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The practical forecasting aspects of the thermohydrogravidynamic theory of the global seismotectonic activicty of the Earth concerning to the Japanese earthquakes near the Tokyo region

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Abstract

The article presents the development of the cosmic geophysics (representing the deterministic thermohydrogravidynamic theory intended for earthquakes prediction) by founding the fundamental global seismotectonic and volcanic periodicities based on the author's generalized differential formulation of the first law of thermodynamics taking into account the energy gravitational influences on the Earth of the Sun (owing to the gravitational interaction of the Sun with the Jupiter and Saturn), the Moon, the Mercury, the Venus, the Mars and the Jupiter. The author presents the evidence that the dates (1605 AD, 1703 AD, 1855 AD, 1923 AD and 2011 AD) of previous strong Japanese earthquakes (near the Tokyo region) may be satisfactory decomposed (relative to the initial date 818 AD of the previous strong earthquake near the Tokyo region) into a linear sums (with different coefficients having the possible values 1 or 0 and the small residual terms) of the established fundamental global seismotectonic and volcanic periodicities.

Keywords

Cosmic Geophysics, Thermohydrogravidynamic Theory, Generalized Differential Formulation of the First Law of Thermodynamics, Seismicity Near Tokyo Region, Earthquakes Prediction

1. Introduction

The problems of the long-term predictions of the strong earthquakes [1-10] is the significant problems of the modern seismology. The analysis of the period 1977-1985 revealed [11] 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.

Concerning to the failure in prediction of the 2011 Tohoku earthquake, Sagiya explained [9] clearly that the long-term evaluation of the likelihood of subduction zone earthquakes in the Tohoku region "was based on the statistical analysis of the complete historical earthquake record for the past 400 years". Sagiya pointed out [9] correctly that "the Tohoku earthquake clearly shows that 400 years is too short a time period to evaluate seismic activity". Sagiya stated correctly "that if we take an empirical approach to evaluating or forecasting natural disasters, all the available information should be taken into account – even though some records have large uncertainties – and all the possibilities should be considered, regardless of their likelihood". Sagiya pointed out [9] with right pragmatism "that we should not overlook inconsistent data, but instead strive to integrate observational information with different temporal and spatial scales". Finally, Sagiya concluded: "Earth science is multidisciplinary. The Japanese seismology community now needs to review all the seismic, geodetic, geomorphological and geological data to find information missing from the current evaluation, and to resolve any inconsistencies". Concerning to the impossibility of prediction of the 2011 Tohoku earthquake based on the statistical analysis of the complete historical earthquake record for the available short period, Yagi's [10] pointed out rightly: "We are not able to obtain accurate information about the patterns of great earthquake occurrences in time and space because of the long period of the seismic cycle. Therefore, we cannot assess the probability of future great earthquakes on the basis of catalogues of recent seismicity alone".

In the special issue [12] of the International Journal of Geophysics, Console et al. assessed the status of the art of earthquake forecasts and their applicability. It was conjectured [12] 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 conjectured [12] that "this regrettable situation could be ascribed to the present poor level of achievements in earthquake forecast". It was pointed out [12] 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".

It is well known that "the deterministic prediction of the time of origin, hypocentral (or epicentral) location, and magnitude of an impending earthquake is an open scientific problem" [13]. It was conjectured [13] that the possible earthquake prediction and warning must be carried out on a deterministic basis. It was conjectured [13] that the present level of knowledge of the geophysical processes "is unable to achieve the objective of a deterministic prediction of an ordinary seismic event, but it certainly will in a more or less distant future tackle the problem with seriousness and avoiding scientifically incorrect, wasteful, and inconclusive shortcuts, as sometimes has been done". Sgrigna and Conti believe [13] that "it should be better to pursue the deterministic prediction approach even if a reliable deterministic method of earthquake prediction will presumably be available only in the more distant future".

Using the established time periodicities [14] of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars and the Jupiter, and considering the presented set of the Chinese earthquakes (Luhuo 1973, Haicheng 1975 and Tang Shan 1976; Bachu 2003, Ruichang 2005 and Yanjin 2006), we predicted in 2007 [14] the nearest year (2008) of the next strong Chinese 2008 earthquakes. The proposed cosmic energy gravitational genesis of the predicted [14] strong Chinese 2008 earthquakes was confirmed by the occurrence of two large earthquakes in 2008 in the areas surrounding Yutian (Xinjiang) and Wenchuan (Sichian).

Taking into account the year 1923 AD of the strongest Kanto 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" [15, 16] based on the established time periodicities $(T_{J,3})_3 = 83$ 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 [14-16] 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. In the special issue on "Geophysical Methods for Environmental Studies" of the International Journal of Geophysics, Tinivella et al. [17] pointed out that the article [18] "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".

The analysis of the period 1977-1993 (characterized by 11015 major earthquakes) revealed [19] the strong earthquakes' tendency to increase the Earth's spin (rotational) energy. The analysis of the same period 1977-1993 revealed [20] "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 thermal energy accumulated in active 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 [14-16, 18] that the seismotetonic and volcanic processes should be considered in the frame of the synthetic thermohydrogravidynamic theory combining the global seismotetonic and volcanic processes of the Earth.

We presented [18] the fundamentals of the cosmic geophysics [14-16] representing the deterministic thermohydrogravidynamic theory of the global seismotectonic and volcanic processes based on the author's generalized differential formulation [14, 21] of the first law of thermodynamics extending the classical formulations by taking into account the combined cosmic and terrestrial non-stationary energy gravitational influence on the continuum region τ . The deterministic thermohydrogravidynamic theory [14-16] is based on the established generalized differential formulation [14, 21] of the first law of thermodynamics (for moving rotating deforming compressible heat-conducting stratified macroscopic continuum region τ subjected to the non-stationary Newtonian gravity):

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

extending the classical formulation [22] 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 $\partial\tau$ 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.

We demonstrated the cosmic energy gravitational genesis [14-16, 18] of the time periodicities of the global seismotectonic activity of the Earth induced by the non-stationary cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Mars. We derived [14-16, 18] the successive approximations of the following time periodicities: $(T_{S\text{-}MOON,3})_1 = 3$ years, $(T_{S\text{-}MOON,3})_2 = 8$ years, $(T_{S\text{-}MOON,3})_3 = 11$ years and $(T_{S\text{-}MOON,3})_3 = 19$ years, $(T_{S\text{-}MOON,3})_4$ = 27 years, $(T_{S\text{-}MOON,3})_5$ = 235 years of recurrence of the maximal (instantaneous and integral) combined energy gravitational influences of the system Sun-Moon on the Earth in the first, second, third, fourth and fifth approximations, respectively. We derived [14-16, 18] the successive approximations of the following time periodicities: $(T_{V,3})_1 = 3$ years, $(T_{V,3})_2 = 8$ years, $(T_{V,3})_3 = 11$ years, of recurrence of the maximal (instantaneous and integral) energy gravitational influences of the Venus on the Earth in the first, second and third approximations, respectively. We derived [14-16, 18] the successive approximations of the following time periodicities: $(T_{J,3})_1 = 11$ years, $(T_{J,3})_2 = 12$ years, $(T_{J,3})_3 = 83$ years of recurrence of the maximal (instantaneous and integral) energy gravitational influences of the Jupiter on the Earth in the first, second and third approximations, respectively. We derived [14-16, 18] the successive approximations of the following time periodicities: $(T_{MARS,3})_1 = 15$ years, $(T_{MARS,3})_2 = 32$ years, $(T_{MARS,3})_3 = 47$ years of recurrence of the maximal (integral and instantaneous) energy gravitational influences of the Mars on the Earth in the first, second and third approximations, respectively.

Based on the generalized differential formulation of the first law of thermodynamics [14-16, 21] used for the Earth and using the successive approximations for the time periodicities of the periodic recurrence of the maximal energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars and the Jupiter, we derived [14-16, 18] the following sets of the global seismotectonic and volcanic periodicities T_{tec} and the global climatic periodicities T_{clim1} of the Earth:

$$T_{tec} = T_{clim1} = T_{energy} = (T_{S\text{-}MOON,3})_i^{l_o} \times (T_{V,3})_j^{l_2} \times (T_{MARS,3})_k^{l_4} \times (T_{J,3})_n^{l_5}, \quad (2)$$

determined by the successive global periodicities T_{energy} (defined by the multiplications of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4, 5$; $j = 1, 2$; $k = 1, 2, 3$; $n = 1, 2, 3$; $l_o = 0,1$; $l_2 = 0,1$; $l_4 = 0,1$; $l_5 = 0,1$) 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 and the Jupiter. We showed [14-16, 18] that the considered empirical time periodicities [5, 6, 8, 23-35] of the seismotectonic activity may be satisfactory approximated by the global seismotectonic and volcanic periodicities T_{tec} (given by (2)) characterized by the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars and the Jupiter.

The proposed cosmic energy gravitational genesis [14] of the strong Chinese 2008 earthquakes was confirmed by the noticeable gravity variations [36] (derived from regional gravity monitoring data in China from 1998 to 2005) before the occurrence of two large earthquakes in 2008 in the areas surrounding Yutian (Xinjiang) and Wenchuan (Sichian). According to the generalized differential formulation of the first law of thermodynamics [14, 21] and the published results of the cosmic geophysics [14-16, 18], the noticeable gravity variations (mentioned in publications [6, 11, 19, 20, 36, 37]) are related with supply of the gravitational energy into the focal region before the occurrence of earthquake. According to the generalized differential formulation of the first law of thermodynamics [14, 21], the noticeable gravity variations in the focal region is the necessary (but not sufficient) condition for preparation of earthquake. A recent research [38] by Zhan and his colleagues confirmed this conclusion demonstrating that significant gravity changes were observed before all nine large earthquakes in China from 2001 to 2008.

Taking into account the established [39, 40] very significant non-stationary energy gravitational influence on the Earth of the Sun owing to the gravitational interaction of the Sun with the Jupiter and using the same successive approximations for the time periodicities $(T_{J,3})_1 = 11$ years, $(T_{J,3})_2 = 12$ years and $(T_{J,3})_3 = 83$ years of recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter [14] and the Sun (owing to the gravitational interaction of the Sun with the Jupiter [39, 40]), we proved [39] the same formula (as the above (2)) for the following sets of the global seismotectonic and volcanic periodicities T_{tec} and the global climatic periodicities T_{clim1} of the Earth:

$$T_{tec} = T_{clim1} = T_{energy} = (T_{S\text{-}MOON,3})_i^{l_o} \times (T_{V,3})_j^{l_2} \times (T_{MARS,3})_k^{l_4} \times (T_{J,3})_n^{l_5}, \qquad (3)$$

determined by the successive global periodicities T_{energy} (defined by the multiplications of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4, 5$; $j = 1, 2$; $k = 1, 2, 3$; $n = 1, 2, 3$; $l_o = 0,1$; $l_2 = 0,1$; $l_4 = 0,1$; $l_5 = 0,1$) 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 interaction of the Sun with the Jupiter. Consequently, the time periodicity 88 years $= 8 \times 11$ years (related with the strongest Japanese 1923 and 2011 earthquakes) is determined by the combined non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Jupiter, the Mars and the Sun owing to the gravitational interaction of the Sun with the Jupiter. 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 [14-16] and the Sun owing to the gravitational interaction of the Sun with the Jupiter [39, 40]) is in good agreement with the estimated (based on the spectral Fourier analysis) climatic time periodicity 88 years [41] obtained from the studies of sediments from Siberian and Mongolian lakes. This good agreement (of the independent experimental seismotectonic [6] and the climatic [41] periodicity 88 years with the global seismotectonic, volcanic and climatic periodicity 88 years [14-16, 18]) is the additional confirmation of the validity of the extended (in this article) deterministic 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.

We founded the range of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40], which contains the empirical time periodicity 704 years [6] of the global seismotectonic activity of the Earth. The founded range of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40] was confirmed also by the evaluated (based on the wavelet analysis) time periodicity of approximately 700 years [42] characterizing the regional climate variability of the Japan Sea. This agreement with the empirical results [6, 42] means the necessity to take into account the founded range $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years of the fundamental global seismotectonic, volcanic and climatic periodicities the global seismotectonic, volcanic and climatic activity of the Earth for evaluation of the global [39, 40] and local seismic and volcanic activity of the Earth. The obtained fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40] clearly demonstrates the correctness of the Mori's [43] conclusion (concerning to the impossibility of prediction of the 2011 Tohoku earthquake based on the statistical analysis of the complete earthquake record for the short time period): "some 400 years of historic records have proved to cover too short a time period to be a reliable guide to the occurrence of the largest earthquakes, even for this very seismically active region". The 2011 Tohoku earthquake clearly showed that the previous probabilistic seismic hazard map [44] for Japan must be corrected by taking into account the fundamental global seismotectonic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40].

In this article, by accepting with gratitude the invitation from the Open Science Publishers, the author presents the article to the American Journal of Earth Sciences with the analysis of the previous strong earthquakes near the Tokyo region and evaluation of a range of the possible intensification of the seismic activity near the Tokyo region in the beginning of the 21st century AD.

To do this, following the "Thermohydrogravidynamics of the Solar System" [14] and the "Statistical thermohydrodynamics of irreversible strike-slip-rotational processes" [21], in Section 2 we present the generalized differential formulation of the first law of thermodynamics (in the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed finite one-component individual continuum (characterized by the symmetric stress tensor $\mathbf{T}$) region τ moving in the non-stationary gravitational field. Based on the generalized differential formulation of the first law of thermodynamics, in Section 2 we present the subsequent development of the established gravitational energy mechanism [14, 21] of the gravitational energy supply into the continuum region τ owing to the local time increase of the potential ψ of the gravitational field inside the continuum region τ subjected to the non-stationary Newtonian gravitational field.

In Section 3 we present the subsequent development [39, 40] of the cosmic geophysics ("representing the deterministic thermohydrogravidynamic theory intended for earthquakes prediction" [18]) by taking into account the established [39, 40] very significant energy gravitational influence of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets) along with the previously established [14-16] energy gravitational influences on the Earth of the Moon and the planets of the Solar System. Based on the generalized differential formulation of the first law of thermodynamics [14, 21] used for the Earth, we present the foundation of the range of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40] (characterized by the mean fundamental global periodicity $T_f(1) = \langle T_{tec,f} \rangle = \langle T_{clim1,f} \rangle = 702$ years) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter and the Saturn), the system Sun-Moon, the Venus and the Jupiter. We present the foundation of the range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec\text{-}endog,f} = T_{clim2,f} = 348 \div 354$ years [39] (characterized by the mean fundamental global periodicity $T_f(2) = \langle T_{tec\text{-}endog,f} \rangle = \langle T_{clim2,f} \rangle = 351$ years) related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter and the Saturn), the system Sun-Moon, the Venus and the Jupiter. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec\text{-}endog,f} = T_{clim2,f} = 176$ years related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth 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. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec,f} = T_{clim1,f} = 88$ years [39] 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. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec\text{-}endog,f} = T_{clim2,f} = 44$ years related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth 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. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec,f} = T_{clim1,f} = 33$ years [39] 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. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec,f} = T_{clim1,f} = 24$ years [39] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon and the Venus. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec\text{-}endog,f} = T_{clim2,f} = 16.5$ years related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth 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. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $T_{tec\text{-}endog,f} = T_{clim2,f} = 12$ years related with the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon and the Venus. We present the foundation of the fundamental global seismotectonic, volcanic and climatic periodicity $(T_{M,MOON,J,3})_{1,tec\text{-}endog} \approx 6$ years (explaining "the unexplained spectral peak at a period of around 6 years" [45] in the spectrum of spin-rate variations for the modern time) related with the periodic tectonic-endogenous heating (of the geo-spheres of the Earth) owing to the periodic combined non-stationary energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter.

In Section 4 we analyze the dates of previous strong Japanese earthquakes near the Tokyo region and evaluate the forthcoming range of the possible intensification of the seismic activity (after 2013 AD) near the Tokyo region. In Section 4.1 we present the evidence of the impressive linkage (determined by the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40]) of the eruption of Hekla (1300 AD) in Iceland [46], the strong earthquakes [47] in China (1303 AD) and in England (1318 AD) [47] with the increase of the global seismicity and volcanic activity in the end of the 20th century [6] and in the beginning of the 21st century [14-16, 39] including the realized volcanic eruption of Hekla (2000 AD) in Iceland [46] and the realized Chinese 2008 and Japanese 2011 strong earthquakes.

Taking into account the additional date 1855 AD of the strong earthquake [48] near Tokyo along with the previously used [18] data [8] concerning to the strong earthquakes near Tokyo region, in Section 4.2 we present the evidence that the dates of the previous strong Japanese earthquakes (near the Tokyo region) may be satisfactory decomposed into a linear sums (with different coefficients) relative the established (in Section 3) fundamental global seismotectonic and volcanic time periodicities:

$T_f(1) = \langle T_{tec,f} \rangle = 702$ years,

$T_f(2) = \langle T_{tec\text{-}endog,f} \rangle = 351$ years,

$T_f(3) = T_{tec\text{-}endog,f} = 176$ years,

$T_f(4) = T_{tec,f} = 88$ years,

$T_f(5) = T_{tec\text{-}endog,f} = 44$ years,

$T_f(6) = T_{tec,f} = 33$ years,

$T_f(7) = T_{tec,f} = 24$ years,

$T_f(8) = T_{tec\text{-}endog,f} = 16.5$ years,

$T_f(9) = T_{tec\text{-}endog,f} = 12$ years and

$T_f(10) = 6$ years.

Based on the dates of the previous strong Japanese earthquakes near the Tokyo region [8, 48] and using the established fundamental global seismotectonic and volcanic periodicities, we present in Section 4.3 the evaluation of the first forthcoming range of the possible intensification of the seismic activity (after 2013 AD) near the Tokyo region. Taking into account the conclusion given by Sagiya [9], in Section 4.4 we present the evidence that the possible historic information (especially, concerning to the previous possible strong Japanese earthquakes and volcanic eruptions near the Tokyo region during the range 1303÷1315AD) is very important for the additional comprehensive verification of the sub-range 2015÷ 2023 AD of the first forthcoming range 2015÷ 2023÷ 2027.7 AD of the possible intensification of the seismic activity near the Tokyo region.

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 One-component Individual Finite Continuum Region 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 [14-16, 18, 21], 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.

We shall use the differential formulation of the first law of thermodynamics [49] 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 [49], 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 [49]:

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

where $\mathbf{J}_q$ is the heat flux [49]. The viscous-stress tensor $\mathbf{\Pi}$ is taken from the decomposition of the pressure tensor $\mathbf{P}$ [49]:

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

where $\boldsymbol{\delta}$ is the Kronecker delta-tensor.

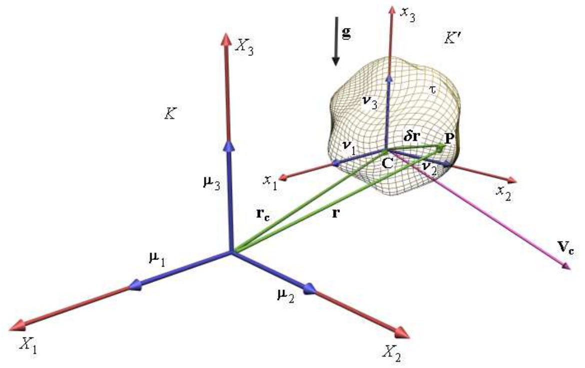

Fig 1. *Cartesian coordinate system K of a Galilean frame of reference and the continuum region mass center-affixed Lagrangian coordinate system* K'.

Using the differential formulation of the first law of thermodynamics [49] for the total derivative 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) [49], the general equation of continuum movement [50]:

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

for the deformed continuum characterized by the symmetric stress tensor $\mathbf{T} = -\mathbf{P}$ [50] 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 [14, 21] 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 [50],

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

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 [49] across the element $d\Omega_\mathbf{n}$ of the continuum boundary surface $\partial\tau$;

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

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

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

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 of the first law of thermodynamics can be rewritten as follows [14, 21]:

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

extending the classical [22, 51] formulations by taking into account (along with the classical infinitesimal change of heat δQ and the classical infinitesimal change of the internal energy $dU_\tau \equiv dU$) the infinitesimal increment of the macroscopic kinetic energy dK_τ, the infinitesimal increment of the gravitational potential energy $d\pi_\tau$, 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 [14, 21]:

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

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 [14, 21] of energy (added or lost as the result of the Newtonian non-stationary gravitational energy influence on the continuum region τ) may be interpreted [14-16, 18, 21, 39] 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, 18, 21] 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

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

presented for Newtonian continuum as follows [14, 18, 21] :

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

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

where

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

is the 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;

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

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;

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

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 $e_{\alpha\beta}$ [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 [22, 51] formulations by taking into account (along with the classical infinitesimal change of heat δQ and the classical infinitesimal change of the internal energy $dU_\tau \equiv dU$) the infinitesimal increment of the macroscopic kinetic energy dK_τ, the infinitesimal increment of the gravitational potential energy $d\pi_\tau$, the classical [22, 51] 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 [14, 18, 21] 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' [22] 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 [51] of the first law of thermodynamics for the general thermodynamic system (in Landau's and Lifshitz's designations [51]):

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

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 [51]) the kinetic energy of the macroscopic continuum motion.

The generalized differential formulation (14) [14, 21] 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, 21] is the generalization of the classical formulations [22, 51] of the first law of thermodynamics. The generalized differential formulations (14) and (21) of the first law of thermodynamics [14, 21] 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 model [14-16, 18, 39] 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 [52, 53] 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 Seismicity and Volcanic Activity of the Earth Induced by the Combined Cosmic and Terrestrial Non-stationary Energy Gravitational Influences and by the Non-potential Terrestrial Stress Forces

We founded [14-16, 18, 39] the physical mechanisms of the energy fluxes to the continuum region τ related with preparation of earthquakes. 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

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

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 of the first law of thermodynamics and to the related evolution equation [14, 18, 21] for the total mechanical energy $(K_\tau + \pi_\tau)$ of the deformed finite individual macroscopic continuum region τ, 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 [14, 18, 21] in the continuum region τ related with the production of earthquake. This conclusion corresponds to the observations [6, 11, 19, 20, 36, 38] 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 [39] (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

$$W_{gr}(\tau) = \iiint_{\tau} \frac{\partial\psi}{\partial t}\rho dV = -\iint_{\partial\tau} (\mathbf{J}_g \cdot \mathbf{n}) d\Omega_n , \qquad (26)$$

where $\mathbf{J}_g$ is the energy flux (characterized by the divergence $\operatorname{div}\mathbf{J}_g = -\rho\frac{\partial\psi}{\partial t}$) 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 [36] 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 [14, 18, 21]) may be considered as the useful theoretical component “needed to remove the subjective nature in the determination of the timeframe of a forecasted earthquake” [36].

The necessity to consider the gravitational field (during the strong earthquakes) is related with the observations of the slow gravitational [54, 55] ground waves resulting from strong earthquakes and spreading out from the focal regions [56, 57] of earthquakes. Lomnitz pointed out [56] 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 [2] 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 [57] 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 [58-60].

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 work:

$$A_{np,\partial\tau} = \int_{t_0}^{t} dt \iint_{\partial\tau} \left(\mathbf{v}\cdot\left(\mathbf{n}\cdot\mathbf{T}\right)\right) d\Omega_{\mathbf{n}} \qquad (27)$$

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 time interval $(t - t_0)$.

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. Taking this into account, the sum $\delta A_c + \delta A_s$ (for Newtonian continuum) in the expression for $A_{np,\partial\tau}$ may be interpreted [14, 18, 21] as the energy flux $\delta F_{vis,c} = \delta A_c + \delta A_s$ (according to the classical hydrodynamic approach [61]) 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. The deduced conclusion is in a good agreement with the results of the detailed experimental studies [62].

3. The Integral Energy Gravitational Influences on the Earth of the Moon, the Planets (of the Solar System) and the Sun owing to the Gravitational Interaction of the Sun with the Outer Large Planets

3.1. The Planetary 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 the fundamentals of the cosmic geophysics [14-16, 18, 39] based on the established generalized formulation (14) 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 derived [14-16, 18] 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 obtained [14-16, 18] 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 planet τ_i (the Mercury, the Venus, the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) at the mass center C_3 of the Earth, we considered [14-16, 18] the ratio

$$s(i) = \frac{\max\limits_t \Delta_g E_3(\tau_i, t)}{\max\limits_t \Delta_g E_3(\tau_1, t)}, \; i = 1, 2, 4, 5, 6, 7, 8, 9 \qquad (28)$$

of the maximal positive integral energy gravitational influence $\max\limits_t \Delta_g E_3(\tau_i, t)$ (of the planet τ_i 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. Based on the expression (28), we calculated [14-16, 18] 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 $s(9) = 1.4495 \cdot 10^{-7}$ (for the Pluto). We see that the Venus and the Jupiter are characterized by the maximal planetary integral energy gravitational influences on the Earth [14-16, 18]. By considering the energy gravitational influence (based on the generalized differential formulation (14) of the first law of thermodynamics) of the Venus on macroscopic continuum region τ near the surface of the Earth, we founded [14-16, 18] the real cosmic energy gravitational genesis of preparation of earthquakes.

3.2. Lunar Integral Energy Gravitational Influence on the Earth

We derived the expression for the lunar instantaneous and integral energy gravitational influences on the Earth in the second approximation [15, 16, 18] considering the elliptical orbits of the Earth and the Moon around the combined mass center $C_{3,MOON}$ of the Earth and the Moon. We obtained [15, 16, 18] 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 [15, 16, 18] the ratio

$$s(\text{Moon, second approx.}) = \frac{\max\limits_t \Delta_g E_3(\text{Moon}, t)}{\max\limits_t \Delta_g E_3(\tau_1, t)} \qquad (29)$$

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 [15, 16] the numerical values $s(\text{Moon, second approx.}) = 13.0693$ characterizing the lunar maximal integral energy gravitational influence on the unit mass at the mass center C_3 of the Earth.

3.3. The Integral 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 [39] 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 (14) of the first law of thermodynamics [14-16, 18] used for the Earth, we derived [39] the relation for the maximal positive integral energy gravitational influences $\max\limits_t \Delta_g E_3(\text{Sun} - \tau_j, t)$ 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 $\max\limits_t \Delta_g E_3(\text{Sun} - \tau_j, t)$ 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 $\max\limits_t \Delta_g E_3(\tau_1, t)$ of the Mercury on the Earth, we considered [23] the following ratio

$$s(\text{Sun} - \tau_j, \text{first approx.}) = \frac{\max\limits_t \Delta_g E_3(\text{Sun} - \tau_j, t)}{\max\limits_t \Delta_g E_3(\tau_1, t)}, \ j = 5,6,7,8 \qquad (30)$$

for the Jupiter (j=5), the Saturn (j=6), the Uranus (j=7) and the Neptune (j=8). Based on the expression (30), we calculated [39] 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): ($s(\text{Sun} - \tau_5, \text{ first approx.}) = 4235.613239$) (for the Sun owing to the gravitational interaction of the Sun with the Jupiter), $s(\text{Sun} - \tau_6, \text{ first approx.}) = 887.4442965$ (for the Sun owing to the gravitational interaction of the Sun with the Saturn), $s(\text{Sun} - \tau_7, \text{ first approx.}) = 93.8337322$ (for the Sun owing to the gravitational interaction of the Sun with the Uranus) and $s(\text{Sun} - \tau_8, \text{ first approx.}) = 87.8477601$ (for the Sun owing to the gravitational interaction of the Sun with the Neptune). Taking into account the calculated relative values $s(\text{Sun} - \tau_j, \text{first approx.})$ 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 [39] 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 [14-16, 18, 39] of preparation of the strong earthquakes, we have the following order of predominance of the maximal integral energy gravitational influences on the Earth [39]: 1) the integral energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the Jupiter $(s(\text{Sun} - \tau_5,\ \text{first approx.}) = 4235.613239)$, 2) the integral energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the Saturn $(s(\text{Sun} - \tau_6,\ \text{first approx.}) = 887.4442965)$, 3) the integral energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the Uranus $(s(\text{Sun} - \tau_7,\ \text{first approx.}) = 93.8337322)$, 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 $(s(\text{Sun} - \tau_8,\ \text{first approx.}) = 87.8477601)$, 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 $(s(\text{Moon}, \text{second approx.}) = 13.0693)$. We see that the Sun induce the main energy gravitational influence on the Earth owing to the combined gravitational interaction of the Sun with the large planets of the Solar System [39]. The Venus, the Jupiter and the Moon induce the main combined planetary and lunar integral energy gravitational influence on the Earth [14-16, 18]. The combined maximal integral energy gravitational influence on the Earth of the Mars ($s(4) = 2.6396$), the Saturn ($s(6) = 1.036$) and the Mercury ($s(1) = 1$) is one order of the magnitude smaller than the maximal integral energy gravitational influence of the Venus [14- 16, 18]. The combined maximal integral energy gravitational influence on the Earth of the Uranus ($s(7) = 0.0133$), the Neptune ($s(8) = 0.003229$) and the Pluto ($s(9) = 1.4495 \cdot 10^{-7}$) is two orders of the magnitude smaller (i.e., negligible) than the maximal integral energy gravitational influence of the Mercury [14-16, 18].

3.4. 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

Taking into account the significant maximal integral energy gravitational influences of the Sun on the Earth [39] owing to the gravitational interaction of the Sun with the outer large planets τ_j $(j = 5, 6, 7, 8)$, we established [39] 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 have the established successive approximations for the commensurable [63] time periodicities of recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth: $\{(T_{\text{S-MOON},3})_i\} = 3$ years $(i = 1)$, 8 years $(i = 2)$, 19 years $(i = 3)$, 27 years $(i = 4)$ for the system Sun-Moon [14-16] including 11 years (i=2) [18, 39]; $\{(T_{V,3})_j\} = 3$ years $(j = 1)$, 8 years $(j = 2)$ for the Venus [14-16] including 11 years (j=3) [18, 39]; $\{(T_{\text{MARS},3})_k\} = 15$ years $(k = 1)$, 32 years $(k = 2)$, 47 years $(k = 3)$ for the Mars [14-16]; $\{(T_{J,3})_n\} = 11$ years $(n = 1)$, 12 years $(n = 2)$, 83 years $(n = 3)$ for the Jupiter [14-16] and for the Sun owing to the gravitational interaction of the Sun with the Jupiter [39]; $\{(T_{\text{SAT},3})_m\} = 29$ years $(m = 1)$, 59 years $(m = 2)$, 265 years $(m = 3)$ for the Saturn [39] and for the Sun owing to the gravitational interaction of the Sun with the Saturn [39]; $\{(T_{U,3})_q\} = 84$ years $(q = 1)$ for the Uranus [39] and for the Sun owing to the gravitational interaction of the Sun with the Uranus [39]; $\{(T_{N,3})_r\} = 165$ years $(r = 1)$, 659 years $(r = 2)$, 2142 years $(r = 3)$ for the Neptune [39] and for the Sun owing to the gravitational interaction of the Sun with the Neptune [39].

We founded [14-16, 39] 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 [15-16, 39] 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 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 [39] the fundamental sets of the fundamental global seismotectonic and volcanic time periodicities $T_{\text{tec},f}$ (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):

$$T_{tec,f} = T_{clim1f} = T_{energyf} = L.C.M.\{(T_{S\text{-}MOON3})_i^{l_o}, (T_{V,3})_j^{l_2}, (T_{MARS3})_k^{l_4}, (T_{J,3})_n^{l_5}, (T_{SAT3})_m^{l_6}, (T_{U,3})_q^{l_7}, (T_{N,3})_r^{l_8}\} \quad (31)$$

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 [39] 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):

$$T_{tec\text{-}endog,f} = T_{clim2,f} = T_{endog,f} = T_{energy,f}/2 = \frac{1}{2} L.C.M.\{(T_{S\text{-}MOON,3})_i^{l_o}, (T_{V,3})_j^{l_2}, (T_{MARS,3})_k^{l_4}, (T_{J,3})_n^{l_5}, (T_{SAT,3})_m^{l_6}, (T_{U,3})_q^{l_7}, (T_{N,3})_r^{l_8}\} \quad (32)$$

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.

To evaluate the behavior of the global seismicity and volcanic activity of the Earth, we deduced [39, 40] from the formula (31) (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 $T_{tec,f}$ = $T_{clim1,f}$ (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 and the Saturn):

$$T_{tec,f} = T_{clim1,f} = (L.C.M.\{3, 8, 12, 29\} \div L.C.M.\{3, 3, 12, 59\}) = 696 \div 708 \text{ years.} \quad (33)$$

The founded range of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40] contains the empirical time periodicity 704 years [6] of the global seismotectonic activity. The founded range of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40] contains the evaluated (based on the wavelet analysis) time periodicity of approximately 700 years [64] characterizing the regional climate variability of the Japan Sea. These agreements with the empirical results [6, 64] confirm the established cosmic energy gravitational genesis of the founded range $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years of the fundamental global seismotectonic, volcanic and climatic periodicities the global seismotectonic, volcanic and climatic activity of the Earth. The range (33) of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years gives the mean fundamental global seismotectonic, volcanic and climatic periodicity

$$\langle T_{tec,f} \rangle = \langle T_{clim1,f} \rangle = 702 \text{ years} \quad (34)$$

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.

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 (32) the range of the following fundamental global seismotectonic, volcanic and climatic periodicities $T_{\text{tec-endog,f}}$ (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):

$$T_{\text{tec-endog,f}} = T_{\text{clim2,f}} = T_{\text{endog,f}} = T_{\text{energy,f}} / 2 = \\ = \frac{1}{2}(L.C.M.\{3, 8, 12, 29\} \div L.C.M.\{3, 3, 12, 59\}) = \\ = 348 \div 354 \text{ years.} \quad (35)$$

The founded range (35) of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{\text{tec-endog,f}} = T_{\text{clim2,f}} = 348 \div 354$ years [39] contains the empirical time periodicity 352 years [6] of the global seismotectonic activity of the Earth. The range (35) of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{\text{tec-endog,f}} = T_{\text{clim2,f}} = 348 \div 354$ years [39] gives the mean fundamental global seismotectonic, volcanic and climatic periodicity

$$\langle T_{\text{tec-endog,f}} \rangle = \langle T_{\text{clim2,f}} \rangle = 351 \text{ years} \quad (36)$$

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 (31) the following fundamental global seismotectonic, volcanic and climatic periodicity $T_{\text{tec,f}} = T_{\text{clim1,f}}$ (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):

$$T_{\text{tec,f}} = T_{\text{clim1,f}} = L.C.M.\{11, 11, 32, 11\} = 352 \text{ years,} \quad (37)$$

which is in agreement with the empirical time periodicity 352 years [6] of the global seismotectonic activity of the Earth.

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 (32) the following fundamental global seismotectonic, volcanic and climatic periodicity $T_{\text{tec-endog,f}}$ (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):

$$T_{\text{tec-endog,f}} = T_{\text{clim2,f}} = T_{\text{endog,f}} = T_{\text{energy,f}} / 2 = \\ = \frac{1}{2} L.C.M.\{11, 11, 32, 11\} = 176 \text{ years.} \quad (38)$$

We have the following empirical data concerning to the recurrence of the strongest earthquakes in different regions of the seismic zone of the Pacific Ring [8]:

$$90 \pm 40 = 50 \div 130 \text{ years - Kamchatka,} \quad (39)$$

$$130 \pm 50 = 80 \div 180 \text{ years - Japan,} \quad (40)$$

$$110 \pm 50 = 60 \div 160 \text{ years - Peru,} \quad (41)$$

$$100 \pm 50 = 50 \div 150 \text{ years - Aleutians.} \quad (42)$$

We see that fundamental global seismotectonic, volcanic and climatic periodicity $T_{\text{tec-endog,f}} = 176$ years is in fairly good agreement with the maximal period of 180 years corresponding to the recurrence of the strongest earthquakes in Japan.

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 (31) the following fundamental global seismotectonic, volcanic and climatic periodicity $T_{\text{tec,f}} = T_{\text{clim1,f}}$ (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):

$$T_{\text{tec,f}} = T_{\text{clim1,f}} = L.C.M.\{8, 8, 11\} = L.C.M.\{8, 11, 11\} = \\ = L.C.M.\{11, 8, 11\} = 88 \text{ years,} \quad (43)$$

which is in agreement with the empirical time periodicity 88 years [6] 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 [15, 16, 18] 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. The fundamental global seismotectonic, volcanic and climatic periodicity $\mathrm{T}_{\text{tec,f}} = \mathrm{T}_{\text{clim1,f}} = 88$ years explains the lover value in the empirical range (40) for Japan.

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 (32) the following fundamental global seismotectonic, volcanic and climatic periodicities $\mathrm{T}_{\text{tec-endog,f}}$ (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):

$$\mathrm{T}_{\text{tec-endog,f}} = \mathrm{T}_{\text{clim2,f}} = \mathrm{T}_{\text{endog,f}} = \mathrm{T}_{\text{energy,f}} / 2 = \frac{1}{2} L.C.M.\{8, 8, 11\} = \frac{1}{2} L.C.M.\{8, 11, 11\} = \frac{1}{2} L.C.M.\{11, 8, 11\} = 44 \text{ years}, \tag{44}$$

which is in agreement with the empirical time periodicity 44 years [6] 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 (31) the following fundamental global seismotectonic, volcanic and climatic periodicity (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):

$$\mathrm{T}_{\text{tec,f}} = \mathrm{T}_{\text{clim1,f}} = L.C.M.\{3, 3, 11\} = L.C.M.\{3, 11, 11\} = L.C.M.\{11, 3, 11\} = 33 \text{ years}, \tag{45}$$

which is close to the established [14] successive approximation of the time periodicity $(\mathrm{T}_{\text{MARS,3}})_2 = 32$ years of recurrence of the maximal (instantaneous and integral) energy gravitational influence of the Mars on the Earth. Consequently, the time periodicity (45) may be considered as fundamental global seismotectonic, volcanic and climatic periodicity 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. The fundamental global seismotectonic, volcanic and climatic periodicity (45) is close to the empirical time periodicity 35 years [5] of the sesmotectonic activity of various regions of the seismic belts around the Pacific Ocean (the Pacific Ring). It was shown [18] that the calculated average time periodicity 34.5 year of the evaluated time range $33 \div 36 = 3 \times (11 \div 12)$ years [14] (of the Earth's periodic seismotectonic and volcanic activity and the global climate variability determined by the combined cosmic non-stationary energy gravitational influence 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) is very close to the empirical time periodicity 35 years [5].

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 (32) 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):

$$\mathrm{T}_{\text{tec-endog,f}} = \mathrm{T}_{\text{clim2,f}} = \mathrm{T}_{\text{endog,f}} = \mathrm{T}_{\text{energy,f}} / 2 = \frac{1}{2} L.C.M.\{3, 3, 11\} = \frac{1}{2} L.C.M.\{3, 11, 11\} = \frac{1}{2} L.C.M.\{11, 3, 11\} = 16.5 \text{ year}. \tag{46}$$

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 1922 AD (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 (46). 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 (46).

We have (for $l_o = 1$, $l_2 = 1$, $l_4 = 0$, $l_5 = 0$, $l_6 = 0$, $l_7 = 0$, $l_8 = 0$) from the formula (31) the following fundamental global seismotectonic and volcanic periodicity (determined by the G-factor related with the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon and the Venus):

$$\mathrm{T}_{\text{tec,f}} = \mathrm{T}_{\text{clim1,f}} = L.C.M.\{3, 8\} = L.C.M.\{8, 3\} = 24 \text{ years}, \tag{47}$$

which is close to the empirical time periodicity 22 years [6] of the global seismotectonic activity of the Earth. It was pointed out [64] that "in 1985 and 1995, L'Aquila experienced so-called swarms, large numbers of fairly small tremors taking place over several weeks". We can see that the difference between the date 1985 AD (of the first so-called swarms in L'Aquila) and the date (2009 AD) of the L'Aquila earthquake (characterized by the magnitude 6.3 [64]) is equal to 24 years consistent with the fundamental global seismotectonic and volcanic periodicity (47).

We have (for $l_o = 1$, $l_2 = 1$, $l_4 = 0$, $l_5 = 0$, $l_6 = 0$, $l_7 = 0$, $l_8 = 0$) from the formula (32) the following fundamental global seismotectonic, volcanic and climatic periodicity (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 and the Venus):

$$T_{\text{tec-endog,f}} = T_{\text{clim2,f}} = T_{\text{endog,f}} = T_{\text{energy,f}} / 2 = = \frac{1}{2} L.C.M.\{3, 8\} = \frac{1}{2} L.C.M.\{8, 3\} = 12 \text{ years}, \tag{48}$$

which is close to empirical time periodicity 11 years [6] of the global seismotectonic activity of the Earth. We can see that the difference between the date 1995 AD (of the second so-called swarms in L'Aquila [64]) and the date (2009 AD) of the L'Aquila earthquake is equal to 14 years, which is near the fundamental global seismotectonic and volcanic periodicity (48).

We founded [15, 16] the existence of the modern short-term time periodicity of 6 years related with periodic intensification of the Chandler's wobble [65] of the Earth's pole (and related Earth's periodic seismotectonic and volcanic activity) induced by the combined non-stationary energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter. We assumed [15, 16] that if the configuration of the Mercury, the Moon, the Jupiter and the Earth is characterized at some time moment by the maximal combined (instantaneous or integral) energy gravitational influence on the Earth, then the Mercury, the Moon, the Jupiter and the Earth will have the recurrence of the same configuration after the different integer numbers of circulations ($i_{M,MOON,J,3}$ circulations around the Sun of the Mercury characterized by the time period T_M, $j_{MOON,M,J,3}$ circulations around the Earth of the Moon characterized by the time period T_{MOON}, $n_{J,M,MOON,3}$ circulations around the Sun of the Jupiter characterized by the time period T_J and $m_{3,M,MOON,J}$ circulations around the Sun of the Earth characterized by the time period T_3) to satisfy the following conditions:

$$i_{M,MOON,J,3} T_M = j_{MOON,M,J,3} T_{MOON} = = n_{J,M,MOON,3} T_J = m_{3,M,MOON,J} T_3. \tag{49}$$

We obtained [15, 16] from the conditions (49) the following integer numbers: $i_{M,MOON,J,3} = i_{M,MOON,3} = 49$, $j_{MOON,M,J,3} = j_{MOON,M,3} = 146$, $n_{J,M,MOON,3} = 1$ and $m_{3,M,MOON,J} = m_{3,M,MOON} = 12$, which denote the existence of the following approximate range of the time periodicities

$$(T_{M,MOON,J,3})_1 = 146 T_{MOON} \div 49 T_M \div T_J \div 12 T_3 = = 11.8025 \div 11.8039 \div 11.858747 \div 12 \text{ years} = = 11.8025 \div 12 \text{ years} \approx 12 \text{ years} \tag{50}$$

of the maximal combined (instantaneous or integral) energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter.

The time periodicity (50) gives the same time periodicity [15, 16]

$$(T_{M,MOON,J,3})_{1,\text{tec}} = (T_{M,MOON,J,3})_1 = = 11.8025 \div 12 \text{ years} \approx 12 \text{ years} \tag{51}$$

of the global periodic tectonic-volcanic intensification (induced by the combined non-stationary energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter) accompanied by increasing output of the atmospheric greenhouse gases.

We obtained [15, 16] from the time periodicity (51) the following time periodicity

$$(T_{M,MOON,J,3})_{1,\text{tec-endoc}} = (T_{M,MOON,J,3})_{1,\text{endoc}} = = (T_{M,MOON,J,3})_1 / 2 = 5.90125 \div 6 \approx 6 \text{ years} \tag{52}$$

related with the periodic tectonic-endogenous heating (of the geo-spheres of the Earth including each geo-block of the Earth) owing to the periodic combined non-stationary energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter. The periodic tectonic-volcanic intensification (determined by the periodic combined non-stationary energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter) must generate the periodic mass redistribution of the terrestrial material inside the Earth related with the periodic change (characterized by the same periodicity (52)) of the angular velocity of the Earth's rotation and related periodic intensification (characterized by the same periodicity (52)) of the Chandler's wobble [65] of the Earth's pole and the global seismic activity of the Earth. The obtained [15, 16] time periodicity (52) is located between the established range of the time periodicities 5 ÷ 7 years related with the established intensification of the seismicity in the Caucasian region [66]. The obtained [15, 16] time periodicity (52) of the periodic change of the angular velocity of the Earth's rotation (determined by the periodic combined non-stationary energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter) is in agreement with "the unexplained spectral peak at a period of around 6 years" [45] in the spectrum of spin-rate variations of the Earth for the modern time. The time periodicities 5 ÷ 7 years (having the mean time periodicity $(T_{M,MOON,J,3})_{1,tec\text{-}endog} \approx 6$ years) characterize the time periods between the strong earthquakes worldwide. Taking into account the date 2004 AD of the greatest (characterized by the magnitude 9.1) earthquake on the west coast of northern Sumatra and using the periodicities 5 ÷ 7 years of the global seismotectonic-volcanic intensification, it is possible to explain the range 2009 ÷ 2011 of the global seismotectonic-volcanic intensification. The L'Aquila 2009, Haiti 2010, Chile 2010, New Zealand 2010 and Japanese 2010 and 2011 earthquakes get into this range 2009 ÷ 2011 AD.

4. The Analysis of the Dates of Previous Strong Earthquakes Near the Tokyo Region and Evaluation of Forthcoming Ranges of Possible Intensification of the Seismic Activity Near the Tokyo Region

4.1. Linkage of the Eruption of Hekla (1300 AD) in Iceland, the Strong Earthquake (1303 AD) in China, and the Strong Earthquake (1318 AD) in England with the Increase of the Global Seismicity and Volcanic Activity in the End of the 20th Century and in the Beginning of the 21st Century

Considering the date (1300 AD) of the eruption of Hekla in Iceland [46] and the date (1303 AD) of great earthquake in China [47] and using the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years = 702±6 years [39], we evaluated [39] the following ranges of the next possible seismotectonic and volcanic activities, respectively, of the Earth

$$1300+696 \div 1300+708 = 1996 \div 2008 \text{ AD}, \qquad (53)$$

$$1303+696 \div 1303+708 = 1999 \div 2011 \text{ AD}. \qquad (54)$$

We see that the date 2000 AD of the realized eruption of Hekla in Iceland [46] gets into the obtained range 1996÷2008 AD of the possible eruptions of Hekla. The date 2008 AD of the realized Chinese 2008 earthquakes gets into the obtained range 1999÷2011 AD of the possible strong Chinese earthquakes.

Considering the date (1318 AD) of the great earthquake in England and the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39], we evaluated [39] the following range of the next possible strong earthquakes (possibly, in England) and volcanic eruptions worldwide

$$1318+696 \div 1318+708 = 2014 \div 2026 \text{ AD}, \qquad (55)$$

which gives the mean date [39, 40]

$$(2014+2026)/2 = 2020 \text{ AD} \qquad (56)$$

of the initial date of the forthcoming range [39, 40]

$$2020 \div 2061 \text{ AD} \qquad (57)$$

of the increased global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century.

Using the founded [39, 40] range of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years = 702±6 years together with the date (63 BC) of greatest earthquake in the ancient Pontus [67], we can evaluate the third from the initial date 63 BC (- 63) time range (of the possible intensification of the global seismotectonic and volcanic activity of the Earth in the 21st century)

$$-63+3\times(702\pm6)=2043\pm18=2025\div2061. \qquad (58)$$

We see that the mean value 2019.5 of the lower values in the ranges (55) and (58) is very close to the lower value of the range (57).

4.2. The Analysis of the Dates of Previous Strong Japanese Earthquakes Near the Tokyo Region

Following to the reasonable Sagiya's conclusion [9] to take into account the all available information concerning the dates of previous Japanese earthquakes, we take into account the dates 818 AD [47] and 1855 AD [48] of the previous strong earthquake near the Tokyo region along with the previously used [18] data [8] for the strong earthquakes near the Tokyo region.

The established fundamental global seismotectonic and volcanic periodicities (founded in Section 3): $T_f(1) = \langle T_{tec,f} \rangle = \langle T_{clim1,f} \rangle = 702$ years (given by (34)),

$T_f(2) = \langle T_{tec\text{-}endog,f} \rangle = \langle T_{clim2,f} \rangle =$ 351 years (given by (36)), $T_f(3) = T_{tec\text{-}endog,f} = T_{clim2,f} =$ 176 years (given by (38)), $T_f(4) = T_{tec,f} = T_{clim1,f} = 88$ years [6, 18, 39] (given by (43)), $T_f(5) = T_{tec\text{-}endog,f} = T_{clim2,f} = 44$ years [6, 39] (given by (44)), $T_f(6) = T_{tec,f} = T_{clim1,f} =$ 33 years, (given by (45)), $T_f(7) = T_{tec,f} = T_{clim1,f} = 24$ years [39] (given by (47)), $T_f(8) = T_{tec\text{-}endog,f} = T_{clim2,f} = 16.5$ years (given by (46)), $T_f(9) = T_{tec\text{-}endog,f} = T_{clim2,f} =$ 12 years [39] (given by (48)) and $T_f(10) = (T_{M,MOON,J,3})_{1,tec\text{-}endog} =$ 6 years (given by (52)) represent the fundamental seismotectonic and volcanic time scales to obtain the simple decompositions (relative to the initial date $t_0 = 818$ = 818 AD of the previous strong earthquake near the Tokyo) of each date $t(k)$ $(k = 1, 2, 3, 4, 5)$ of the strong earthquakes (occurred on $t(1) =$ 1605 AD, $t(2) =$ 1703 AD, $t(3) =$ 1855 AD, $t(4) =$ 1923 AD, $t(5) =$ 2011 AD) near Tokyo region as a linear sum

$$t(k) = t_0 + \sum_{i=1}^{10} \alpha_{ki} T_f(i) + t_{res}(t_0, k) \qquad (59)$$

with the coefficients α_{ki} (having the possible values $\alpha_{ki} = 1$ or $\alpha_{ki} = 0$) and the small residual parts $t_{res}(t_0, k)$ for each date t_k $(k = 1, 2, 3, 4, 5)$. Under the imposed condition $-0.5 \le t_{res}(t_0, k) \le 2$ for the residual components $t_{res}(t_0, k)$ for $k = 1, 2, 3, 4, 5,$ we obtain the following simple decompositions:

t(1)=1605 = 818 + 702 +44 + 24 +16.5 +0.5, (60)

t(2)=1703 = 818 + 702 +176 +6 +1, (61)

t(3)=1855 = 818+702 +176 +88+ 33+24 +12+2, (62)

t(4)=1923 = 818+ 702+351 + 33 + 12+6+1, (63)

t(5)=2011 = 818+702+351+88+44+6+2, (64)

which illustrate the fundamental significance of the established fundamental global seismotectonic and volcanic periodicities $T_f(i)$ $(i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10)$ for determination of possible dates of strong earthquakes. Table 1 shows the different fundamental global seismotectonic and volcanic periodicities participating in the above decompositions. The obtained decompositions (60)-(64) (containing the fundamental global seismotectonic and volcanic periodicity $T_f(1) = \langle T_{tec,f} \rangle = \langle T_{clim1,f} \rangle = 702$ years) clearly demonstrate the correctness of the Mori's [43] conclusion (concerning to the impossibility of prediction of the 2011 Tohoku earthquake based on the statistical analysis of the complete earthquake record for the short time period of 400 years.

The decomposition (64) gives the following main total sum (without the residual component $t_{res}(t_0, 5) = 2$) in the right hand side of (64):

2009 = 818+702+351+88+44+6, (64a)

which is in fairly good agreement with the date of sufficiently strong (moderate) Japanese earthquake occurred on 14 March, 2010 near Tokyo (with the epicenter in the Fukushima Prefecture). It means that the moderate earthquake (occurred on 14 March, 2010) may be considered as a foreshock of the strong 2011 Japanese earthquakes including the Tokyo region. We see that the next partial sum 818+702+351+88+44 = 2003 is in good agreement with the date 2003 AD of the strongest Hokkaido earthquake occurred on 25 September, 2003.

Using the previous dates $t(k)$ $(k = 4, 3, 2)$ of the strong earthquakes near the Tokyo region, we can obtain the decompositions of the final considered date $t_f = t(5) = 2011$ (2011 AD) of the strong earthquake near Tokyo region relative to the initial dates $t(k)$ $(k = 4, 3, 2)$ of the previous strong earthquakes near the Tokyo region as a linear sum

$$t(5)=2011=t(k) + \sum_{i=1}^{10} \beta_{ki} T_f(i) + t_{res}(t_f, k) \qquad (65)$$

with the different coefficients β_{ki} (having the possible values $\beta_{ki} = 1$ or $\beta_{ki} = 0$) and the small residual parts $t_{res}(t_f, k)$ for each date $t(k)$ $(k = 4, 3, 2)$. Under the imposed condition ($-0.5 \le t_{res}(t_f, k) \le 2$ for $k = 4, 3, 2$), we obtain the following simple decompositions (for $k = 4, 3, 2$):

t(5)=2011=1923+88, k=4, (66)

t(5)=2011=1703+176+88+44, k=3, (67)

t(5)=2011=1855+88+44+24, k=2. (68)

Table 1. *The realized fundamental global seismotectonic and volcanic periodicities participating in the obtained decompositions (60)-(64) of the previous dates* $t(k)\ (k=1,2,3,4,5)$ *of the strong earthquakes near the Tokyo region.*

$t(k)$	t_0	**702**	**351**	**176**	**88**	**44**	**33**	**24**	**16.5**	**12**	**6**	$t_{res}(k)$
1605	818	702	-	-	-	44	-	24	16.5	-	-	0.5
1703	818	702	-	176	-	-	-	-	-	-	6	1
1855	818	702	-	176	88	44	-	24	-	-	-	2
1923	818	702	351	-	-	-	33	-	-	12	6	0
2011	818	702	351	-	88	44	-	-	-	-	6	2

The obtained (in 2009 AD) decompositions (66) and (67) indicated [15, 16] the definable date 2011 AD of the possible strong earthquakes near the Tokyo region. It was the main argument to announce in 2009 [15] and in 2010 [16] "the time range 2010 ÷ 2011 AD of the next sufficiently strong Japanese earthquake near the Tokyo region". The occurrence (on 11 March, 2011) of the strong 2011 earthquake near the Tokyo region confirms the validity of the established fundamental global seismotectonic and volcanic periodicities $T_f(3)=T_{tec\text{-}endog,f}$ = 176 years [39] (given by (38)), $T_f(4)=T_{tec,f}$ = 88 years [14-16, 18, 39] (given by (43)) and $T_f(5)=T_{tec\text{-}endog,f}$ = 44 years [14-16, 18, 39] (given by (44)), which are presented in decompositions (66) and (67). The presented decomposition (68) (based on the analyzed additional date 1885 AD [48] of the strong Japanese earthquake near the Tokyo region) confirms the validity of the established fundamental global seismotectonic and volcanic periodicity $T_f(7)=T_{tec,f}$ = 24 years [14-16, 18, 39] given by (47).

Using the previous date $t(1)$ =1605 (1605 AD) of the strong earthquake near the Tokyo region, we can obtain the decomposition of the final considered date $t_f=t(5)=2011$ (2011 AD) of the strong earthquake near the Tokyo region relative to the initial date $t(1)$ =1605 of the previous strong earthquake near the Tokyo region as a linear sum

$$t(5)=2011=t(1)+\sum_{i=1}^{10}\beta_{1i}T_f(i)+t_{res}(t_f,1) \qquad (69)$$

with the different coefficients β_{1i} (having the possible values $\beta_{1i}=1$ or $\beta_{1i}=0$) and the small residual parts $t_{res}(t_f,1)$ under the imposed condition $-0.5\le t_{res}(t_f,1)\le 2$ for $k=1$. We obtain the following simple decomposition (for $k=1$):

$$t(5)=2011=1605+351+33+16.5+6-0.5,\ k=1. \qquad (70)$$

This decomposition (70) gives the following main total sum (without the residual component $t_{res}(t_f,1)=-0.5$) in the right hand side of (70):

$$2011.5= 1605+351+33+16.5+6, \qquad (71)$$

which is in agreement with the dates (29 April, 2012; 29 May, 2012; 1 June, 2012 and 3 July, 2012) of sufficiently strong (moderate) earthquakes near Tokyo. It means that these earthquakes (occurred on 29 May, 2012; 1 June, 2012 and 3 July, 2012) may be considered as aftershocks of the previous strong 2011 Japanese earthquakes (occurred on 11 March, 2011) near Tokyo region. We see that the main sum (71) gives the dates of the aftershocks of the previous strong 2011 Japanese earthquakes. Taking this fact into account, we can consider the next partial sum (without the residual component $t_{res}(t_f,1)=-0.5$ and the term of 6 years in the right hand side of (70)):

$$2005.5= 1605+351+33+16.5, \qquad (72)$$

which is in agreement with the date (July 23, 2005) of sufficiently strong (moderate) earthquakes (characterized my magnitude of 6.1) near Tokyo (south coast of Honshu). We see that the partial sum (72) gives the date of the foreshock of the previous strong 2011 Japanese earthquake near the Tokyo region.

Using the previous additional date [47] $t_0=818$ (818 AD) of the strong earthquakes near Tokyo region, we can obtain the additional decomposition (along with (64)) of the final considered date (2011 AD) of the strong earthquake near Tokyo region $t_f=t(5)=2011$ relative the initial date $t_0=818$ of the previous strong earthquake near Tokyo region as a linear sum

$$t(5)=2011=t_0+\sum_{i=1}^{10}\beta_{0i}T_f(i)+t_{res}(t_f,0) \qquad (73)$$

with the different coefficients β_{0i} (having the possible values $\beta_{0i}=1$ or $\beta_{0i}=0$) and the small residual parts $t_{res}(t_f,0)$ under the obvious imposed condition $-0.5\le t_{res}(t_f,0)\le 2.5$ for the initial date $t_0=818$. We obtain the following additional simple decomposition (for $t_0=818$):

$$t(5)=2011=818+702+351+88+33+16.5+2.5. \qquad (74)$$

This decomposition (74) gives the following main total sum (without the residual component $t_{res}(t_f,0)=2.5$) in the right hand side of (74):

$$2008.5= 818+702+351+88+33+16.5, \quad (75)$$

which is in agreement with the date (14 June, 2008) of sufficiently strong (moderate) Japanese earthquake struck on 14 June, 2008 the mid Tohoku region, northeastern Honshu. It means that the moderate earthquake (occurred on 14 June, 2008) may be considered as a foreshock of the strong 2011 Japanese earthquakes occurred in the Tohoku region and near the Tokyo region.

4.3. The Evaluation of the First Forthcoming Range of the Possible Intensification of the Seismic Activity (after 2013 AD) Near the Tokyo Region

Using the established fundamental global seismotectonic and volcanic periodicity $T_f(10)=6$ years (given by (52)) and the date 2011 AD of the strong Japanese 2011 earthquakes, we can evaluate the following date of the possible intensification of the Japanese seismic activity (including the Tokyo region)

$$2011+6=2017 = 2017\text{ AD}, \quad (76)$$

which gets into the range (55).

Taking into account the presented above mathematical formalism and using the previous dates (818 AD, 1605 AD, 1703 AD, 1855 AD and 2011 AD) of the strong earthquakes near the Tokyo region, we can obtain the decompositions of the obtained date (2017 AD given by (76)) of the possible earthquake near Tokyo region relative to the dates (818 AD, 1605 AD, 1703 AD, 1855 AD and 2011) of the previous strong earthquakes near Tokyo region as a following linear sums

$$2017 = 2011 +6, \quad (77)$$

$$2017= 1855+88+44+24+6, \quad (78)$$

$$2017= 1703+176+88+44+6, \quad (79)$$

$$2017= 1605+351+44+16.5+0.5, \quad (80)$$

$$2017= 818+702+351+88+44+12+2 \quad (81)$$

characterized by the narrow range $0 \le t_{res} \le 2$ of the residual parts. Taking into account these decompositions (77)-(81), we get the refined range (including the possible preventive foreshocks)

$$2015 \div 2017 \quad (82)$$

of the possible intensification of the Japanese seismic activity (including the Tokyo region).

Using the established fundamental global seismotectonic and volcanic periodicity $T_f(9)=T_{tec\text{-}endog,f}=12$ years (given by (48)) and the date 2011 AD of the strong Japanese earthquakes, we can evaluate the following date of the possible intensification of the Japanese seismic activity (including the Tokyo region)

$$2011+12 = 2023 = 2023\text{ AD}, \quad (83)$$

which gets into the range (55).

Using the established fundamental global seismotectonic and volcanic periodicity $T_f(8)=T_{tec\text{-}endog,f}=16.5$ years (given by (46)) and the date 2011 AD of the strong Japanese earthquakes, we can evaluate the following date of the possible intensification of the Japanese seismic activity (including the Tokyo region)

$$2011+16.5= 2027.5\text{ AD}. \quad (84)$$

Thus, taking into account the obtained dates (82), (83) and (84), we can evaluate the following first forthcoming range

$$2015 \div 2023 \div 2027.7 \quad (85)$$

of the possible intensification of the Japanese seismic activity (including the Tokyo region). The possible correction of the upper value in the range (85) may be reasonably obtained (after the analysis of the Japanese seismic activity after 2015 AD) based on the presented formalism like as it was realized using the presented above decompositions (77)-(81) for the date 2017 AD given by (76).

4.4. The Necessity of the Historic Information concerning to the Previous Possible Strong Earthquakes and Volcanic Eruptions Near the Tokyo Region to Support the Sub-Range 2015 ÷ 2023 AD of the Possible Intensification of the Seismic Activity Near the Tokyo Region

We predicted previously the range 2010÷2011 AD [15, 16] of possible strong Japanese earthquakes based on the fundamental global seismotectonic periodicity 88 years and using the date (1923 AD) of the strong Japanese earthquake near Tokyo. Taking into account the possible (not documented) strong Japanese earthquakes and volcanic eruptions near the Tokyo region in the range

$$1303 \div 1315\text{AD} \quad (86)$$

and using the founded range of the fundamental global periodicities $T_{tec,f}=T_{clim1,f}=696 \div 708$ years [39] (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), we evaluate the time ranges (presented in Table 2) of the possible intensification of the seismic and volcanic activity near the Tokyo region. The time ranges (presented in Table 2) give the total range 1999÷2023 AD, which is characterized by the mean date 2011 AD consistent with the realized strongest Japanese 2011 earthquakes.

Table 2. *Time ranges (presented in years) of the possible intensification of the seismic and volcanic activity near the Tokyo region determined by the founded range of the fundamental global periodicities* $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years *[39].*

Number of date from the range 1303÷1315	The date of previous possible strong Japanese earthquakes and volcanic eruptions	The time range of next possible strong Japanese earthquakes and volcanic eruptions
1	1303 AD	1303 +696 ÷ 1303+708 =1999÷2011 AD
2	1304 AD	1304 +696 ÷ 1304+708 =2000÷2012 AD
3	1305 AD	1305 +696 ÷ 1305+708 =2001÷2013 AD
4	1306 AD	1306 +696 ÷ 1306+708 =2002÷2014 AD
5	1307 AD	1307 +696 ÷ 1307+708 =2003÷2015 AD
6	1308 AD	1308 +696 ÷ 1308+708 =2004÷2016 AD
7	1309 AD	1309 +696 ÷ 1309+708 =2005÷2017 AD
8	1310 AD	1310 +696 ÷ 1310+708 =2006÷2018 AD
9	1311 AD	1311 +696 ÷ 1311+708 =2007÷2019 AD
10	1312 AD	1312 +696 ÷ 1312+708 =2008÷2020 AD
11	1313 AD	1313 +696 ÷ 1313+708 =2009÷2021 AD
12	1314 AD	1314 +696 ÷ 1314+708 =2010÷2022 AD
13	1315 AD	1315 +696 ÷ 1315+708 =2011÷2023 AD

We have not obtained the documented confirmations of the realized (and documented) strong Japanese earthquakes and volcanic eruptions in the range 1303÷1315 AD near the Tokyo region. However, following the arguments presented by Sagiya [9], we can assume that the strong earthquakes and volcanic eruptions were realized in the range 1303÷1315 AD near the Tokyo region. It is very important to answer on the significant question about the possibility of the strong Japanese volcanic eruptions and earthquakes (and related tsunami) during the range 1303÷1315 AD near the Tokyo region.

The necessity of the possible historic information concerning the previous possible strong earthquakes and volcanic eruptions (especially, in the range 1303÷1315AD) near the Tokyo region is very important for the additional comprehensive verification of the sub-range 2015÷ 2023 AD of the first forthcoming range 2015÷ 2023÷ 2027.7 AD of the possible intensification of the seismic and volcanic activity near the Tokyo region

5. Conclusions

We have presented in this article the development of the cosmic geophysics [14-16, 18] by taking into account the established [39] 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). Based on the generalized differential formulation (14) of the first law of thermodynamics [14, 21] used for the Earth, we have presented the foundation of the fundamental global seismotectonic, volcanic and climatic periodicities: $T_f(1) = \langle T_{tec,f} \rangle = \langle T_{clim1,f} \rangle = 702$ years (which is the mean value of the range of the fundamental global periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40]) and $T_f(2) = \langle T_{tec\text{-}endog,f} \rangle = \langle T_{clim2,f} \rangle = 351$ years (which is the mean value of the range of the fundamental global periodicities $T_{tec\text{-}endog,f} = T_{clim2,f} = 348 \div 354$ years [39]) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter and the Saturn), the system Sun-Moon, the Venus and the Jupiter; $T_f(3) = T_{tec\text{-}endog,f} = T_{clim2,f} = 176$ 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; $T_f(4) = T_{tec,f} = T_{clim1,f} = 88$ years [6, 18, 39] and $T_f(5) = T_{tec\text{-}endog,f} = T_{clim2,f} = 44$ years [6, 39] 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; $T_f(6) = T_{tec,f} = T_{clim1,f} = 33$ years [39] and $T_f(8) = T_{tec\text{-}endog,f} = T_{clim2,f} = 16.5$ years [39] 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; $T_f(7) = T_{tec,f} = T_{clim1,f} = 24$ years [39] and $T_f(9) = T_{tec\text{-}endog,f} = T_{clim2,f} = 12$ years [39] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon and the Venus; and

$T_f(10) = (T_{M,MOON,J,3})_{1,tec\text{-}endog} = 6$ years [15, 16] (determined by the combined non-stationary energy gravitational influences on the Earth of the Mercury, the Moon, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter), which explains "the unexplained spectral peak at a period of around 6 years" [45] in the spectrum of spin-rate variations of the Earth for the modern time.

We have presented the evidence of the linkage (determined by the range of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708$ years [39, 40]) of the eruption of Hekla (1300 AD) in Iceland, the strong earthquake (1303 AD) in China, and the strong earthquake (1318 AD) in England with the increase of the global seismicity and volcanic activity of the Earth in the end of the 20th century and in the beginning of the 21st century including the strongest Japanese 2011 Tohoku earthquake.

We have analyzed the dates (818 AD [47]; 1605 AD [8]; 1703 AD [8]; 1855 AD [48]; 1923 AD and 2011 AD) of the previous strong Japanese earthquakes near the Tokyo region. We have presented the evidence that the dates (1605 AD, 1703 AD, 1855 AD, 1923 AD and 2011 AD) of the previous strong Japanese earthquakes (near the Tokyo region) may be satisfactory decomposed (relative to the initial date 818 AD of the previous strong earthquake near the Tokyo region) into a linear sums

$$t(k) = t_0 + \sum_{i=1}^{10} \alpha_{ki} T_f(i) + t_{res}(t_0, k) \quad (87)$$

(with different coefficients α_{ki} having the possible values $\alpha_{ki} = 1$ or $\alpha_{ki} = 0$ and the small residual terms $t_{res}(t_0, k)$ for $k = 1, 2, 3, 4, 5$) of the established fundamental global seismotectonic and volcanic periodicities $T_f(i), i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10$.

Based on the dates of the previous strong Japanese earthquakes (near the Tokyo region) and using the established fundamental global seismotectonic and volcanic periodicities, we have presented the evaluation of the first forthcoming range $2015 \div 2023 \div 2027.7$ AD (given by (85)) of the possible intensification of the seismic and volcanic activity (after 2013 AD) near the Tokyo region. We have presented the evidence that the possible historic information (especially, concerning to the previous possible strong Japanese earthquakes and volcanic eruptions near the Tokyo region during the range 1303÷1315AD) is very important for the additional comprehensive verification of the sub-range $2015 \div 2023$ AD of the first forthcoming range $2015 \div 2023 \div 2027.7$ AD of the possible intensification of the seismic activity near the Tokyo region

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