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The Linkage of the Different Distinct Great Volcanic Eruptions of the Thera (Santorini) in the Range (1700÷1450 ±14) BC and the Related Subsequent Intensifications of the Global Seismicity and Volcanic Activity in the End of the 19TH Century and in the Beginning of the 20TH Century, in the End of the 20TH Century, And in the Beginning of the 21ST Century AD

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ABSTRACT

The article presents the development of the cosmic geophysics (representing the deterministic thermohydrogravidynamic theory based on the author's generalized differential formulation of the first law of thermodynamics) by taking into account the non-stationary energy gravitational influences on the Earth of the Sun (owing to the gravitational interaction of the Sun with the outer large planets) along with the non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Mars and the Jupiter. The author presents the evidence of the founded ranges of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = (3510 \pm 30)$ years and $T_{tec,f} = T_{clim1,f} = T_{energy,f} = (702 \pm 6)$ years (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn) based on the established links between the different distinct great eruptions of the Thera (Santorini) in the range (1700÷1450 ±14) BC and the subsequent intensifications of the global seismicity and volcanic activity in the end of the 19^{th} century and in the beginning of the 20^{th} century, in the end of the 20^{th} century, and in the beginning of the 21^{st} century AD.

Keywords

Cosmic geophysics; thermohydrogravidynamic theory; generalized differential formulation of the first law of thermodynamics; global seismicity and volcanic activity.

Academic Discipline And Sub-Disciplines

Physics; non-equilibrium thermodynamics; hydrodynamics; continuum mechanics; non-stationary Newtonian gravitation; thermohydrogravidynamics; cosmic geophysics, seismology; volcanology; history; archeology; natural hazards.

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1. INTRODUCTION

We have the documented time 63 BC of "the greatest earthquake ever experienced" [1] destroyed many cities of the ancient Pontus located in Asia Minor. The ancient Minoan empire declined as a consequence of the great Minoan volcanic eruptions at islands Thera [2] and Crete [3]. The "conventionally accepted" [4] date of ($1500 \div 1450$) BC of the volcanic eruption at Thera (Santorini) is based on the archaeological evidence [5]. Archaeologists [6] and geophysicists [2] placed usually the Minoan volcanic eruption at island Thera (Santorini) near 1500 BC. This volcanic eruption had the global planetary evidences revealed worldwide [7]. Especially, Stanley and Sheng reported [8] the evidence for the presence of ash ejected from the explosion of Santorini in sediment cores recovered in the eastern Nile Delta of Egypt. Weisbued [9] pointed out that some biblical scholars have suggested that the Israelites' exodus from Egypt took place a date closer to 1450 BC (i.e., near the date 1450 BC of the last major eruption of Thera (Santorini) [7]), whereas LaMoreaux [7] dated it to about 1440 BC.

Despite the global planetary consequences [7] of the great Minoan volcanic eruption, the exact date of the eruption has not been determined. Marinatos [3] dated the great Minoan volcanic eruption to about 1400 BC, whereas Hammer et al. concluded [10] that the eruption of Thera occurred in the range ($1665 \div 1625$) BC. The eruption catalogue of Simkin et al. [11] gives the range of dates ($1490 \div 1450$) BC for Santorini eruption. Betancourt suggested [12] the range ($1700 \div 1640$) BC as the most probable date of the eruption of Thera. Running the radiocarbon analysis of samples from Akrotini, Hubberten et al. concluded [13] that the catastrophic eruption of Thera occurred most probably in the same range ($1700 \div 1640$) BC giving "the exact time of the great eruption seem to agree a date of about 1670 BC" [14], whereas Antonopoulos [14] dated it to about the range ($1600 \div 1500$) BC ("1550 BC plus or minus 50 years").

Friedrich et al. [15] argued: "Precise and direct dating of the Minoan eruption of Santorini (Thera) in Greece, a global Bronze Age time marker, has been made possible by the unique find of an olive tree, buried alive in life position by the tephra (pumice and ashes) on Santorini". The "radiocarbon wiggle-matching" dating analysis of the olive tree revealed [15] that the eruption occurred during the range ($1627 \div 1600$) BC with 95.4% probability. The authors [15] argued: "It is a century earlier than the date derived from traditional Egyptian chronologies". The studies [4] of the tree frost rings of the bristlecone pine in California revealed the frost damage (related with the period of global cooling) between 1628 and 1626 BC. Based on revealed frost-ring damage, LaMarche and Hirschboeck dated [4] tentatively the cataclysmic eruption of Santorini (Thera) to ($1828 \div 1626$) BC. This estimate ($1828 \div 1626$) BC is based on the accepted hypothesis "that major eruptions are likely to be closely followed by notable frost events – at better than the 99.9% confidence level". LaMoreaux has stated [7]: "It is believed that this is an earlier time when Thera began its period of volcanic activity. This could represent the first of a series of large eruptions which left two major caldera that have occurred at Thera. A final large eruption and collapse took place in 1450 BC, which agrees with archaeological evidence".

Antonopoulos indicated [14] that it is important to remember that the date about 1550 BC "is the date of the beginning of the eruption and not of the widespread destruction in Crete". It is very important for subsequent analysis to take into account the additional information related with the date about 1550 BC [14]: "It is also the date when the Thera volcano became active again after a long period of quiescence and ejected the coarser pumice which form the lowest layer in the tephra deposits. The effects of this phase of the eruption were probably confined only to Thera. It did not result in the formation of the caldera, but all settlements on the island were obliterated, and all the inhabitants were either killed or driven away. Thus, since just a few skeletons and valuables have been found, it seems as if the inhabitants had enough warning to collect some of their belongings and evacuate".

Finally, LaMoreaux stated [7] (LaMoreaux, 1995): "The eruptions of Thera (Santorini) between 1628 and 1450 BC constituted a natural catastrophe unparalleled in all history. The last major eruption in 1450 BC destroyed the entire Minoan Fleet at Crete at a time when the Minoans dominated the Mediterranean world". LaMoreaux has believed [7] that "over the period from 1628 to 1450 BC Thera experienced a number of very explosive volcanic events". As we can see from the first point of view, the exact date of the eruption of Thera (Santorini) is the subject of controversy. We intent to consider this controversy in this article by establishment of the non-controversial different ranges of dates of the different distinct eruptions of Thera (Santorini).

We presented [16] the extension of the non-equilibrium thermohydrodynamic theory [17, 18] on the global seismotectonic and volcanic processes [19-23] based on the author's generalized differential formulation [18-20] of the first law of thermodynamics

$$dU_\tau + dK_\tau + d\pi_\tau = \delta Q + \delta A_{np\partial\tau} + dG \qquad (1)$$

extending the classical formulation [24] by taking into account (along with the classical infinitesimal change of heat δQ and the classical infinitesimal change of the internal energy dU_τ) the infinitesimal increment of the macroscopic kinetic energy dK_τ, the infinitesimal increment of the gravitational potential energy $d\pi_\tau$, the generalized expression for the infinitesimal work $\delta A_{np\partial\tau}$ done by the non-potential terrestrial stress forces (determined by the symmetric stress tensor $\mathbf{T}$) acting on the boundary of the continuum region τ, the infinitesimal increment dG of energy due to the cosmic and terrestrial non-stationary energy gravitational influence on the continuum region τ during the infinitesimal time dt.

In this article, by accepting with gratitude to Editor-in-Chief, the personal invitation to submit an article to the Journal of Advances in Physics, we present the article developing the prognostic aspects of the thermohydrogravidynamic theory [19-23] by taking into account the established links between the great earthquakes and great volcanic eruptions in the ancient history of humankind from the different distinct eruptions of the Thera (dated in the following ranges: (1700÷1640) BC [12, 13], (1628÷1626) BC [4], (1627÷1600) BC [15], (1600÷1500) BC [14], (1628÷1450) BC [7]) to the increase of the global seismicity and the global volcanic activity in the end of the 19th century and in the beginning of the 20th century [25], the subsequent increase of the global seismicity and the volcanic activity in the end of the 20th century [26], and the subsequent increase of the global seismicity and the volcanic activity in the beginning of the 21st century [20-23].

The problems of the long-term predictions of the strong earthquakes [25-32] and the volcanic eruptions [11, 32] are the significant problems of the modern geophysics. In the special issue [33] of the International Journal of Geophysics, Console et al. assessed the status of the art of earthquake forecasts and their applicability. It was conjectured [33] that the recent destructive earthquakes occurred in Sichuan (China, 2008), Italy (2009), Haiti (2010), Chile (2010), New Zealand (2010), and Japan (2011) "have shown that, in present state, scientific researchers have achieved little or almost nothing in the implementation of short- and medium-term earthquake prediction, which would be useful for disaster mitigation measures". It was pointed out [33] that "although many methods have been claimed to be capable of predicting earthquakes (as numerous presentations on earthquake precursors regularly show at every international meeting), the problem of formulating such predictions in a quantitative, rigorous, and repeatable way is still open".

The analysis of the period 1977-1985 revealed [34] the strongly non-random tendencies in the earthquake-induced geodetic changes (owing to the mass redistribution of material inside of the Earth) related with the change of the angular velocity of the Earth's rotation and the Earth's gravitational field. It is clear that the great volcanic eruptions are related also with the mass redistribution of material inside of the Earth related with the change of the angular velocity of the Earth's rotation and the Earth's gravitational field. The analysis of the period 1977-1993 (characterized by 11015 major earthquakes) revealed [35] the strong earthquakes' tendency to increase the Earth's spin (rotational) energy. The analysis of the same period 1977-1993 revealed [36] "an extremely strong tendency for the earthquakes to decrease the global gravitational energy" confirming the inherent relation of the earthquakes with the transformation of the Earth's gravitational energy into the seismic-wave energy and frictional heat. It is clear that the great volcanic eruptions are related with the transformation of the internal energy accumulated in magma chambers to the macroscopic kinetic energy and to the potential energy of the eruptive volumes of magma during the volcanic eruptions. Owing to these combined energy conservation for seismic and volcanic events, it was pointed out [16, 19-23] that the seismotetonic and volcanic processes should be considered in the frame of the synthetic thermohydrogravidynamic theory. That is why, we present in this article the developed thermohydrogravidynamic theory [16, 19-23] intended for combined consideration of the global seismotetonic and volcanic processes of the Earth.

Following the "Statistical thermohydrodynamics of irreversible strike-slip-rotational processes" [19] and the "Thermohydrogravidynamics of the Solar System" [20], in Section 2 we present the generalized differential formulation of the first law of thermodynamics and the related evidence of the cosmic and terrestrial energy gravitational genesis of the seismotectonic and volcanic activity of the Earth. In Section 2.1 we present the generalized differential formulation [16, 21-23] of the first law of thermodynamics (for the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed one-component individual finite continuum region τ (characterized by the symmetric stress tensor $\mathbf{T}$) moving in the non-stationary Newtonian gravitational field. In Section 2.2 we present the evidence of the cosmic and terrestrial energy gravitational genesis [16, 21-23] of the global seismicity and volcanic activity of the Earth induced by the combined cosmic and terrestrial non-stationary energy gravitational influences on the individual continuum region τ (of the lithosphere of the Earth) and by the non-potential terrestrial stress forces acting on the boundary surface $\partial\tau$ of the continuum region τ.

In Section 3 we present the subsequent development of the cosmic geophysics [16, 20-22] by taking into account the very significant energy gravitational influence of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets [23]) along with the previously established [16, 20-22] energy gravitational influences on the Earth of the Moon and the planets of the Solar System. In Section 3.1 we present the foundation of the planetary instantaneous and integral energy gravitational influences on the Earth [16, 20-22]. In Section 3.2 we present the foundation of the lunar instantaneous and integral energy gravitational influences on the Earth [16, 21-22]. In Section 3.3 we present the foundation of the energy gravitational influences of the Sun on the Earth [23] owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune) of the Solar System.

In Section 4 we present the foundation of the fundamental global time periodicities [23] of the periodic global seismotectonic and volcanic activity and the global climate variability of the Earth. In Section 4.1 we present the foundation of the fundamental global time periodicities of the periodic global seismotectonic and volcanic activity and the global climate variability determined by the different combinations of the non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune [23]. In Section 4.2 we present the foundation of the fundamental global time periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = (3510 \pm 30)$ years and $T_{tec,f} = T_{clim1,f} = T_{energy,f} = (702 \pm 6)$ years of the periodic global seismotectonic and volcanic activity and the global climate variability determined by the combined non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn. In Section 4.3 we present the evidence of the founded range of the fundamental global periodicities

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$T_{tec,f} = T_{clim1,f} = T_{energy,f} = (696 \div 708)$ years (of the global seismicity and volcanic activity of the Earth) based on the established links between the different volcanic eruptions of Hekla in Iceland BC.

In Section 4.4 we present the evidence of the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = (702 \pm 6)$ years based on the statistical analysis of the historical eruptions of the Katla and the Hekla volcanic systems in Iceland. In Section 4.4.1 we present the generalized formulation of the weak law of large numbers. In Section 4.4.2 we present the statistical analysis of eruptions of Katla volcanic system. In Section 4.4.3 we present the statistical analysis of eruptions of Hekla volcanic system.

In Section 5 we present the evidence of the founded ranges of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 3510 \pm 30$ years and $T_{tec,f} = T_{clim1,f} = T_{energy,f} = (702 \pm 6)$ years (of the global seismicity and volcanic activity) based on the established links between the great volcanic eruptions and earthquakes in the history of humankind from the different distinct eruptions of the Thera (Sanntorini) in the range (1700÷1450 ±14) BC to the subsequent intensifications of the global seismicity and volcanic activity of the Earth in the end of the 19th century and in the beginning of the 20th century [25], in the end of the 20th century [26, and in the beginning of the 21st century AD [20-23]. In Section 5.1 we present the evidence of the linkage of Thera (Santorini) eruption in the range (1700 ÷ 1640) BC [12, 13] and the eruption of Tambora in 1815 AD. In Section 5.2 we present the evidence of the linkage of the eruption of Thera (Santorini) in the range (1627 ÷ 1600) BC [15], the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD), the eruptions of Santorini in 1866 and the great eruption of Krakatau in 1883 AD. In Section 5.3 we present the evidence of the linkage of the increase of the global seismicity and volcanic activity in the end of the 19th century and in the beginning of the 20th century [25] and the eruption of Thera (Santorini) in the range (1600 ÷ 1500) BC [14].

Using the date 1450 BC [7] of last major eruption of Thera and assuming the same ambiguity ±14 years (as in the studies [15] with 95.4% probability), we consider in Section 5.4 the range of the possible dates (1450±14) BC of the last major eruption of Thera. In Section 5.4 we present the evidence of the linkage of the last major eruption of Thera (1450 ±14 BC) and the greatest earthquake [1] (Cassius Dio Cocceianus) destroyed the ancient Pontus (63 BC) and the strong volcanic eruptions during (50±30) BC [58]. In Section 5.5 we present the evidence of the linkage of the last major eruption of Thera (1450 ±14 BC), the great frost event (628 AD) [4] related with the atmospheric veil induced by the great unknown volcanic eruption (apparently, Rabaul' [4] eruption), and the strong Japanese earthquake (684 AD) near the Tokyo region. In Section 5.6 we present the evidence of the linkage of the last major eruption of Thera (1450 ±14 BC) and the strong earthquakes [65] occurred in England (1318 AD and 1343 AD), Armenia (1319 AD), Portugal (1320 AD, 1344 AD and 1356 AD), Japan (1361 AD) and the volcanic eruptions [60] in Iceland on the Hekla volcanic system (1341 AD and 1389 AD) and on the Katla volcanic system (1357 AD). In Section 5.7 we present the evidence of the forthcoming range of the possible intensification (from 2014÷2016 AD) of the global seismotectonic and volcanic activity and the climate variability of the Earth in the 21st century AD related with the last major eruption of Thera (1450 ±14 BC).

In Section 6 we present the conclusions.

2. THE GENERALIZED DIFFERENTIAL FORMULATION OF THE FIRST LAW OF THERMODYNAMICS AND THE COSMIC AND TERRESTRIAL ENERGY GRAVITATIONAL GENESIS OF THE SEISMOTECTONIC AND VOLCANIC ACTIVITY OF THE EARTH

2.1. The Generalized Differential Formulation of the First Law of Thermodynamics (for the Galilean Frame of Reference) for Non-equilibrium Shear-rotational States of the Deformed One-component Individual Finite Continuum Region (Characterized by the Symmetric Stress Tensor T) Moving in the Non-stationary Newtonian Gravitational Field

We shall assume that τ is an individual continuum region (bounded by the closed continual boundary surface $\partial\tau$) moving in the three-dimensional Euclidean space with respect to a Cartesian coordinate system K. Following the works [16, 19-23], we shall consider the deformed finite one-component individual continuum region τ in non-equilibrium shear-rotational states. We shall consider the small continuum region τ in a Galilean frame of reference with respect to a Cartesian coordinate system K centred at the origin O and determined by the axes X_1, X_2, X_3 (see Fig. 1). The unit normal K-basis coordinate vectors triad $\boldsymbol{\mu}_1, \boldsymbol{\mu}_2, \boldsymbol{\mu}_3$ is taken in the directions of the axes X_1, X_2, X_3, respectively. The K-basis vector triad is taken to be right-handed in the order $\boldsymbol{\mu}_1, \boldsymbol{\mu}_2, \boldsymbol{\mu}_3$, see Fig. 1. $\mathbf{g}$ is the local gravity acceleration. The speed of the mass centre C of the continuum region τ is defined by the following expression

$$\mathbf{V}_c = \frac{d\mathbf{r}_c}{dt} = \frac{\iiint_\tau \mathbf{v}\rho dV}{m_\tau}, \tag{2}$$

where $\mathbf{v} = \frac{d\mathbf{r}}{dt}$ is the hydrodynamic velocity vector, the operator $d/dt = \partial/\partial t + \mathbf{v}\cdot\nabla$ denotes the total derivative following the continuum substance. The relevant three-dimensional fields such as the velocity and the local mass density (and also the first and the second derivatives of the relevant fields) are assumed to vary continuously throughout the entire continuum bulk of the continuum region τ. The instantaneous macroscopic kinetic energy of the continuum region τ (bounded by the continuum boundary surface $\partial\tau$) is given by the expression:

$$K_\tau \equiv \iiint_\tau \frac{\rho \mathbf{v}^2}{2} dV, \tag{3}$$

where $\mathbf{v}$ is the local hydrodynamic velocity vector, ρ is the local mass density, dV is the mathematical differential of physical volume of the continuum region. We use the common Riemann's integral here and everywhere.

We shall use the differential formulation of the first law of thermodynamics [37] for the specific volume $\vartheta = 1/\rho$ of the one-component deformed continuum with no chemical reactions:

$$\frac{du}{dt} = \frac{dq}{dt} - p\frac{d\vartheta}{dt} - \vartheta\ \mathbf{\Pi} : \mathrm{Grad}\,\mathbf{v}, \tag{4}$$

where u is the specific (per unit mass) internal thermal energy, p is the thermodynamic pressure, $\mathbf{\Pi}$ is the viscous-stress tensor, $\mathbf{v}$ is the hydrodynamic velocity of the continuum macrodifferential element [37], dq is the differential change of heat across the boundary of the continuum region (of unit mass) related with the thermal molecular conductivity described by the heat equation [37]:

$$\rho\frac{dq}{dt} = -\mathrm{div}\,\mathbf{J}_q, \tag{5}$$

where $\mathbf{J}_q$ is the heat flux [37]. The viscous-stress tensor $\mathbf{\Pi}$ is taken from the decomposition of the pressure tensor $\mathbf{P}$ [37]:

$$\mathbf{P} = p\boldsymbol{\delta} + \mathbf{\Pi}, \tag{6}$$

where **δ** is the Kronecker delta-tensor.

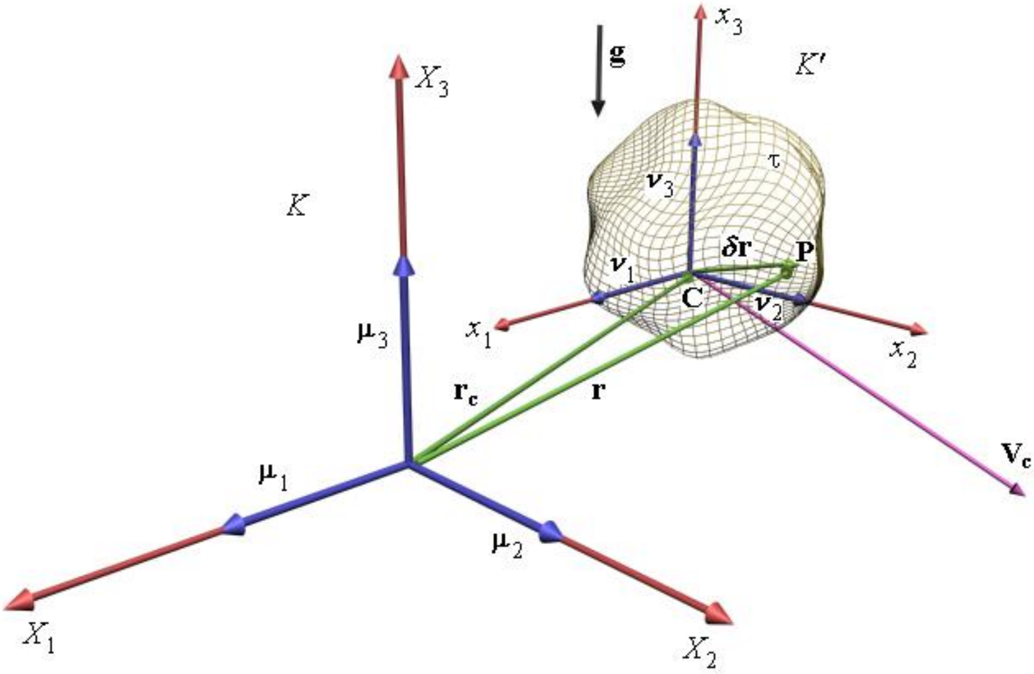

Fig 1: Cartesian coordinate system K of a Galilean frame of reference and the Lagrangian coordinate system K' related with the mass center C of an individual finite continuum region τ characterized by the wide variety of sizes from the geo-block or the magma chamber the of the Earth (of the planet of the terrestrial group) to the whole Earth (or the planet of the Solar System)

Using the differential formulation of the first law of thermodynamics [37] for the total derivative $\mathrm{du/dt}$ (following the liquid substance) of the specific (per unit mass) internal thermal energy u of the one-component deformed continuum with no chemical reactions, the heat equation (5), the general equation of continuum movement [38]:

$$\frac{d\mathbf{v}}{dt} = \frac{1}{\rho}\operatorname{div}\mathbf{T} + \mathbf{g} \tag{7}$$

for the deformed continuum characterized by the symmetric stress tensor $\mathbf{T} = -\mathbf{P}$ [38] of general form and taking into account the time variations of the potential ψ of the non-stationary gravitational field (characterized by the local gravity acceleration $\mathbf{g} = -\nabla\psi$) inside of an arbitrary finite macroscopic individual continuum region τ, we derived [19, 20] the generalized differential formulation (for the Galilean frame of reference) of the first law of thermodynamics (for moving rotating deforming compressible heat-conducting stratified macroscopic continuum region τ subjected to the non-stationary Newtonian gravitational field):

$$d\,(K_\tau + U_\tau + \pi_\tau) = dt\iint_{\partial\tau}\left(\mathbf{v}\cdot(\mathbf{n}\cdot\mathbf{T})\right)d\Omega_{\mathbf{n}} - dt\iint_{\partial\tau}\left(\mathbf{J}_q\cdot\mathbf{n}\right)d\Omega_{\mathbf{n}} + dt\iiint_{\tau}\frac{\partial\psi}{\partial t}\rho dV\,, \tag{8}$$

where

$$\delta A_{np,\partial\tau} = dt\iint_{\partial\tau}\left(\mathbf{v}\cdot(\mathbf{n}\cdot\mathbf{T})\right)d\Omega_{\mathbf{n}} \tag{9}$$

is the differential work done during the infinitesimal time interval dt by non-potential stress forces acting on the boundary surface $\partial\tau$ of the continuum region τ; $d\Omega_{\mathbf{n}}$ is the differential element (of the boundary surface $\partial\tau$ of the continuum region τ) characterized by the external normal unit vector $\mathbf{n}$; $\mathbf{t} = \mathbf{n}\cdot\mathbf{T}$ is the stress vector [38];

$$\delta Q = -dt \iint_{\partial\tau} \left(\mathbf{J}_q \cdot \mathbf{n}\right) d\Omega_{\mathbf{n}} \tag{10}$$

is the differential change of heat related with the thermal molecular conductivity of heat across the boundary $\partial\tau$ of the continuum region τ, $\mathbf{J}_q$ is the heat flux [37] across the element $d\Omega_{\mathbf{n}}$ of the continuum boundary surface $\partial\tau$;

$$\pi_\tau \equiv \iiint_\tau \psi \rho dV \tag{11}$$

is the macroscopic potential energy (of the macroscopic individual continuum region τ) related with the non-stationary potential ψ of the gravitational field;

$$U_\tau \equiv \iiint_\tau u \rho dV \tag{12}$$

is the classical microscopic internal thermal energy of the macroscopic individual continuum region τ;

$$K_\tau = \iiint_\tau \frac{\rho \mathbf{v}^2}{2} dV \tag{13}$$

is the instantaneous macroscopic kinetic energy of the macroscopic individual continuum region τ.

The generalized differential formulation (8) of the first law of thermodynamics can be rewritten as follows [19, 20]:

$$dU_\tau + dK_\tau + d\pi_\tau = \delta Q + \delta A_{np,\partial\tau} + dG \tag{14}$$

extending the classical [24, 39] formulations by taking into account (along with the classical infinitesimal change of heat δQ and the classical infinitesimal change $dU_\tau \equiv dU$ of the internal energy U_τ) the infinitesimal increment dK_τ of the macroscopic kinetic energy K_τ, the infinitesimal increment $d\pi_\tau$ of the gravitational potential energy π_τ, the generalized infinitesimal work $\delta A_{np,\partial\tau}$ done during the infinitesimal time interval dt by non-potential stress forces (pressure, compressible and viscous forces for Newtonian continuum) acting on the boundary surface $\partial\tau$ of the continuum region τ, the infinitesimal amount dG of energy [19, 20]:

$$dG = dt \iiint_\tau \frac{\partial \psi}{\partial t} \rho dV \tag{15}$$

added or lost as the result of the Newtonian non-stationary gravitational energy influence on the continuum region τ during the infinitesimal time interval dt. The infinitesimal amount dG [19, 20] of energy (added or lost as the result of the Newtonian non-stationary gravitational energy influence on the continuum region τ) may be interpreted [16, 19-23] as the differential energy gravitational influence dG on the continuum region τ during the infinitesimal time interval dt.

According to the generalized differential formulation (14) of the first law of thermodynamics for the continuum region τ, the differential flux of energy into the continuum region τ may occur by means of the differential work done by non-potential stress forces

$$\delta A_{np,\partial\tau} = dt \iint_{\partial\tau} \left(\mathbf{v} \cdot \left(\mathbf{n} \cdot \mathbf{T}\right)\right) d\Omega_{\mathbf{n}} \tag{16}$$

presented for Newtonian continuum as follows [16, 19, 20]:

$$\delta A_{np,\partial\tau} = \delta A_p + \delta A_c + \delta A_s = \tag{17}$$

$$= - dt \iint_{\partial\tau} p(\mathbf{v}\cdot\mathbf{n})\, d\Omega_{\mathbf{n}} \; - dt \iint_{\partial\tau} \left(\frac{2}{3}\eta - \eta_v\right) \mathrm{div}\, \mathbf{v}(\mathbf{v}\cdot\mathbf{n})\, d\Omega_{\mathbf{n}} + dt \iint_{\partial\tau} 2\eta\, v_\beta n_\alpha e_{\alpha\beta} d\Omega_n ,$$

where

$$\delta A_p = - dt \iint_{\partial\tau} p(\mathbf{v}\cdot\mathbf{n})\, d\Omega_{\mathbf{n}} \tag{18}$$

is the classical differential work of the hydrodynamic pressure forces acting on the boundary surface $\partial\tau$ of the individual continuum region τ (bounded by the continuum boundary surface $\partial\tau$) during the infinitesimal time interval dt;

$$\delta A_c = - dt \iint_{\partial\tau} \left(\frac{2}{3}\eta - \eta_v\right) \mathrm{div}\, \mathbf{v}(\mathbf{v}\cdot\mathbf{n})\, d\Omega_{\mathbf{n}} \tag{19}$$

is the differential work (related with the combined effects of the acoustic compressibility, molecular kinematic viscosity and molecular volume viscosity) of the acoustic (compressible) pressure forces acting on the boundary surface $\partial\tau$ of the individual continuum region τ during the infinitesimal time interval dt;

$$\delta A_s = dt \iint_{\partial\tau} 2\eta\, v_\beta n_\alpha e_{\alpha\beta} d\Omega_n \tag{20}$$

is the differential work of the viscous Newtonian forces (related with the combined effect of the velocity shear, i.e. the deformation of the continuum region τ, and the molecular kinematic viscosity) acting during the differential time dt on the boundary surface $\partial\tau$ of the continuum region τ characterized by the rate of strain tensor $e_{\alpha\beta}$ [17, 18], the coefficient of molecular kinematic (shear) viscosity $\nu = \eta/\rho$ and the coefficient of molecular volume (second) viscosity $\nu_2 = \eta_v/\rho$.

The generalized differential formulation (14) of the first law of thermodynamics for the Newtonian continuum can be rewritten as follows:

$$dU_\tau + dK_\tau + d\pi_\tau = \delta Q + \delta A_p + \delta A_c + \delta A_s + dG \tag{21}$$

extending the classical [24, 39] formulations by taking into account (along with the classical infinitesimal change of heat δQ and the classical infinitesimal change $dU_\tau \equiv dU$ of the internal energy U_τ) the infinitesimal increment dK_τ of the macroscopic kinetic energy K_τ, the infinitesimal increment $d\pi_\tau$ of the gravitational potential energy π_τ, the classical [24, 39] differential work δA_p of the hydrodynamic pressure forces, the established differential work δA_c of the acoustic (compressible) pressure forces, the established differential work δA_s of the viscous Newtonian forces, and the infinitesimal amount dG of energy [16, 19, 20] added or lost as the result of the Newtonian non-stationary gravitational energy influence on the continuum region τ during the infinitesimal time interval dt.

Under partial conditions $dK_\tau = 0$, $d\pi_\tau = 0$, $\delta A_c = 0$, $\delta A_s = 0$, $dG = 0$, the generalized differential formulation (21) of the first law of thermodynamics can be rewritten as follows:

$$dU_\tau = \delta Q + \delta A_p , \tag{22}$$

which is consistent with the following Gibbs' [24] formulation of the first law of thermodynamics for the fluid body (in Gibbs' designations):

$$d\varepsilon = dH - dW , \tag{23}$$

where $d\varepsilon$ is the differential of the internal thermal energy of the fluid body, dH is the differential change of heat across the boundary of the fluid body related with the thermal molecular conductivity (associated with the corresponding external or internal heat fluxes), $dW = pdV$ is the differential work produced by the considered fluid body on its surroundings (surrounding fluid) under the differential change dV of the fluid volume V under the thermodynamic pressure p.

The partial formulation (22) is consistent with the following formulation [39] of the first law of thermodynamics for the general thermodynamic system (in Landau's and Lifshitz's designations [39]):

$$dE = dQ - pdV, \tag{24}$$

where $dA = -pdV$ is the differential work produced by the surroundings (surroundings of the thermodynamic system) on the thermodynamic system under the differential change dV of volume V of the thermodynamic system characterized by the thermodynamic pressure p; dQ is the differential heat transfer (across the boundary of the thermodynamic system) related with the thermal interaction of the thermodynamic system and the surroundings (surrounding environment); E is the energy of the thermodynamic system, which should contain (as supposed [39]) the kinetic energy of the macroscopic continuum motion.

The generalized differential formulation (14) of the first law of thermodynamics (given for the Galilean frame of reference) is valid for non-equilibrium shear-rotational states of the deformed finite individual continuum region τ (characterized by the symmetric stress tensor $\mathbf{T}$) moving in the non-stationary gravitational field. The generalized differential formulation of the first law of thermodynamics (14) is the generalization of the classical formulations [24, 39] of the first law of thermodynamics. The generalized differential formulations (14) and (21) of the first law of thermodynamics takes into account the significant generalized terms:

1) the generalized expression (9) for the differential work $\delta A_{np,\partial\tau}$ done during the infinitesimal time interval dt by non-potential stress forces acting on the boundary surface $\partial\tau$ of the individual continuum region τ and

2) the new additional expression (15) for the differential energy gravitational influence dG on the continuum region τ during the infinitesimal time interval dt related with the time variations of the potential ψ of the non-stationary gravitational field inside the individual continuum region τ due to the deformation of the individual continuum region τ and due to the external (terrestrial and cosmic) gravitational influence on the individual continuum region τ moving in the total (combined: internal and external) non-stationary gravitational field.

We founded the generalized thermohydrogravidynamic shear-rotational model [16, 19, 20] of the earthquake focal region based on the generalized differential formulation (21) of the first law of thermodynamics for the Newtonian continuum using the above three expressions (18), (19) and (20) for the differential works δA_p, δA_c and δA_s together with the generalized expression [17, 18] for the instantaneous macroscopic kinetic energy K_τ of the small macroscopic individual continuum region τ.

2.2. Cosmic and Terrestrial Energy Gravitational Genesis of the Global Seismicity and Volcanic Activity of the Earth Induced by the Combined Cosmic and Terrestrial Non-stationary Energy Gravitational Influences on the Individual Continuum Region τ (of the lithosphere of the Earth) and by the Non-potential Terrestrial Stress Forces Acting on the Boundary Surface $\partial\tau$ of the Continuum Region τ

We founded [16, 19-23] the physical mechanisms of the energy fluxes to the continuum region τ related with preparation of earthquakes and volcanic eruptions. The generalized differential formulation (14) of the first law of thermodynamics shows that the non-stationary gravitational field (related with the non-stationary gravitational potential ψ) gives the following gravitational energy power

$$W_{gr}(\tau) = \iiint_\tau \frac{\partial\psi}{\partial t}\rho dV = \frac{dG}{dt} \tag{25}$$

associated with the gravitational energy power of the total combined (external cosmic, global terrestrial and internal related with the macroscopic continuum region τ) gravitational field. If the macroscopic continuum region τ is not very large, consequently, it cannot induce the significant time variations to the potential ψ of the gravity field inside the continuum region τ. According to the generalized differential formulation (14) of the first law of thermodynamics, the energy power of the gravitational field may produce the fractures [14, 18, 21] in the continuum region τ.

The generalized differential formulation (14) of the first law of thermodynamics and the expression (25) for the gravitational energy power $W_{gr}(\tau)$ show that the local time increase of the potential ψ of the gravitational field is the gravitational energy mechanism of the gravitational energy flux into the continuum region τ. The local time increase of the potential ψ of the gravitational field inside the continuum region τ ($\partial\psi/\partial t > 0$) is related with the gravitational energy flux into the continuum region τ. According to the generalized differential formulation (14) of the first law of thermodynamics, the total energy $(K_\tau + U_\tau + \pi_\tau)$ of the continuum region τ is increased if $\partial\psi/\partial t > 0$. According to the generalized differential formulation (14) of the first law of thermodynamics, the gravitational energy flux into the continuum region τ may induce the formation of fractures [16, 19-23] in the continuum region τ related with the production of earthquake. This conclusion corresponds to the observations [26, 34-36, 40, 41] of the identified anomalous variations of the gravitational field before strong earthquakes.

The generalized differential formulation (14) of the first law of thermodynamics gives also the theoretical foundation of the detected non-relativistic classical "gravitational" waves [23] (the propagating disturbances of the gravitational field of the Earth) from the moving focal regions of earthquakes. The theoretical foundation of the non-relativistic classical "gravitational" waves is based on the fact that the gravitational energy power $W_{gr}(\tau)$ (in the last differential term dG of the generalized differential formulation (14) of the first law of thermodynamics) can be rewritten as

$$W_{gr}(\tau) = \iiint_{\tau} \frac{\partial\psi}{\partial t}\rho dV = -\iint_{\partial\tau} (\mathbf{J_g}\cdot\mathbf{n}) d\Omega_{\mathbf{n}}, \quad (26)$$

where $\mathbf{J_g}$ is the energy flux characterized by the divergence

$$\operatorname{div}\mathbf{J_g} = -\rho\frac{\partial\psi}{\partial t} \quad (27)$$

of the gravitational energy (across the boundary $\partial\tau$ of the continuum region τ) related with the time change of the potential ψ of the gravitational field inside the continuum region τ. It was pointed out [41] that the past experience and empirical data showed that "earthquakes typically occur within one to two years after a period of significant gravity changes in the region in question". The gravitational energy power $W_{gr}(\tau)$ (in last differential term dG of the generalized differential formulation (14) of the first law of thermodynamics) may be considered as the useful theoretical component "needed to remove the subjective nature in the determination of the timeframe of a forecasted earthquake" [41].

The necessity to consider the gravitational field (during the strong earthquakes) is related with the observations of the slow gravitational [42, 43] ground waves resulting from strong earthquakes and spreading out from the focal regions [44, 45] of earthquakes. Lomnitz pointed out [44] that the gravitational ground waves (related with great earthquakes) "have been regularly reported for many years and remain a controversial subject in earthquake seismology". Richter presented [28] the detailed analysis of these observations and made the conclusion that "there is almost certainly a real phenomenon of progressing or standing waves seen on soft ground in the meizoseismal areas of great earthquakes". Lomnitz presented [45] the real evidence of the existence of the slow gravitational waves in sedimentary layers during strong earthquakes. The fundamental connections of the geodynamics, seismicity and volcanism with gravitation (and the slow gravitational ground waves resulting from strong earthquakes) are presented in the works [46-48].

According to the generalized differential formulation (14) of the first law of thermodynamics, the supply of energy (related with the energy flux) into the continuum region τ is related with the differential work:

$$\delta A_{np,\partial\tau} = dt\iint_{\partial\tau} \left(\mathbf{v}\cdot(\mathbf{n}\cdot\mathbf{T})\right) d\Omega_{\mathbf{n}} \quad (28)$$

done by non-potential stress forces (pressure, compressible and viscous forces for Newtonian continuum) acting on the boundary surface $\partial\tau$ of the continuum region τ during the differential time interval dt.

The considered mechanisms of the energy flux into the Earth's macroscopic continuum region τ should result to the irreversible process of the splits formation in the rocks related with the generation of the high-frequency acoustic waves from the focal continuum region τ before the earthquake and volcanic eruption. Taking this into account, the sum

$\delta A_c + \delta A_s$ (for Newtonian continuum) in the expression (17) for $A_{np,\partial\tau}$ may be interpreted [16, 20-23] as the energy flux

$$\delta F_{vis,c} = \delta A_c + \delta A_s \tag{29}$$

(according to the classical hydrodynamic approach [49] directed across the boundary $\partial\tau$ of the continuum region τ due to the compressible and viscous forces (for Newtonian continuum) acting on the boundary surface $\partial\tau$ of the continuum region τ.

The considered two mechanisms of the energy flux into the Earth's macroscopic continuum region τ should result to the significant increase of the energy flux of the geo-acoustic energy from the focal region τ before the earthquake and volcanic eruption. The deduced conclusion is in a good agreement with the results of the detailed experimental studies [50].

3. THE DEVELOPMENT OF THE COSMIC GEOPHYSICS BY TAKING INTO ACCOUNT THE ENERGY GRAVITATIONAL INFLUENCE OF THE SUN ON THE EARTH OWING TO THE GRAVITATIONAL INTERACTION OF THE SUN WITH THE OUTER LARGE PLANETS

3.1. Planetary Instantaneous and Integral Energy Gravitational Influences on the Earth

Taking into account the energy gravitational influences on the Earth of the Moon and the planets of the Solar System, we developed [16, 20-23] the fundamentals of the cosmic geophysics. The deterministic thermohydrogravidynamic theory is based on the established [19, 20] generalized formulation of the first law of thermodynamics for moving rotating deforming compressible heat-conducting stratified macroscopic continuum region τ (demonstrated on Fig. 1) subjected to the non-stationary Newtonian gravitational field.

We derived [21, 22] the analytical expression for the energy gravitational influences (on the Earth) of the inner and the outer planets in the second approximation of the elliptical orbits of the planets of the Solar System. We evaluated of the relative maximal planetary instantaneous energy gravitational influences on the Earth in the first approximation of the circular orbits of the planets of the Solar System. We used [20-22] the maximal positive value $\max\limits_t \frac{\partial\psi_{3M}(C_3,t,\mathrm{int})}{\partial t}$ (the maximal power of the energy gravitational influence (on the unit mass at the mass center C_3 of the Earth) of the Mercury moving around the mass center of the Sun along the hypothetical circular orbit) as a scale of the energy gravitational influences on the Earth of the planets of the Solar System, the Moon and the Sun. To evaluate the relative instantaneous energy gravitational influence of the inner planet τ_i (the Mercury and the Venus) at the mass center C_3 of the Earth, we considered [20-23] the ratio

$$f(i,C_3) = \frac{\max\limits_t \frac{\partial\psi_{3i}(C_3,t,\mathrm{int})}{\partial t}}{\max\limits_t \frac{\partial\psi_{3M}(C_3,t,\mathrm{int})}{\partial t}},\ i = 1,2 \tag{30}$$

of the maximal positive value $\max\limits_t \frac{\partial\psi_{3i}(C_3,t,\mathrm{int})}{\partial t}$ (of the partial derivative of the gravitational potential created by the inner planet τ_i at the mass center C_3 of the Earth) and the maximal positive value $\max\limits_t \frac{\partial\psi_{3M}(C_3,t,\mathrm{int})}{\partial t}$ of the partial derivative of the gravitational potential created by the Mercury at the mass center C_3 of the Earth. To evaluate the relative instantaneous energy gravitational influence of the outer planet τ_i (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) at the mass center C_3 of the Earth, we considered [20-23] the ratio

$$f(i,C_3) = \frac{\max\limits_t \frac{\partial\psi_{3i}(C_3,t,\mathrm{ext})}{\partial t}}{\max\limits_t \frac{\partial\psi_{3M}(C_3,t,\mathrm{int})}{\partial t}},\ i = 4,5,6,7,8,9 \tag{31}$$

of the maximal positive value $\max_t \frac{\partial \psi_{3i}(C_3, t, ext)}{\partial t}$ (of the partial derivative of the gravitational potential created by the outer planet τ_i at the mass center C_3 of the Earth) and the maximal positive value $\max_t \frac{\partial \psi_{3M}(C_3, t, int)}{\partial t}$ of the partial derivative of the gravitational potential created by the Mercury at the mass center C_3 of the Earth.

Based on the formulas (30) and (31), we calculated [21, 22] the following numerical values (characterizing the planetary maximal instantaneous energy gravitational influences on the unit mass at the mass center C_3 of the Earth): $f(2, C_3)$ =37.69807434 (for the Venus), $f(5, C_3)$ = 7.41055774 (for the Jupiter), $f(1, C_3)$ = 1 (for the Mercury by definition), $f(4, C_3)$ = 0.67441034 (for the Mars), $f(6, C_3)$ = 0.24601009 (for the Saturn), $f(7, C_3)$ =0.00319056 (for the Uranus), $f(8, C_3)$ = 0.00077565 (for the Neptune) and $f(9, C_3)$ = $3.4813 \cdot 10^{-8}$ (for the Pluto). We see that the Venus and the Jupiter are characterized by the maximal planetary instantaneous energy gravitational influences on the Earth.

We obtained [20-22] the evaluation of the relative maximal planetary integral energy gravitational influences on the Earth in the approximation of the circular orbits of the planets of the Solar System. To evaluate the relative maximal planetary integral energy gravitational influence of the inner planet τ_i (the Mercury and the Venus) at the mass center C_3 of the Earth, we considered the ratio

$$s(i) = \frac{\max_t \Delta_g E_3(\tau_i, t)}{\max_t \Delta_g E_3(\tau_1, t)}, \quad i = 1, 2 \tag{32}$$

of the maximal positive integral energy gravitational influence $\max_t \Delta_g E_3(\tau_i, t)$ (of the inner planet τ_i at the mass center C_3 of the Earth) and the maximal positive integral energy gravitational influence $\max_t \Delta_g E_3(\tau_1, t)$ of the Mercury at the mass center C_3 of the Earth. To evaluate the relative maximal planetary integral energy gravitational influence of the outer planet τ_i (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) at the mass center C_3 of the Earth, we considered [20-22] the ratio

$$s(i) = \frac{\left|\min_t \Delta_g E_3(\tau_i, t)\right|}{\max_t \Delta_g E_3(\tau_1, t)}, \quad i = 4, 5, 6, 7, 8, 9 \tag{33}$$

of the absolute (positive) value $\left|\min_t \Delta_g E_3(\tau_i, t)\right|$ of the integral energy gravitational influence $\Delta_g E_3(\tau_i, t)$ (of the outer planet τ_i at the mass center C_3 of the Earth) and the maximal positive integral energy gravitational influence $\max_t \Delta_g E_3(\tau_1, t)$ of the Mercury at the mass center C_3 of the Earth.

Based on the expressions (32) and (33), we calculated [20-22] the following numerical values $s(i)$ (characterizing the planetary maximal integral energy gravitational influences on the unit mass at the mass center C_3 of the Earth): $s(2) = 89.6409$ (for the Venus), $s(5) = 31.319$ (for the Jupiter), $s(4) = 2.6396$ (for the Mars), $s(6) = 1.036$ (for the Saturn), $s(1) = 1$ (for the Mercury by definition), $s(7) = 0.0133$ (for the Uranus), $s(8) = 0.003229$ (for the Neptune) and $s(9) = 1.4495 \cdot 10^{-7}$ (the Pluto). We see that the Venus and the Jupiter are characterized by the maximal planetary integral energy gravitational influences on the Earth. By considering the energy gravitational influence (based on the generalized differential formulation of the first law of thermodynamics) of the Venus on macroscopic continuum region τ near the surface of the Earth, we founded [20-22] the real cosmic energy gravitational genesis of preparation of earthquakes.

3.2. Lunar Instantaneous and Integral Energy Gravitational Influences on the Earth

We derived the expression for the lunar instantaneous and integral energy gravitational influences on the Earth in the second approximation [21, 22] (Simonenko, 2009; 2010) considering the elliptical orbits of the Earth and the Moon around the combined mass center $C_{3,MOON}$ of the Earth and the Moon. To evaluate the relative maximal instantaneous energy gravitational influence of the Moon at the mass center C_3 of the Earth, we considered the ratio

$$f_{MOONM}(C_3, \text{second approx}) = \frac{\text{char. max. pos.} \frac{\partial}{\partial t} \psi_{3MOON}(C_3, t, \text{second approx.})}{\max\limits_t \frac{\partial}{\partial t} \psi_{3M}(C_3, t, \text{int})} \quad (34)$$

of the characteristic maximal positive value $\text{char.max.pos.} \frac{\partial}{\partial t} \psi_{3MOON}(C_3, t, \text{second approx.})$ (of the partial derivative of the gravitational potential $\psi_{3MOON}(C_3, t, \text{second approx.})$ created by the Moon at the mass center C_3 of the Earth) and the maximal positive value $\max\limits_t \frac{\partial \psi_{3M}(C_3, t, \text{int})}{\partial t}$ of the partial derivative of the gravitational potential created by the Mercury at the mass center C_3 of the Earth. The calculated [21, 22] the non-dimensional numerical value (characterizing the lunar maximal instantaneous energy gravitational influence on the unit mass at the mass center C_3 of the Earth) $f_{MOONM}(C_3, \text{second approx.}) = 19.44083$ means that the maximal power of the energy gravitational influence of the Moon (on the unit mass at the mass center C_3 of the Earth) is 19.44083 times larger than the maximal power of the energy gravitational influence (on the unit mass at the mass center C_3 of the Earth) of the Mercury moving around the mass center of the Sun along the hypothetical circular orbit.

Taking into account the calculated [21, 22] maximal planetary and lunar instantaneous energy gravitational influences on the unit mass at the mass center C_3 of the Earth, we have the following order of significance (in respect of the importance of the planetary and lunar instantaneous energy gravitational influences on the Earth): the Venus, the Moon, the Jupiter, the Mercury, the Mars, the Saturn, the Uranus, the Neptune and the Pluto.

We obtained [21, 22] the evaluation of the maximal integral energy gravitational influence of the Moon on the unit mass at the mass center C_3 of the Earth in the approximation of the elliptical orbits of the Earth and the Moon around the combined mass center $C_{3,MOON}$. To evaluate the maximal positive integral energy gravitational influence of the Moon at the mass center C_3 of the Earth, we considered [21, 22] the ratio

$$s(\text{Moon,second approx.}) = \frac{\max\limits_t \Delta_g E_3(\text{Moon}, t)}{\max\limits_t \Delta_g E_3(\tau_1, t)} \quad (35)$$

of the maximal positive integral energy gravitational influence $\max\limits_t \Delta_g E_3(\text{Moon}, t)$ (of the Moon on the unit mass at the mass center C_3 of the Earth) and the maximal positive integral energy gravitational influence $\max\limits_t \Delta_g E_3(\tau_1, t)$ of the Mercury at the mass center C_3 of the Earth. We calculated [21, 22] the numerical value $s(\text{Moon,second approx.}) = 13.0693$ characterizing the lunar maximal integral energy gravitational influence on the unit mass at the mass center C_3 of the Earth.

Taking into account the calculated [21, 22] maximal planetary and lunar integral energy gravitational influences on the unit mass at the mass center C_3 of the Earth, we have the following order of significance (in respect of the importance of the planetary and lunar integral energy gravitational influences on the Earth): the Venus, the Jupiter, the Moon, the Mars, the Saturn, the Mercury, the Uranus, the Neptune and the Pluto.

3.3. The Energy Gravitational Influences of the Sun on the Earth owing to the Gravitational Interaction of the Sun with the Outer Large Planets (the Jupiter, the Saturn, the Uranus and the Neptune) of the Solar System

We evaluated [23] the energy gravitational influence (instantaneous and integral) of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune) of the Solar System. We evaluated [23] the characteristic maximal positive instantaneous energy gravitational influences of the

Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets of the Solar System) as compared with the maximal planetary instantaneous energy gravitational influences on the Earth of the planets of the Solar System. The evaluations of the relative characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets of the Solar System) are obtained [23] in the approximation of the elliptical orbit of the Earth τ_3 around the combined mass center of the Sun and the outer large planet τ_j ($j=5,6,7,8$). We used [23] the maximal positive value $\max_t \frac{\partial \psi_{3M}(C_3, t, int)}{\partial t}$ (of the partial derivative of the gravitational potential created by the Mercury (moving around the mass center of the Sun along the hypothetical circular orbit) at the mass center C_3 of the Earth) as a scale for evaluation of the energy gravitational influence of the Sun on the mass center C_3 of the Earth owing to the gravitational interaction of the Sun with the outer large planet τ_j ($j=5,6,7,8$) of the Solar System. We considered [23] the ratio (for $j=5,6,7,8$):

$$f_{SUN\,M}(j, C_3, char.) = \frac{char.\,max.\,pos. \frac{\partial}{\partial t}\psi^S_{3j}(C_3, t)}{\max_t \frac{\partial}{\partial t}\psi_{3M}(C_3, t, int)} \quad (36)$$

of the characteristic maximal positive value $char.\,max.\,pos. \frac{\partial}{\partial t}\psi^S_{3j}(C_3, t)$ (of the partial derivative $\frac{\partial}{\partial t}\psi^S_{3j}(C_3, t)$ of the gravitational potential $\psi^S_{3j}(C_3, t)$ created by the Sun at the mass center C_3 of the Earth τ_3 owing to the gravitational interaction of the Sun with the outer large planet τ_j) and the maximal positive value $\max_t \frac{\partial \psi_{3M}(C_3, t, int)}{\partial t}$ of the partial derivative of the gravitational potential created by the Mercury at the mass center C_3 of the Earth. Based on the above expression (36), we calculated [23] the following values (characterizing the maximal instantaneous energy gravitational influences of the Sun on the unit mass at the mass center C_3 of the Earth owing to the gravitational interaction of the Sun with the outer large planet τ_j): $f_{SUN\,M}(5, C_3, char.) = 884.935424$ (for the Sun owing to the gravitational interaction of the Sun with the Jupiter), $f_{SUN\,M}(6, C_3, char.) = 194.923355$ (for the Sun owing to the gravitational interaction of the Sun with the Saturn), $f_{SUN\,M}(7, C_3, char.) = 21.27951$ (for the Sun owing to the gravitational interaction of the Sun with the Uranus) and $f_{SUN\,M}(8, C_3, char.) = 20.833557$ (for the Sun owing to the gravitational interaction of the Sun with the Neptune). Taking into account the calculated numerical values $f_{SUN\,M}(j, C_3, char.)$, we established [23] the following order of significance of the outer large planets of the Solar System: the Jupiter (τ_5), the Saturn (τ_6), the Uranus (τ_7) and the Neptune (τ_8) in respect of the evaluated characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets of the Solar System.

We evaluated the maximal positive integral energy gravitational influences of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets) in the first approximation of the circular orbits of the planets of the Solar System. Based on the generalized differential formulation [10, 16, 19] of the first law of thermodynamics used for the Earth, we derived [23] the relation for the maximal positive integral energy gravitational influences $\max_t \Delta_g E_3(Sun - \tau_j, t)$ of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets τ_j $(j=5,6,7,8)$. Using the maximal positive integral energy gravitational influence $\max_t \Delta_g E_3(Sun - \tau_j, t)$ of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planet τ_j, $j=5,6,7,8$) and using the maximal positive integral energy gravitational influence $\max_t \Delta_g E_3(\tau_1, t)$ of the Mercury on the Earth, we considered [23] (Simonenko, 2012a) the following ratio (for $j=5,6,7,8$)

$$s(Sun - \tau_j, first\ approx.) = \frac{\max_t \Delta_g E_3(Sun - \tau_j, t)}{\max_t \Delta_g E_3(\tau_1, t)}. \quad (37)$$

Based on the above expression, we calculated [23] the following values (characterizing the maximal integral energy gravitational influences of the Sun on the unit mass at the mass center C_3 of the Earth owing to the gravitational interaction of the Sun with the outer large planet τ_j): $s(Sun-\tau_5,\ \text{first approx.})=4235.613239$ (for the Sun owing to the gravitational interaction of the Sun with the Jupiter), $s(Sun-\tau_6,\ \text{first approx.})=887.4442965$ (for the Sun owing to the gravitational interaction of the Sun with the Saturn), $s(Sun-\tau_7,\ \text{first approx.})=93.8337322$ (for the Sun owing to the gravitational interaction of the Sun with the Uranus) and $s(Sun-\tau_8,\ \text{first approx.})=87.8477601$ (for the Sun owing to the gravitational interaction of the Sun with the Neptune). Taking into account the calculated relative values $s(Sun-\tau_j, \text{first approx.})$ characterizing the maximal integral energy gravitational influences of the Sun on the unit mass at the mass center C_3 of the Earth owing to the gravitational interaction of the Sun with the outer large planets, we established [23] the following order of signification of the outer large planets τ_j $(j=5,6,7,8)$ of the Solar System: the Jupiter, the Saturn, the Uranus and the Neptune in respect of the importance of the integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets.

Taking into account the cosmic energy gravitational genesis [16, 20-23] of preparation of the strong earthquakes, we have [23] the following order of predominance of the prevalent maximal integral energy gravitational influences on the Earth [23]: 1) the integral energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the Jupiter $(s(Sun-\tau_5,\ \text{first approx.})=4235.613239)$, 2) the integral energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the Saturn $(s(Sun-\tau_6,\ \text{first approx.})=887.4442965)$, 3) the integral energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the Uranus $(s(Sun-\tau_7,\ \text{first approx.})=93.8337322)$, 4) the integral energy gravitational influence of the Venus on the Earth $(s(2)=89.6409)$, 5) the integral energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the Neptune $(s(Sun-\tau_8,\ \text{first approx.})=87.8477601)$, 6) the integral energy gravitational influence of the Jupiter on the Earth $(s(5)=31.319)$ and the integral energy gravitational influence of the Moon on the Earth $(s(\text{Moon,second approx.})=13.0693)$.

4. THE FUNDAMENTAL GLOBAL TIME PERIODICITIES OF THE PERIODIC GLOBAL SEISMOTECTONIC AND VOLCANIC ACTIVITY OF THE EARTH

4.1.The Fundamental Global Time Periodicities of the Periodic Global Seismotectonic and Volcanic Activity and the Global Climate Variability Determined by the Different Combinations of the Non-stationary Energy Gravitational Influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the Gravitational Interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune

Taking into account the significant maximal integral energy gravitational influences of the Sun on the Earth [23] owing to the gravitational interaction of the Sun with the outer large planets τ_j $(j=5,6,7,8)$, we established [23] the fundamental global time periodicities (related to the combined planetary, lunar and solar non-stationary energy gravitational influences on the Earth) of the periodic global seismotectonic (and volcanic) activity and the global climate variability of the Earth induced by the different combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

We established successive approximations for the commensurable [51] time periodicities of recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth: $\{(T_{S\text{-}MOON,3})_i\}=3$ years $(i=1)$, 8 years $(i=2)$, 19 years $(i=3)$, 27 years $(i=4)$ for the system Sun-Moon [20-22] including 11 years (i=2) [16, 23]; $\{(T_{V,3})_j\}=3$ years $(j=1)$, 8 years $(j=2)$ for the Venus [20-22] including 11 years (j=3) [16, 23]; $\{(T_{MARS,3})_k\}=15$ years $(k=1)$, 32 years $(k=2)$, 47 years $(k=3)$ for the Mars [20-22]; $\{(T_{J,3})_n\}=11$ years $(n=1)$, 12 years $(n=2)$, 83 years $(n=3)$ for the Jupiter [20-22] and for the Sun owing to the gravitational interaction of the Sun with the Jupiter [23]; $\{(T_{SAT,3})_m\}=29$ years $(m=1)$, 59 years $(m=2)$, 265 years $(m=3)$ for the Saturn [23] and for the

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Sun owing to the gravitational interaction of the Sun with the Saturn [23]; $\{(T_{U,3})_q\} = 84$ years $(q = 1)$ for the Uranus [23] and for the Sun owing to the gravitational interaction of the Sun with the Uranus [23]; $\{(T_{N,3})_r\} = 165$ years $(r = 1)$, 659 years $(r = 2)$, 2142 years $(r = 3)$ for the Neptune [23] and for the Sun owing to the gravitational interaction of the Sun with the Neptune [23].

We founded [16, 20-23] that the time periodicities of the global seismotectonic (and volcanic) activity and the global climate variability of the Earth are determined by the combined cosmic factors: G-factor related with the combined cosmic non-stationary energy gravitational influences on the Earth, $G(a)$-factor related to the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor, $G(b)$-factor related to the periodic atmospheric-oceanic warming or cooling as a consequence of the periodic variable (increasing or decreasing) output of the greenhouse volcanic gases and the related variable greenhouse effect induced by the periodic variable tectonic-volcanic activity (intensification or weakening) due to the G-factor, $G(c)$-factor [21-23] related to the periodic variations of the solar activity owing to the periodic variations of the combined planetary non-stationary energy gravitational influence on the Sun. We take into account (in this article) the combined cosmic G, $G(a)$ and $G(b)$-factors related with the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

Based on the generalized differential formulation (14) of the first law of thermodynamics used for the Earth as a whole, we founded [23] the fundamental sets of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f}$ (of the periodic global seismotectonic and volcanic activities owing to the G-factor) and the fundamental global climatic periodicities $T_{clim1,f}$ (of the periodic global climate variability and the global variability of the quantities of the fresh water and glacial ice resources owing to the $G(b)$-factor):

$$T_{tec,f} = T_{clim1,f} = T_{energy,f} = L.C.M.\{(T_{S\text{-}MOON,3})_i^{l_o}, (T_{V,3})_j^{l_2}, (T_{MARS,3})_k^{l_4}, (T_{J,3})_n^{l_5}, (T_{SAT,3})_m^{l_6}, (T_{U,3})_q^{l_7}, (T_{N,3})_r^{l_8}\} \quad (38)$$

determined by the successive global fundamental periodicities $T_{energy,f}$ (defined by the least common multiples $L.C.M.$ of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4$; $j = 1, 2$; $k = 1, 2, 3$; $n = 1, 2, 3$; $m = 1, 2, 3$; $q = 1$; $r = 1, 2, 3$; $l_o = 0,1$; $l_2 = 0,1$; $l_4 = 0,1$; $l_5 = 0,1$; $l_6 = 0,1$; $l_7 = 0,1$; $l_8 = 0,1$) of recurrence of the maximal combined energy gravitational influences on the Earth of the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

Based on the generalized differential formulation (14) of the first law of thermodynamics used for the Earth as a whole, we deduced [23] the fundamental set of the fundamental global seismotectonic and volcanic time periodicities $T_{tec\text{-}endog,f}$ (of the periodic global seismotectonic and volcanic activities determined by the $G(a)$-factor related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor) and the fundamental global climatic periodicities $T_{clim2,f}$ (of the periodic global climate variability and the global variability of the quantities of the fresh water and glacial ice resources owing to the $G(a)$ and $G(b)$-factors):

$$T_{tec\text{-}endog,f} = T_{clim2,f} = T_{endog,f} = T_{energy,f}/2 = \frac{1}{2} L.C.M.\{(T_{S\text{-}MOON,3})_i^{l_o}, (T_{V,3})_j^{l_2}, (T_{MARS,3})_k^{l_4}, (T_{J,3})_n^{l_5}, (T_{SAT,3})_m^{l_6}, (T_{U,3})_q^{l_7}, (T_{N,3})_r^{l_8}\} \quad (39)$$

determined by the successive global fundamental periodicities $T_{energy,f}$ (defined by the least common multiples $L.C.M.$ of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4$; $j = 1, 2$; $k = 1, 2, 3$; $n = 1, 2, 3$; $m = 1, 2, 3$; $q = 1$; $r = 1, 2, 3$; $l_o = 0,1$; $l_2 = 0,1$; $l_4 = 0,1$; $l_5 = 0,1$; $l_6 = 0,1$; $l_7 = 0,1$; $l_8 = 0,1$) of recurrence of the maximal combined energy gravitational influences on the Earth of the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

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4.2.The Fundamental Global Time Periodicities (3510±30) Years and (702 ±6) Years of the Periodic Global Seismotectonic and Volcanic Activity and the Global Climate Variability Determined by the Combined Non-stationary Energy Gravitational Influences on the Earth of the System Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the Gravitational Interactions of the Sun with the Jupiter and the Saturn

We deduced [23] from formula (38) (for $l_o = 1,\ l_2 = 1,\ l_4 = 1,\ l_5 = 1,\ l_6 = 1,\ l_7 = 0,\ l_8 = 0$) the fundamental global seismotectonic, volcanic and climatic periodicity (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn)

$$\mathrm{T_{tec,f}} = \mathrm{T_{clim1,f}} = \mathrm{T_{energy,f}} = L.C.M.\{3, 3, 15, 12, 59\} = 3 \times 5 \times 4 \times 59 \text{ years} = 3540 \text{ years}. \quad (40)$$

We obtained [23] from formula (38) (for $l_o = 1,\ l_2 = 1,\ l_4 = 1,\ l_5 = 1,\ l_6 = 1,\ l_7 = 0,\ l_8 = 0$) the fundamental global seismotectonic, volcanic and climatic periodicity (of the Earth's periodic global seismotectonic and volcanic activity and the global climate variability)

$$\mathrm{T_{tec,f}} = \mathrm{T_{clim1,f}} = \mathrm{T_{energy,f}} = L.C.M.\{8, 8, 15, 12, 29\} = 5 \times 696 \text{ years} = 3480 \text{ years} \quad (41)$$

determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn. The time periodicities (40) and (41) give the range of the following fundamental global seismotectonic, volcanic and climatic periodicities $\mathrm{T_{tec,f}}$ = $\mathrm{T_{clim1,f}}$ (determined by the G-factor related with the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn):

$$\mathrm{T_{tec,f}} = \mathrm{T_{clim1,f}} = \mathrm{T_{energy,f}} = 3480 \div 3540 \text{ years} = 5(696 \div 708) = (3510 \pm 30) \text{ years}. \quad (42)$$

Based on the formula (39) and using the range (42), we obtain the range of the following fundamental global seismotectonic, volcanic and climatic periodicities $\mathrm{T_{tec\text{-}endog f}}$ (determined by the $\mathrm{G}(a)$-factor related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn):

$$\mathrm{T_{tec\text{-}endog f}} = \mathrm{T_{clim2,f}} = \mathrm{T_{endog f}} = \mathrm{T_{energy,f}}/2 = 5 \times (348 \div 354) = (1755 \pm 15) \text{ years}. \quad (43)$$

We deduced [23, 52] from the formula (38) (for $l_o = 1,\ l_2 = 1,\ l_4 = 0,\ l_5 = 1,\ l_6 = 1,\ l_7 = 0,\ l_8 = 0$) the range of the following fundamental global seismotectonic, volcanic and climatic periodicities $\mathrm{T_{tec,f}}$ = $\mathrm{T_{clim1,f}}$ (determined by the G-factor related with the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn):

$$\mathrm{T_{tec,f}} = \mathrm{T_{clim1,f}} = (L.C.M.\{3, 8, 12, 29\} \div L.C.M.\{3, 3, 12, 59\}) = 696 \div 708 \text{ years}, \quad (44)$$

which contains the empirical time periodicity 704 years [26] of the global seismotectonic activity. The founded range of the fundamental global seismotectonic, volcanic and climatic periodicities $\mathrm{T_{tec,f}} = \mathrm{T_{clim1,f}} = 696 \div 708$ years [23, 52] contains the evaluated (based on the wavelet analysis) time periodicity of approximately 700 years [53] characterizing the regional climate variability of the Japan Sea. These agreements with the empirical results [26, 53] confirm the established cosmic energy gravitational genesis of the founded range $\mathrm{T_{tec,f}} = \mathrm{T_{clim1,f}} = 696 \div 708$ years of the fundamental global seismotectonic, volcanic and climatic periodicities the global seismotectonic, volcanic and climatic activity of the Earth. The range (44) of the fundamental global seismotectonic, volcanic and climatic periodicities $\mathrm{T_{tec,f}} = \mathrm{T_{clim1,f}} = 696 \div 708$ years gives the mean fundamental global seismotectonic, volcanic and climatic periodicity (which is near the empirical time periodicity 704 years [26])

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$$\langle T_{tec,f} \rangle = \langle T_{clim1,f} \rangle = 702 \text{ years} \quad (45)$$

determined by the G-factor related with the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn. Since the ratio $\langle T_{tec,f} \rangle / (T_{MARS,3})_1 = 46.8$ is near the integer number 47 and the ratio $\langle T_{tec,f} \rangle / (T_{MARS,3})_2 = 21.937$ is near the integer number 22, we can conclude that the time periodicities (44) are determined also by the contribution of the non-stationary energy gravitational influence of the Mars on the Earth.

We have (for $l_o = 1,\ l_2 = 1,\ l_4 = 0,\ \ l_5 = 1,\ l_6 = 1,\ l_7 = 0,\ l_8 = 0$) from the formula (39) the range of the following fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec\text{-}endogf}$ (determined by the $G(a)$-factor related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn):

$$T_{tec\text{-}endogf} = T_{clim2,f} = T_{endogf} = T_{energyf} / 2 =$$

$$= \frac{1}{2}(L.C.M.\{3, 8, 12, 29\} \div L.C.M.\{3, 3, 12, 59\}) = 348 \div 354 \text{ years}. \quad (46)$$

The founded range (46) of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec\text{-}endogf} = T_{clim2,f} = 348 \div 354$ years [23] contains the empirical time periodicity 352 years [26] of the global seismotectonic activity of the Earth. The range (46) of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec\text{-}endogf} = T_{clim2,f} = 348 \div 354$ years [23] gives the mean fundamental global seismotectonic, volcanic and climatic periodicity (which is near the empirical time periodicity 352 years [26])

$$\langle T_{tec\text{-}endog,f} \rangle = \langle T_{clim2,f} \rangle = 351 \text{ years} \quad (47)$$

determined by the $G(a)$-factor related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

We have (for $l_o = 1,\ l_2 = 1,\ l_4 = 1,\ \ l_5 = 1,\ l_6 = 0,\ l_7 = 0,\ l_8 = 0$) from the formula (38) the following fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec,f}$ = $T_{clim1,f}$ (determined by the G-factor related with the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter):

$$T_{tec,f} = T_{clim1,f} = L.C.M.\{11, 11, 32, 11\} = 352 \text{ years}, \quad (48)$$

which is in agreement with the empirical time periodicity 352 years [26] of the global seismotectonic activity of the Earth.

We have (for $l_o = 1,\ l_2 = 1,\ l_4 = 0,\ \ l_5 = 1,\ l_6 = 0,\ l_7 = 0,\ l_8 = 0$) from the formula (38) the following fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec,f}$ = $T_{clim1,f}$ (determined by the G-factor related with the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter):

$$T_{tec,f} = T_{clim1,f} = L.C.M.\{8, 8, 11\} = L.C.M.\{8, 11, 11\} = L.C.M.\{11, 8, 11\} = 88 \text{ years}, \quad (49)$$

which is in agreement with the empirical time periodicity 88 years [26] (Abramov, 1997) of the global seismotectonic activity of the Earth. Since the ratio 88 years/ T_{MARS}=46.786 in near the integer number 47, we concluded [16, 21-23] that the time periodicity 88 years is determined also by the contribution of the non-stationary energy gravitational influence of the Mars on the Earth. We see that the range of the fundamental global seismotectonic, volcanic and climatic periodicities (44) contains approximately 8 cycles of the fundamental global seismotectonic, volcanic and climatic periodicity (49).

Taking into account the year 1923 AD of the strongest Japanese earthquake near the Tokyo region, we predicted "the time range $2010 \div 2011$ AD of the next sufficiently strong Japanese earthquake near the Tokyo region" [17, 18] based on the established time periodicities $(\mathrm{T}_{J,3})_3 = 83$ years (determined by the non-stationary energy gravitational influences on the Earth of the Jupiter) and 88 years $= 8 \times 11$ years (determined by the combined non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Mars). The proposed [20-22] cosmic energy gravitational genesis of the strongest Japanese earthquakes was confirmed by occurrence of the strong Japanese earthquakes on 14 March, 2010 and on 11 March, 2011.

The time periodicity 88 years (of the global seismotectonic and volcanic activity and the global climate variability related with recurrence of the maximal combined energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [16, 20-22] and the Sun owing to the gravitational interaction of the Sun with the Jupiter [23]) is in good agreement with the estimated (based on the spectral Fourier analysis) climatic time periodicity 88 years [54] obtained from the studies of sediments from Siberian and Mongolian lakes. This good agreement (of the independent experimental seismotectonic [26] and the climatic [54] periodicity 88 years with the global seismotectonic, volcanic and climatic periodicity 88 years [16, 20-23]) is the additional confirmation of the validity of the extended (in this article) thermohydrogravidynamic theory of the seismotectonic, volcanic and climatic activity of the Earth taking into account the solar non-stationary energy gravitational influences on the Earth owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune. In the special issue on "Geophysical Methods for Environmental Studies" of the International Journal of Geophysics, Tinivella et al. [55] pointed out that the article [16] "proposes a possible cosmic energy gravitational genesis of the strong Chinese 2008 and the strong Japanese 2011 earthquakes, based on the established generalized differential formulation of the first law of thermodynamics".

We have (for $l_o = 1,\ l_2 = 1,\ l_4 = 0,\ \ l_5 = 1,\ l_6 = 0,\ l_7 = 0,\ l_8 = 0$) from the formula (39) the following fundamental global seismotectonic, volcanic and climatic periodicity $\mathrm{T}_{\text{tec-endogf}}$ (determined by the $G(a)$-factor related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter):

$$\mathrm{T}_{\text{tec-endogf}} = \mathrm{T}_{\text{clim2,f}} = \mathrm{T}_{\text{endogf}} = \mathrm{T}_{\text{energyf}} / 2 = \qquad (50)$$

$$= \frac{1}{2} L.C.M.\{8, 8, 11\} = \frac{1}{2} L.C.M.\{8, 11, 11\} = \frac{1}{2} L.C.M.\{11, 8, 11\} = 44 \text{ years},$$

which is in agreement with the empirical time periodicity 44 years [26] of the global seismotectonic activity of the Earth. The fundamental global periodicity (50) is in fairly good agreement with the mentioned [56] time periodicity 41.6 years of the Chandler's wobble [57] of the Earth's pole.

4.3. The Evidence of the Founded Range of the Fundamental Global Periodicities 696 ÷708 years (of the Global Seismicity and Volcanic Activity of the Earth) Based on the Established Links between the Different Volcanic Eruptions of Hekla in Iceland BC

We have the following dates of the different volcanic eruptions of Hekla in Iceland BC [58]:

(1120±50) BC, (51)

(2690±80) BC, (52)

(5470±130) BC. (53)

Taking into account the date (53) as the initial date, we can evaluate the range of the dates of the possible volcanic eruption of Hekla (after the 4 cycles of the fundamental global periodicities $\mathrm{T}_{\text{tec}} = \mathrm{T}_{\text{clim1}} = \mathrm{T}_{\text{energy}} = 696 \div 708$ years [23]):

-(5470±130)+4×(702±6) = -(2662±154) = (2662±154) BC, (54)

which includes the possible range (52) of the real eruptions of Hekla.

Taking into account the date (53) as the initial date, we can evaluate the range of the dates of the possible volcanic eruptions of Hekla (after the 6 cycles of the fundamental global periodicities $696 \div 708$ years):

-(5470±130)+6×(702±6) = -(1258±166) = (1258±166) BC, (55)

which includes the possible range (51) of the real eruption of Hekla. This good agreements are the additional confirmations of the validity the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 696 \div 708$ years [23].

4.4. The Evidence of the Founded Range of the Fundamental Global Seismotectonic and Volcanic Time Periodicities $T_{tec} = T_{clim1} = T_{energy} =$ 696 ÷708 years Based on the Statistical Analysis of the Historical Eruptions of the Katla and the Hekla Volcanic Systems in Iceland

4.4.1. The Generalized Formulation of the Weak Law of Large Numbers

We shall use the generalization [18] of the classical special formulation [59] of the weak law of large numbers for the statistical analysis of the historical eruptions of the Katla and the Hekla volcanic systems [60]. The generalization [18] of the classical special formulation [59] of the weak law of large numbers takes into account the coefficients of correlations $\rho(x_i, x_k) \neq 0$ between the random variables x_i and x_k of the infinite set of random variables $x_1, x_2, \ldots, x_n$ .... characterized by the same variance $\sigma^2 = \overline{(x_i - a)^2}$ and the same statistical mean $a = \overline{x_i}$ of the random variables $x_1, x_2, \ldots, x_n$ .... . The classical formulation [59] of the weak law of large numbers is related with the coefficients of correlations $\rho(x_i, x_k) = 0$ for $i \neq k$.

It was founded [18] mathematically that the limit of probability

$$\lim_{n\to\infty} \Pr\left\{\left|\frac{(x_1 + x_2 + \ldots + x_n)}{n} - a\right| < \varepsilon\right\} = 1 \tag{56}$$

is satisfied (for any $\varepsilon > 0$) if the following condition [18]:

$$\lim_{n\to\infty} \frac{\sigma^2}{n^2} \sum_{i,k=1;i\neq k}^{n} \rho(x_i, x_k) = 0 \tag{57}$$

is satisfied for the coefficients of correlations $\rho(x_i, x_k)$.

Let us formulate the conditions of creation of the various possible binary combinations $((t_2)_i, (t_1)_i)$ of different previous $(t_1)_i$ and subsequent $(t_2)_i$ dates of real volcanic eruptions. We take the dates $(t_1)_i$ and $(t_2)_i$ from the experimental sequence $\{T_k\} = T_1, T_2, \ldots, T_N$ of different dates of real volcanic eruptions, where T_1 is the initial date of real volcanic eruption, T_N the final date of real volcanic eruption. We form the various possible pair combinations $((t_2)_i, (t_1)_i)$ (i=1, 2, 3, …, n) of two dates $(t_1)_i$ and $(t_2)_i$ taken from the experimental sequence $\{T_k\} = T_1, T_2, \ldots, T_N$ of different dates of real volcanic eruptions. To obtain the experimental evidence of the founded ranges of the fundamental global volcanic periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 696 \div 708$ years, we take into account all possible binary combinations $((t_2)_i, (t_1)_i)$ satisfying the imposed conditions (k=0, 1)

$$\left|(t_2)_i - (t_1)_i - (702 \pm 6k)\right| \leq 88 \text{ years,} \tag{58}$$

which gives (for k=1) two slightly different imposed conditions

$$\left|(t_2)_i - (t_1)_i - 696)\right| \leq 88 \text{ years,} \tag{59}$$

$$\left|(t_2)_i - (t_1)_i - 708)\right| \leq 88 \text{ years.} \tag{60}$$

The condition (58) gives (for k=0) the single “mean” imposed condition

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$$\left|(t_2)_i - (t_1)_i - 702\right| \le 88 \text{ years.} \quad (61)$$

Considering the various possible pair combinations $((t_2)_i, (t_1)_i)$ of two dates $(t_1)_i$ and $(t_2)_i$ under imposed conditions (59) and (60), we obtain the random variable $x_i \equiv (\Delta t)_i = (t_2)_i - (t_1)_i$ characterizing by the mean value

$$\langle \Delta t \rangle = \frac{1}{n} \sum_{i=1}^{n} (\Delta t)_i \,, \quad (62)$$

which must be very close to the statistical mean $a = \overline{x_i} \equiv \overline{(\Delta t)_i}$ for sufficiently large number n according to the generalized [18] formulation (56) if the condition (57) is satisfied for the coefficients of correlations $\rho(x_i, x_k)$. We assume that the condition (57) is satisfied, that means the small correlations between the different eruptions of the Katla and the Hekla volcanic systems [60] characterized by the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 696 \div 708$ years [23].

4.4.2. The Statistical Analysis of Eruptions of Katla Volcanic System

The real dates of Katla volcanic system eruptions are given by the following empirical sequence [60]: $\{T_k\} = T_1, T_2, \ldots, T_N$ = 920, 934, 938, 1179, 1245, 1262, 1357, 1416, 1440, 1500, 1580, 1612, 1625, 1660, 1721, 1755, 1823, 1860, 1918, 1955, 1999, 2011 AD. Taking into account the imposed condition (59), we obtain from this empirical sequence [60] the first binary combination $((t_2)_1, (t_1)_1) =$ (2011, 1245) characterized by differences $(\Delta t)_1 = (t_2)_1 - (t_1)_1 = 766$ years and the subsequent binary combinations $((t_2)_i, (t_1)_i)$ of two dates $(t_1)_i$ and $(t_2)_i$ (characterized by the differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ between the dates of different eruptions of the Katla volcanic system) presented in Tables 1a, 1b and 1c.

Table 1a. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Katla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i=1, 2, 3, 4, 5, 6, 7, 8, 9

$(t_2)_i$	2011	2011	2011	1999	1999	1999	1955	1955	1955
$(t_1)_i$	1245	1262	1357	1245	1262	1357	1179	1245	1262
$(\Delta t)_i$	766	749	654	754	737	642	776	710	693

Table 1b. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Katla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i=10, 11, 12, 13, 14, 15, 16, 17, 18

$(t_2)_i$	1918	1918	1918	1860	1860	1823	1721	1660	1660
$(t_1)_i$	1179	1245	1262	1179	1245	1179	938	934	938
$(\Delta t)_i$	739	673	656	681	615	644	783	726	722

Table 1c. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Katla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i=19, 20, 21, 22, 23, 24, 25, 26, 27

$(t_2)_i$	1625	1625	1625	1612	1612	1612	1580	1580	1580

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$(t_1)_i$	920	934	938	920	934	938	920	934	938
$(\Delta t)_i$	705	691	687	692	678	674	660	646	642

Taking into account the presented (in Tables 1a, 1b and 1c) n=27 numerical values $(\Delta t)_i = (t_2)_i - (t_1)_i$ (i= 1, …, 27), we obtain the mean empirical time periodicity (between the eruptions of the Katla volcanic system)

$$\langle \Delta t \rangle_{696} = \frac{1}{27}\sum_{i=1}^{27}(\Delta t)_i = 696.111 \text{ years,} \qquad (63)$$

entering into the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [23] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Taking into account the imposed condition (60), we obtain from the above empirical sequence [60] the first binary combination $((t_2)_1, (t_1)_1) =$ (2011, 1245) characterized by $(\Delta t)_1 = (t_2)_1 - (t_1)_1 = 766$ years and the subsequent binary combinations $((t_2)_i, (t_1)_i)$ of two dates $(t_1)_i$ and $(t_2)_i$ (characterized by the differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ between the dates of different eruptions of the Katla volcanic system) presented in Tables 2a, 2b and 2c.

Table 2a. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Katla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i=1, 2, 3, 4, 5, 6, 7, 8, 9

$(t_2)_i$	2011	2011	2011	1999	1999	1999	1955	1955	1955
$(t_1)_i$	1245	1262	1357	1245	1262	1357	1179	1245	1262
$(\Delta t)_i$	766	749	654	754	737	642	776	710	693

Table 2b. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Katla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i=10, 11, 12, 13, 14, 15, 16, 17, 18

$(t_2)_i$	1918	1918	1918	1860	1823	1721	1660	1660	1625
$(t_1)_i$	1179	1245	1262	1179	1179	938	934	938	920
$(\Delta t)_i$	739	673	656	681	644	783	726	722	705

Table 2c. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Katla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i=19, 20, 21, 22, 23, 24, 25, 26

$(t_2)_i$	1625	1625	1612	1612	1612	1580	1580	1580
$(t_1)_i$	934	938	920	934	938	920	934	938
$(\Delta t)_i$	691	687	692	678	674	660	646	642

Taking into account the presented (in Tables 2a, 2b and 2c) n= 26 numerical values (obtained without exception of one combination from Tables 1a, 1b and 1c), we obtain the mean experimental time periodicity (between the eruptions of the

Katla volcanic system [60])

$$\langle \Delta t \rangle_{708} = \frac{1}{26}\sum_{i=1}^{26}(\Delta t)_i = 699.2306 \text{ years} \qquad (64)$$

entering into the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [23] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

The mean value

$$(\langle \Delta t \rangle_{696} + \langle \Delta t \rangle_{708})/2 = 697.67 \text{ years} \qquad (65)$$

of the calculated mean empirical time periodicities (63) and (64) (of the considered eruptions of the Katla volcanic system [60]) is in fairly good agreement with the mean value 702 years the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [23]. We can see that the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [23] contains the calculated mean experimental time periodicities (63) and (64) of the considered eruptions of the Katla volcanic system [60]. This agreement confirms the established cosmic energy gravitational genesis [23] of the founded range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [23] (Simonenko, 2012a).

4.4.3. The Statistical Analysis of Eruptions of Hekla Volcanic System

The real dates of Hekla volcano eruptions are given by the following empirical sequence [60]: $\{T_k\} = T_1, T_2, ..., T_N$ = 1104, 1158, 1206, 1222, 1300, 1341, 1389, 1440, 1510, 1554, 1597, 1636, 1693, 1725, 1766-1768, 1845, 1878, 1913, 1947-1948, 1970, 1980-1981, 1991, 2000 AD. Taking into account the imposed condition (61), we obtain from this empirical sequence [60] the first binary combination $((t_2)_1, (t_1)_1)$ = (2000, 1222) characterized by the difference $(\Delta t)_1 = (t_2)_1 - (t_1)_1 = 778$ years, the second binary combination $((t_2)_2, (t_1)_2)$ = (2000, 1300) characterized by the difference $(\Delta t)_2 = (t_2)_2 - (t_1)_2 = 700$ years, and the subsequent binary combinations $((t_2)_i, (t_1)_i)$ of two dates $(t_1)_i$ and $(t_2)_i$ (characterized by the differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ between the dates of different eruptions of the Hekla volcanic system [60]) presented (for i= 3, 4, …, 28, 29) in Tables 3a, 3b and 3c.

Table 3a. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Hekla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i=3, 4, 5, 6, 7, 8, 9, 10, 11

$(t_2)_i$	2000	1991	1991	1991	1980.5	1980.5	1980.5	1980.5	1970
$(t_1)_i$	1341	1222	1300	1341	1206	1222	1300	1341	1206
$(\Delta t)_i$	659	769	691	650	774.5	758.5	680.5	639.5	764

Table 3b. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Hekla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$ for i= 12, 13, 14, 15, 16, 17, 18, 19, 20

$(t_2)_i$	1970	1970	1970	1947.5	1947.5	1947.5	1913	1913	1913
$(t_1)_i$	1222	1300	1341	1206	1222	1300	1158	1206	1222
$(\Delta t)_i$	748	670	629	741.5	725.5	647.5	755	707	691

Table 3c. Dates $(t_1)_i$, $(t_2)_i$ of eruptions of the Hekla and differences $(\Delta t)_i = (t_2)_i - (t_1)_i$

for i=21, 22, 23, 24, 25, 26, 27, 28, 29

$(t_2)_i$	1878	1878	1878	1878	1845	1845	1845	1845	1767
$(t_1)_i$	1104	1158	1206	1222	1104	1158	1206	1222	1104
$(\Delta t)_i$	774	720	672	656	741	687	639	623	663

Taking into account the presented (in Tables 3a, 3b and 3c) n=29 numerical values, we obtain the mean empirical time periodicity (between the eruptions of the Hekla volcanic system [60])

$$\langle \Delta t \rangle_{702} = \frac{1}{29} \sum_{i=1}^{29} (\Delta t)_i = 701.8447 \text{ years,} \tag{66}$$

which is in good agreement with the fundamental mean periodicity $\langle T_{tec,f} \rangle = \langle T_{clim1,f} \rangle = 702$ years (given by (45)) of founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [23] (Simonenko, 2012a) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Thus, the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [23] (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn) is confirmed statistically based on the empirical dates of different eruptions of Katla and Hekla volcanic systems [60].

5. THE EVIDENCE OF THE FOUNDED RANGES OF THE FUNDAMENTAL GLOBAL PERIODICITIES (702 ±6) YEARS AND (3510±30) YEARS (OF THE GLOBAL SEISMICITY AND VOLCANIC ACTIVITY) BASED ON THE ESTABLISHED LINKS BETWEEN THE GREAT VOLCANIC ERUPTIONS AND EARTHQUAKES IN THE HISTORY OF HUMANKIND FROM THE DIFFERENT DISTINCT ERUPTIONS OF THE THERA (SANTORINI) IN THE RANGE (1700÷1450 ±14) BC TO THE MODERN INCREASE OF THE GLOBAL SEISMICITY AND VOLCANIC ACTIVITY IN THE BEGINNING OF THE 21ST CENTURY AD

5.1. Linkage of Thera (Santorini) Eruption in the Range (1700 ÷ 1640) BC and the Eruption of Tambora in 1815 AD

We find the linkage of the eruption of Tambora (1815 AD) and the Thera (Santorini) eruption in the range (1700 ÷ 1640) BC [12, 13]. The eruption of Thera (Santorini) was the great natural cataclysm. However, in terms of the erupted volume, it ranks smaller [61] than the eruption of the Tambora occurred in 1815 AD. Considering the eruption of the Tambora occurred (1815 AD), we can evaluate (based on the founded [23] fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years) the corresponding range of dates $t_p(1815\,AD)$ of the previous great eruptions from the obvious relation

$$t_p(1815\,AD) + (3510 \pm 30) \text{ years} = 1815 \text{ years}, \tag{67}$$

which gives the following range of dates of the previous possible great eruptions:

$$t_p(1815\,AD) = 1815 \text{ years} - (3510 \pm 30) \text{ years} = -1725 \div -1665 = (1725 \div 1665)\,BC, \tag{68}$$

which is in satisfactory agreement with the suggested range (1700 ÷ 1640) BC [12, 13] of the eruption of Thera (Santorini). This satisfactory agreement confirms the founded [23] fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

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5.2. Linkage of the Eruption of Thera (Santorini) in the Range 1627÷1600 BC, the Greatest (in the United States in the Past 150 Years up to 1872) Earthquake in Owens Valley, California (1872 AD), the Eruptions of Santorini in 1866 and the Great Eruption of Krakatau in 1883 AD

Papazachos [62] considered (see also [14]) the largest eruptions (accompanied by tsunamis) of the Santorini volcano, which occurred (during the last five centuries) in 1457, 1573, 1560, 1866 and 1925 AD. The date 1925 AD of the eruption of Santorini is close to the year 1923 AD of the strongest Japanese earthquake in the Kanto region (and in Torbat-e Heydariyeh, Iran; Sichuan, China; Kamchatka, USSR; Humbolt County, California, USA). We can interpret the eruptions of Santorini in 1866 and 1925 AD, the eruption of Krakatau in 1883 AD and the greatest (in the USA in the past 150 years up to 1872) earthquake in 1872 AD (Owens Valley, California) as terrible manifestations (in the 19th and 20th centuries) of the founded [23] fundamental seismotectonic and volcanic periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years) owing to the following evaluations.

Using the obtained range (1627÷1600) BC of the first Santorini's eruption (based on the "radiocarbon wiggle-matching" dating analysis [15] with 95.4% probability), we can evaluate the range of the dates of the possible volcanic eruptions and strong earthquakes (after 1 cycle of the fundamental global periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years):

$$-(1613.5 \pm 13.5) + 3510 \pm 30 = (1896.5 \pm 43.5) \text{ AD} = (1853 \div 1940) \text{ AD}, \quad (69)$$

which contains the dates 1866 AD and 1925 AD of the eruption of Santorini, the date 1872 AD of the greatest (in the USA in the past 150 years up to 1872) earthquake in Owens Valley (California), the date 1883 AD of the eruption of Krakatau.

We can interpret the greatest (in the USA in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD) as the terrible manifestation of the periodic increase of the global seismicity and volcanic activity related with the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years [23]. Using the mean date 1613.5 BC of the obtained range (1627÷1600) BC of the eruption of Santorini [15], we get the time duration 3485.5 years from this mean date 1613.5 BC and the greatest earthquake in Owens Valley, California (1872 AD). We get the ratio of the obtained time duration 3485.5 years to the time periodicities $T_{tec} = (3510 \pm 30)$ years:

$$\frac{(1613.5 + 1872)}{(3510 \pm 30)} = \frac{3485.5}{(3480 \div 3540)} = 0.9846 \div 1.00158 \quad (70)$$

which is very close to the integer number 1 denoting that the greatest earthquake in Owens Valley, California (1872 AD) is related with the eruption of Santorini in the range (1627÷1600) BC [15].

We can interpret the great eruption of Krakatau in 1883 AD as the terrible manifestation of the periodic increase of the global seismicity and volcanic activity related with the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years [23]. Considering the eruption of Krakatau in 1883 AD, we can obtain the time duration 3496.5 years between the great eruption of Krakatau in 1883 AD and the mean date 1613.5 BC of the obtained range (1627÷1600) BC of the eruption of Santorini [15]. We get the ratio of the obtained time duration 3496.5 years to the time periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years:

$$\frac{(1613.5 + 1883)}{(3510 \pm 30)} = \frac{3496.5}{(3480 \div 3540)} = 0.9877 \div 1.0047, \quad (71)$$

which is very close to the integer number 1 denoting that the great eruption of Krakatau in 1883 AD is related with the eruption of Thera (Santorini) in the range (1627÷1600) BC [15]. The obtained closeness of the above two ratios (70) and (71) to the integer number 1 confirms the founded [23] fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

5.3. Linkage of the Increase of the Global Seismicity and Volcanic Activity in the End of the 19th Century and in the Beginning of the 20th Century and the Eruption of Thera (Santorini) in the Range (1600÷1500) BC

We find the linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 19th century and in beginning of the 20th century [25] and the eruption of Thera (Santorini) between 1600 and 1500 BC

[14].

The former President of the Seismological Society of America made in 1969 the statement [25] about the increase of the global seismicity recorded in the range (1896 ÷ 1906) AD up to 1969: “One notices with some amusement that certain religious groups have picked this rather unfortunate time to insist that the number of earthquakes is increasing. In part they are misled by the increasing number of small earthquakes that are being catalogued and listed by newer, more sensitive stations throughout the world. It is worth remarking that the number of great [that is, 8.0 and over on the Richter scale] earthquakes from 1896 to 1906 (about twenty-five) was greater than in any ten-year interval since”.

The seismologists [63, 64] revealed the range (1900 ÷ 1920) AD characterized by the maximal energy release per year for the whole time period up to 1977. The eruption of Santorini occurred in 1925 AD near the end of the established range (1900 ÷ 1920) AD. Considering the range (1896 ÷ 1925) AD as the range of the maximal global seismic and volcanic activity in the end of the 19th century and in the beginning of the 20th century (including the eruption of Santorini in 1925 AD), we obtain (based on the founded [23] fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} =$ (3510 ± 30) years) the corresponding time range $t_p(1896 \div 1925\ AD)$ of the previous maximal global seismic and volcanic activities from the obvious equation

$$t_p(1896 \div 1925\ AD) + (3510 \pm 30)\ years = (1896 \div 1925)\ years = (1910.5 \pm 14.5)\ AD, \quad (72)$$

which gives the following range of the corresponding previous maximal global seismic and volcanic activities:

$$t_p(1896 \div 1925\ AD) = -(1599.5 \pm 44.5) = (1644 \div 1555)\ BC, \quad (73)$$

which includes the established range (1627 ÷ 1600) BC [15] and the subrange (1600 ÷ 1555) BC of the established range (1600 ÷ 1500) BC [14] of the previous eruptions of Santorini. This satisfactory agreement confirms the founded [23] fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

5.4. Linkage of the Last Major Eruption of Thera (1450 ±14 BC) and the Greatest Earthquake Destroyed the Ancient Pontus (63 BC) and the Strong Volcanic Eruptions During (50±30) BC

Using the date 1450 BC [7] of last major eruption of Thera and assuming the same ambiguity ±14 years (as in the studies [15] with 95.4% probability), we shall consider the range of the possible dates (1450±14) BC of the last major eruption of Thera. Under this assumption, we can evaluate the range of the dates of the possible strong volcanic eruptions and strong earthquakes (after 2 cycles of the fundamental global periodicities $T_{tec} = T_{clim1} = T_{energy} =$ 696 ÷708 years):

-(1450±14)+2×(702±6) = -46±26 = (-72÷-20) = (7 2÷20) BC, (74)

which contains the date 63 BC [1] of the greatest earthquake destroyed the ancient Pontus. This range is in a good agreement with the time range [58] of the strong volcanic eruptions

(50±30) BC=(80÷20) BC, (75)

that confirms the founded [23] fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec} = T_{clim1} = T_{energy} =$ 696 ÷708 years. This agreement confirms the validity of the considered possible dates (1450±14) BC of the last major eruption of Thera [7].

5.5. Linkage of the Last Major Eruption of Thera (1450 ±14 BC), the Great Frost Event (628 AD) Related with the Atmospheric Veil Induced by the Great Unknown Volcanic Eruption, and the Strong Japanese Earthquake (684 AD) Near the Tokyo Region

Considering the range of the possible dates (1450±14) BC of last major eruption of Thera, we can evaluate the range of the dates of the possible strong volcanic eruptions and strong earthquakes (after 3 cycles of the fundamental global periodicities $T_{tec} = T_{clim1} = T_{energy} =$ 696 ÷708 years):

-(1450±14)+3×(702±6) = (656±32)AD = (624÷688)BC, (76)

which contains the date 626 AD of the recorded atmospheric veil (related with the great unknown volcanic eruption, apparently, Rabaul' [4] in Europe and the resulted great frost events in 628 AD [4]. This range (76) contains the date 684 AD [65] of the strong Japanese earthquake near the Tokyo region. This satisfactory agreements confirm the validity of the considered possible dates (1450±14) BC of the last major eruption of Thera [7].

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5.6. Linkage of the Last Major Eruption of Thera (1450 ±14 BC) and the Strong Earthquakes Occurred in England (1318 AD and 1343 AD), Armenia (1319 AD), Portugal (1320 AD, 1344 AD and 1356 AD), Japan (1361 AD) and the Volcanic Eruptions in Iceland on the Hekla Volcanic System (1341 AD and 1389 AD) and on the Katla Volcanic System (1357 AD)

Considering the range of the possible dates (1450±14) BC of last major eruption of Thera, we can evaluate the range of the dates of the possible strong volcanic eruptions and strong earthquakes (after 4 cycles of the fundamental global periodicities $T_{tec} = T_{clim1} = T_{energy} = 696 \div 708$ years):

$$-(1450 \pm 14)+4\times(702 \pm 6)= (1358 \pm 38) \text{ AD} = (1320 \div 1396) \text{ AD}, \quad (77)$$

which is near the dates the strong earthquakes [65] occurred in England (1318 AD) and Armenia (1319 AD), respectively. The range (77) contains the date 1343 AD of the strong earthquake in England [65], the dates (1320 AD, 1344 AD and 1356 AD) of the strong earthquakes in Portugal, the date 1348 AD of the strong earthquake in Austria, the date 1361 AD of the strong earthquakes in Japan, the dates (1341 AD and 1389 AD) of the volcanic eruptions [60] in Iceland on the Hekla volcanic system and the date 1357 AD of the volcanic eruption the Katla volcanic systems. We see that mean date 1358 AD of the range (77) is in good agreement with the lower date 1350 AD of the range (1350÷1700) AD of the "Litle Ice Age" [58]. Consequently, we can conclude that the "Litle Ice Age" [58] is induced by the intensification of the volcanic eruptions of the Earth during the range (77).

5.7. The Forthcoming Range of the Possible Intensification of the Global Seismotectonic and Volcanic Activity and the Climate Variability of the Earth in the 21st Century AD Related with the Last Major Eruption of Thera (1450 ±14 BC)

We have presented above the evident linkages between the different distinct eruptions of the Thera (Santorini) dated in the following ranges: (1700÷1640) BC [12, 13], (1628÷1626) BC [4], (1627÷1600) BC [15], (1600÷1500) BC [14], (1628÷1450) BC [7] and the eruptions of the Tambora (1815 AD), the Santorini (1866 AD and 1925 AD) and the Krakatau (1883 AD).

Using the obtained range (1600÷1500) BC [14] of the eruption of Santorini, we can evaluate the range of the dates of the possible strong volcanic eruptions and strong earthquakes (after 1 cycle of the fundamental global periodicities $T_{tec} = T_{clim1} = T_{energy} = (3510 \pm 30)$ years [23]):

$$-(1550 \pm 50) + 3510 \pm 30 = (1960 \pm 80) \text{ AD} = (1880 \div 2040) \text{ AD}, \quad (78)$$

which explains the intensification of the global seismic and volcanic activity in the end of the 19th century and in the beginning of the 20th century [25], then in the end of the 20th century [26] and in the beginning of the 21th century [20-23].

Considering the range of the possible dates (1450±14) BC of the last major eruption of Thera, we can evaluate the range of the dates of the possible intensification of volcanic and seismic activity (after 5 cycles of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 696 \div 708$ years or after 1 cycle of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = (3510 \pm 30)$ years [23]):

$$-(1450 \pm 14)+5\times(702 \pm 6) = (2060 \pm 44)\text{AD} = (2016 \div 2104) \text{ AD}. \quad (79)$$

The intersection of the ranges (78) and (79) gives the combined range:

$$(2016 \div 2040) \text{ AD}, \quad (80)$$

determining the forthcoming intensification of the global seismic and volcanic activity in the beginning of the 21th century.

Considering the date (1300 AD) of the eruption of Hekla (1300 AD) in Iceland [60] and the date (1303 AD) of great earthquake in China [65] and using the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 696 \div 708$ years of the global seismotectonic and volcanic activities and the climate variability of the Earth, we evaluated [23], respectively, the following ranges

$$(1300+696 \div 1300+708) = (1996 \div 2008) \text{ AD}, \quad (81)$$

$$(1303+696 \div 1303+708) = (1999 \div 2011) \text{ AD}, \quad (82)$$

which give of the next possible strong volcanic eruptions and strong earthquakes.

We see that the date 2000 AD of the realized eruption of Hekla in Iceland [60] gets into the obtained range 1996÷2008 AD of the possible eruptions of Hekla. The date 2008 AD of realized strong Chinese 2008 earthquakes gets into the obtained range 1999÷2011 AD of the strong Chinese earthquakes. This agreements confirm the founded [23] fundamental global seismotectonic, volcanic and climatic periodicities $\mathrm{T}_{\mathrm{tec,f}} = \mathrm{T}_{\mathrm{clim1,f}} = \mathrm{T}_{\mathrm{energy,f}} = 696 \div 708$ years of the global seismotectonic and volcanic activities and the climate variability of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Considering the date 1318 AD [65] of the strong earthquake in England and using the founded range of the fundamental global periodicities $\mathrm{T}_{\mathrm{tec,f}} = \mathrm{T}_{\mathrm{clim1,f}} = \mathrm{T}_{\mathrm{energy,f}} = 696 \div 708$ years, we evaluated [23] the following range (of the forthcoming possible strong earthquakes worldwide and possibly in England)

(1318+696÷1318+708) = (2014÷2026) AD, (83)

characterized by the satisfactory agreement of the lower date 2014 AD with the lower date 2016 AD of the range (79).

The ranges (80) and (83) mean that the moderate intensification of the global seismic and volcanic activity of the Earth is possible from 2014÷2016 AD. Thus, based on the date (1450±14) BC of the last major volcanic eruption at Thera (Santorini) and the date 1318 AD of the strong earthquake in England, we evaluate (based on the of the fundamental global seismotectonic and volcanic periodicities $\mathrm{T}_{\mathrm{tec,f}} = \mathrm{T}_{\mathrm{clim1,f}} = \mathrm{T}_{\mathrm{energy,f}} = 696 \div 708$ years or $\mathrm{T}_{\mathrm{tec,f}} = \mathrm{T}_{\mathrm{clim1,f}} = \mathrm{T}_{\mathrm{energy,f}} = (3510 \pm 30)$ years [23]) the possible forthcoming intensification (from (2014÷2016) AD) of the global seismic and volcanic activity of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

5.8. The Forthcoming Possible Intensification of the Seismic Activity Near Santorini (Thera) Volcano (Greece) and the Possible Volcanic Eruption of Santorini (Thera)

The previous eruptions of Santorini (in the 20th century AD) were occurred in 1925, 1928, 1939 and 1950 AD [66]. It was pointed out [67] that "since its last eruption in 1950, Santorini volcano (Greece) remained in a dormant state". However, it was pointed out [67] also that "at the beginning of 2011 the volcano showed signs of unrest with increased microseismic activity and significant ground uplift, reaching 14 cm within a year (2011 March – 2012 March), according to InSAR time-series". The authors [67] confirmed that "ALOS PALSAR data indicate the onset of the phenomenon in early 2010 where an aseismic pre-unrest phase of increased subsidence (1-3 cm) preceded the uplift". It is clear that these related phenomena are the signs of the forthcoming eruption of Santorini owing the following evaluations.

We have (for $l_o = 1,\ l_2 = 1,\ l_4 = 0,\ \ l_5 = 1,\ l_6 = 0,\ l_7 = 0,\ l_8 = 0$) from the formula (39) the following fundamental global seismotectonic, volcanic and climatic periodicity (determined by the $\mathrm{G}(a)$-factor related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter):

$$\mathrm{T}_{\mathrm{tec\text{-}endogf}} = \mathrm{T}_{\mathrm{clim2,f}} = \mathrm{T}_{\mathrm{endogf}} = \mathrm{T}_{\mathrm{energy\,f}} / 2 =$$

$$\frac{1}{2} L.C.M.\{3, 3, 11\} = \frac{1}{2} L.C.M.\{3, 11, 11\} = \frac{1}{2} L.C.M.\{11, 3, 11\} = 16.5 \text{ years}. \quad (84)$$

Considering the largest earthquakes in the world since 1990 AD, we can see that the difference between the date 1906 AD (of the largest earthquake on the coast of Ecuador characterized by the magnitude of 8.8) and the date 1922AD (of the largest earthquake on the Chile-Argentina border characterized by the magnitude of 8.5) is equal to 16 years, which is near the fundamental global seismotectonic and volcanic periodicity (84). We can see that the difference between the date 1906 AD and the date 1923AD (of the largest Japanese Kanto earthquake characterized by the magnitude of 8.2) is equal to 17 years, which is near the fundamental global seismotectonic and volcanic periodicity (84). We can see also that the difference between the date 1923 AD (of the largest Japanese Kanto earthquake and the largest earthquake on the Russian Kamchatka characterized by the magnitude of 8.5) and the date 1938 AD (of the largest earthquake in the Indonesian Banda Sea characterized by the magnitude of 8.5) is equal to 15 years, which is near the fundamental global seismotectonic and volcanic periodicity (84). The fundamental global periodicity (84) is in fairly good agreement with the mentioned [56] time periodicities (16±2) years of the Chandler's wobble [57] of the Earth's pole.

We see that the sum of the date 1950 AD of the last eruption of Santorini [66] and the fundamental global seismotectonic and volcanic periodicities (50) and (84) gives the date of the next intensification of Santorini volcano:

$$1950 + 44 + 16.5 = 2010.5 \text{ AD}, \quad (85)$$

which is in good agreement with the indicated "onset of the phenomenon in early 2010" [67] on the Santorini volcano. Taking into account the date 1925 AD of the previous eruption of Santorini [66], we see that the sum of the date 1925 AD and the fundamental global seismotectonic and volcanic periodicity (49) gives the date of the next possible intensification of Santorini volcano:

$$1925 + 88 = 2013 \text{ AD}, \quad (86)$$

which is in agreement with the modern intensification [67] of microseismic activity near Santorini volcano and significant ground uplift. Taking into account the date 1928 AD of the previous eruption of Santorini [66] (Papadopoulos and Orfanogiannaki, 2005), we see that the sum of the date 1928 AD and the fundamental global seismotectonic and volcanic periodicity (49) gives the date of the next possible forthcoming intensification of Santorini volcano:

$$1928 + 88 = 2016 \text{ AD}, \quad (87)$$

which is in the excellent agreement with the lower date 2016 AD of the obtained range (79) of the possible intensification of the global volcanic and seismic activity of the Earth after 5 cycles of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 696 \div 708$ years [23] from the considered initial date (1450±14) BC of the last major volcanic eruption at Thera (Santorini). It is clear that the date (87) cannot be considered as rigorous prediction of the next eruption of Santorini volcano without the detailed combined experimental studies of the increased microseismic activity [67] and the gravitational field near Santorini volcano, which can be fulfilled based on the generalized differential formulation (14) of the first law of thermodynamics [18-20].

CONCLUSIONS

We have presented the development of the cosmic geophysics [16, 20-22] extended by taking into account the very significant non-stationary energy gravitational influences on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune) evaluated [23] based on the previously established generalized differential formulation [19, 20] of the first law of thermodynamics for moving rotating deforming compressible heat-conducting stratified macroscopic continuum region τ subjected to the non-stationary Newtonian gravitational field. We have presented the foundation of the ranges of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = T_{energy,f} = 3510 \pm 30$ years and $T_{tec,f} = T_{clim1,f} = T_{energy,f} =$ (702±6) years (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn [23]) based on the different established links between the great volcanic eruptions and earthquakes in the history of humankind from the different distinct eruptions during the range (1700÷1450 ±14) BC of the Thera (dated in the following ranges: (1700÷1640) BC [12, 13], (1628 ÷ 1626) BC [4], (1627÷1600) BC [15], (1600÷1500) BC [14], (1628÷1450) BC [7]) to the subsequent intensifications of the global seismicity volcanic activity in the end of the 19th century and in the beginning of the 20th century [25], in the end of the 20th century [26], and in the beginning of the 21st century AD [20-23].

Based on the founded [23] ranges of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = (702 \pm 6)$ years and $T_{tec,f} = T_{clim1,f} = (3510 \pm 30)$ years and taking into account the founded date (1450±14) BC of the last major volcanic eruption at Thera [7] and the date 1318 AD of the strong earthquake in England [65], we have presented the evaluation of the date (2014÷2016) AD of the forthcoming intensification of the global seismotectonic and volcanic processes of the Earth in the 21st century (during the range (80)) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

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Author's biography with Photo

Sergey Victorovich Simonenko was born in Uglekamensk, U.S.S.R. on July 2, 1959. He has graduated in 1884 the Moscow Institute of Physics and Technology (Engineer-Physicist Diploma, the Speciality – Thermodynamics and Aerodynamics), the Faculty of Aerophysics and Cosmic Explorations, the Specialization – Physics of Oceans. He has earned the Ph. D. in Physical and Mathematical Sciences from the Pacific Oceanological Institute, Far Eastern Branch of Russian Academy of Sciences, Vladivostok, Russia, 1993. Ph. D. thesis has the title "the generation of internal gravity waves by the bottom topography".

In 2000 Dr. Simonenko has been appointed as a Leading Scientist of the V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russia. The author's biographies (including information concerning previous positions and publications) have been included in the international biographical publications: Who's Who in the World (2006, 2007, 2008, 2009, 2010) published by America's biographical publisher Marquis Who's Who®. The author's biographies have been included also in the following publications of the International Biographical Centre (IBC, Cambridge, England): 2000 Outstanding Intellectuals of the 21st Century (2006, 2007, 2008, 2009, 2010, 2011, 2012; 2013); Outstanding Scientists of the 21st Century, Inaugural Edition (2007); Cambridge Blue Book (2008/9); 2000 Outstanding Scientists (2008/2009); Dictionary of International Biography (2008, 2009, 2010, 2011; 2012; 2013); Top Two Hundred of the IBC (2010).

In recognition of his significant accomplishments in physics of turbulence and cosmic physics, the author's biography has been published by the American Biographical Institute (ABI) in the Fourth Edition of Great Minds of the 21st Century (2010). For outstanding accomplishments in physics (thermohydrodynamics and thermohydrogravidynamics), Dr. Sergey V. Simonenko has been inducted by the Governing Board of Editors of the ABI into The American Biographical Institute's Great Minds of the 21st Century Hall of Fame, which is subject of notice in the Fourth Edition of Great Minds of the 21st Century (ABI, USA, 2010).

Since 1993, the first major field of the author's theoretical study was related with the development of the non-equilibrium statistical thermohydrodynamic theory of the small-scale dissipative turbulence founded in the monograph Non-equilibrium Statistical Thermohydrodynamics of Turbulence (Moscow, Nauka, 2006).

Since 2004, the second major field of the author's theoretical study was related with the development of the deterministic thermohydrogravi-dynamic theory of the global seismotectonic activity of the Earth founded initially in the section "Statistical thermohydrodynamics of irreversible strike-slip-rotational processes" of the collective monograph (together with E.E. Milanovsky, A.V. Vikulin, V.E. Khain et al.) Rotational Processes in Geology and Physics (Moscow, KomKniga, 2007) published under decision of the Scientific Council of the Geological Faculty of Lomonosov Moscow State University. The development of the thermohydrogravidynamic theory (based on the author's generalized differential formulation of the first law of thermodynamics) resulted to the publication of the monograph Thermohydrogravidynamics of the Solar System (Nakhodka, Institute of Technology and Business Press, 2007) founded the cosmic physics (combining the cosmic geophysics and the cosmic geology) for creation of the urgent technologies of the long-term deterministic predictions of the strong earthquakes, planetary cataclysms, the Earth's climate and fresh water resources subjected to the non-stationary energy gravitational influences of the Solar System and our Galaxy.

Dr. Simonenko has been awarded by a set of International Awards (presented on his website: www.drsergeyvsimonenkohondgibc.ru). Especially, in recognition of an outstanding contribution to physics of turbulence and cosmic geophysics, Dr. Simonenko has been awarded in 2008 by the IBC Lifetime Achievement Award, which is subject of notices in the IBC publications since 2008. In 2009 he has been inaugurated as a Vice-President of the Recognition Board of the World Congress of Arts, Sciences and Communications (Cambridge, England). In 2010 he has been appointed as a Lifetime Deputy Governor of the American Biographical Institute Research Association. His "contributions to the cosmic physics and earthquakes prediction" have been recognized by inclusion into Director General's Roll of Honour, which is the subject of notices in Seventh Edition of 2000 Outstanding Intellectuals of the 21st Century (IBC, Cambridge, England, 2013), and in Thirty Sixth Edition of Dictionary of International Biography (IBC, Cambridge, England, 2013).