. Reid cannot explain the accumulation and focused ejection of the monstrous energy released in strong earthquakes. The theory of stress accumulation in the earth's crust does not provide a convincing explanation for deep-focus earthquakes, because at a depth of more than 20 km, because of the increasing with depth of temperature, rocks become plastic and can not accumulate any stresses.

The proposed theory of Gilat A. and Vol A. can explain all the available factual material about earthquakes and volcanic eruptions, which is already about 100 years old the paradigm of H.F. Reid can not explain. [9]

In this section we will present a number of provisions of Gilat A. and Vol A. theory [7-9]. During the Earth's accretion period, primordial hydrogen and helium, comprising 98%–99% of space matter, were trapped and stored in the Earth's core and mantle as a solid and liquid solutions and chemical compounds, with help of endothermic reactions. Since the stabilization of the planet, the energy expended on the capture of H and He is quasi-continuously released by the exothermic reactions of degassing of the Earth. The resulting heat and continuous explosions produce all manifestations of magmatic activity in general and volcanic eruptions in particular. Analyses of gases from fresh lavas of Kamchatka volcanoes made by I.I. Glustchenko show that primary explosive gases uncontaminated by meteoric water and air (H_2, Cl_2, CO, OH, F_2, Br_2, H_2S, CH_4) comprise 10%–70% of total volcanic gases. Gases, saturated with energy, form passages for magma into magmatic chambers, break through fragile rocks and supply energy for volcanic eruptions.

In the next section, we will consider a physical model for explaining the method of provoking an earthquake of small strength.

3.2 A steam model of the earthquake that arose when water was injected

By injecting a huge amount of water into the depths of the earth, moderate earthquakes can be provoked. This happened in 1962 near Denver (US-well depth 3800 m), in Matsushiro

(Japan - the depth of the well 1800 m). The method of provoking earthquakes was opened in Denver (USA). Here, since 1962, spent liquids have been injected into a 3,600 m deep well drilled in fractured granites. For several decades before 1962, only three minor earthquakes were noted in this region, and from 1962 to 1968 more than 600 minor earthquakes occurred here. It was possible even to reveal some connection between the amount of fluid pumped and the number of earthquakes. Basically, concussions arose in the fault zone below the bottom of the well.

Something similar happened in Turkey. After studying the statistics of earthquakes in the last quarter of a century, seismologists have noticed that the number of small tremors here increases noticeably in a month or two after the melting of snow if there were heavy snowfall in winter. [10]

This phenomenon of provoking a weak earthquake is sometimes explained in the literature as follows: "Obviously, the liquid played the role of a lubricant, which facilitated the movement of plates." [10]

The last earthquakes in the Tiberias region occurred at depths of 1-15 km, so the plate movement cannot explain them.

We offer the following description of the physical mechanism of earthquakes in the areas of Denver (USA), Japan and Turkey: when a water stream enters magma with t = 1200 C, the first portion of water that enters magma passes into a vapor state, i.e. there is an explosion that discards water that did not have time to enter the magma. If this water flow again gets into the magma, then a second explosion will occur similarly, etc. These explosions are earthquakes that occur when water is pumped. We will call the physical model of such earthquakes a steam model of earthquakes that occurred when water was injected.

4. System of earthquake prevention measures at shallow depth

Based on the explosive and steam physical models of the earthquake, we describe the proposed measures to prevent earthquakes at shallow depths, which in general are a system for preventing an earthquake at shallow depth.

The amount of the primary explosive gas in the earthquake focus must be reduced to reduce the probability of an earthquake at shallow depth, in analogy with the decrease in the likelihood of volcanic eruptions, considered [3].

Thermal waters of Khamey Tiberias (Israel) rise to the surface from an almost 2-kilometer cracks in the earth's crust, thanks to the Syrian-African fault, and remove some of the primary explosive gas and thermal energy from the area of the source of the future earthquake. With an increase in primary explosive gases in the vicinity of the source coming from the Earth, this amount of remote primary explosive gas and remote thermal energy may not be enough, which can lead to an explosive earthquake. In addition, an increase in the flow of water from the Kinneret Lake and other sources into the hearth zone can cause a weak steam earthquake.

1st measure) We propose to increase the amount of remote primary explosive gas by raising additional water from the dug well in the Tiberias area with the depth of HR. Pumping out additional water: we reduce the probability of a weak steam earthquake; we pump out some of the primary explosive gases in the vicinity of the source (which are dissolved in the pumped water); we simultaneously reduce the probability of an explosive earthquake at shallow depth. Thus, the more we additionally pump out water together with the primary explosive gas in the vicinity of the source, so we can prevent a stronger earthquake at shallower depth with greater probability (because the accumulated primary explosive gas can lead to an average and severe earthquake). In order not to disturb the formed natural system of supply of mineralized water in Khamey Tiberias, we must start the working pipe at a sufficiently large distance from the complex of Khamey Tiberias, in fact creating a new branch of the complex.

(2nd measure) When pumping water from the working pipe, we must simultaneously inject a certain amount into the depth of the earth along the second well to a depth of H_2 to keep the water balance. In this case, $H_2 < H_R$. In this case, H_R must be sufficiently small. In this case, the mass of injected water m_2 should be less than the mass of pumped water m_R.

Pumping the same cooled mineralized water, we must clean it of the primary explosive gas.

The technique of pumping large amounts of water leads to a large number of weak earthquakes and has a fundamental drawback:

An earthquake of up to five points is considered weak, but even earthquakes of magnitude 3 in large numbers can damage buildings, gas and water networks. The mayor of Tiberias told at the meeting that many buildings in the city were cracked, including about half of the kindergartens, many of which are private [11]. Reducing the amount of water in the source of a possible earthquake will reduce the probability of a steam earthquake, i.e. will lead to a decrease in the probability of a large number of weak earthquakes.

We emphasize that an average or strong earthquake can occur if the amount of the primary explosive gas accumulates in a sufficiently large amount. Therefore, a decrease in the accumulating primary explosive gas is the way to reduce the probability of an average or strong earthquake. The first steam earthquake naturally leads to an explosion of explosive gas, accumulated in the source, ie. The first steam earthquake occurs together with an explosive earthquake and their joint magnitude is higher than that of a separate steam earthquake. Indeed, the first tremors in different regions of Tiberias in July 2018 were a magnitude of 4.1 - 4.6, and the last tremors in different regions of Tiberias were a magnitude of 2 - 3. Therefore, pumping a small amount of water through a second well can lead to a small number of weak steam earthquakes (preferably one or a maximum of two) that can clean the focus from the primary explosive gas as well.

Thus, we propose the creation of a system for the prevention of shallow earthquakes in Tiberias consisting of two wells (from the working well, we pump out water and remove the primary explosive gas in the outbreak (measure 1), into the second well, we inject water purified from the primary explosive gas, which as a last resort, will provoke a small amount of weak joint steam and explosive earthquakes and thus remove the explosive gas in the source (measure 2)). The number of such systems for the prevention of shallow earthquakes may be several in the Tiberias region.

5. Discussion

1) The system of prevention of shallow earthquakes will require work on the determination of the primary explosive gas and its quantity in mineralized water in Hamei Tiberias. It is very likely that this gas belongs to the list of volcanic explosive gases from Kamchatka volcanoes (H_2, Cl_2, CO, OH, F_2, Br_2, H_2S, CH_4) [8].
2) The Syrian-African rift passes through Tiberias and stretches from the Sea of Galilee to the Eilat Gulf itself, facilitating the penetration of the primary explosive gas. Earthquakes occur as a rule in the Tiberias region, in which the thermal waters of Khamei Tiberia are located (see Introduction in our article). Another healing component of this place is the natural mud of the sawmill - which is a volcanic sediment deposited on the surface. Thus, with a high probability, the thermal waters of Hamey Tiberias contribute to the penetration of the primary explosive gas leading to earthquakes.

6. Acknowledgments

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M.G. Noppe has Academic Status - Associate Professor in Department of Applied and Theoretical Physics of Novosibirsk State Technical University. He is Senior Member of IEEE. M.G. Noppe proposed and uses a new paradigm to prevent volcanic eruptions and earthquakes. This proposal can save majority of humanity from death due to "volcanic winter" - the climate change during eruption of super-volcanoes (Yellowstone (USA), Campi Flegrei (Italia), Long Valley(USA)); of underwater volcano Kikai Caldera and will prevent human casualties and material losses from the eruption of small volcanoes (Vesuvius, Ruapehu, Popocatépetl, Etna and other).