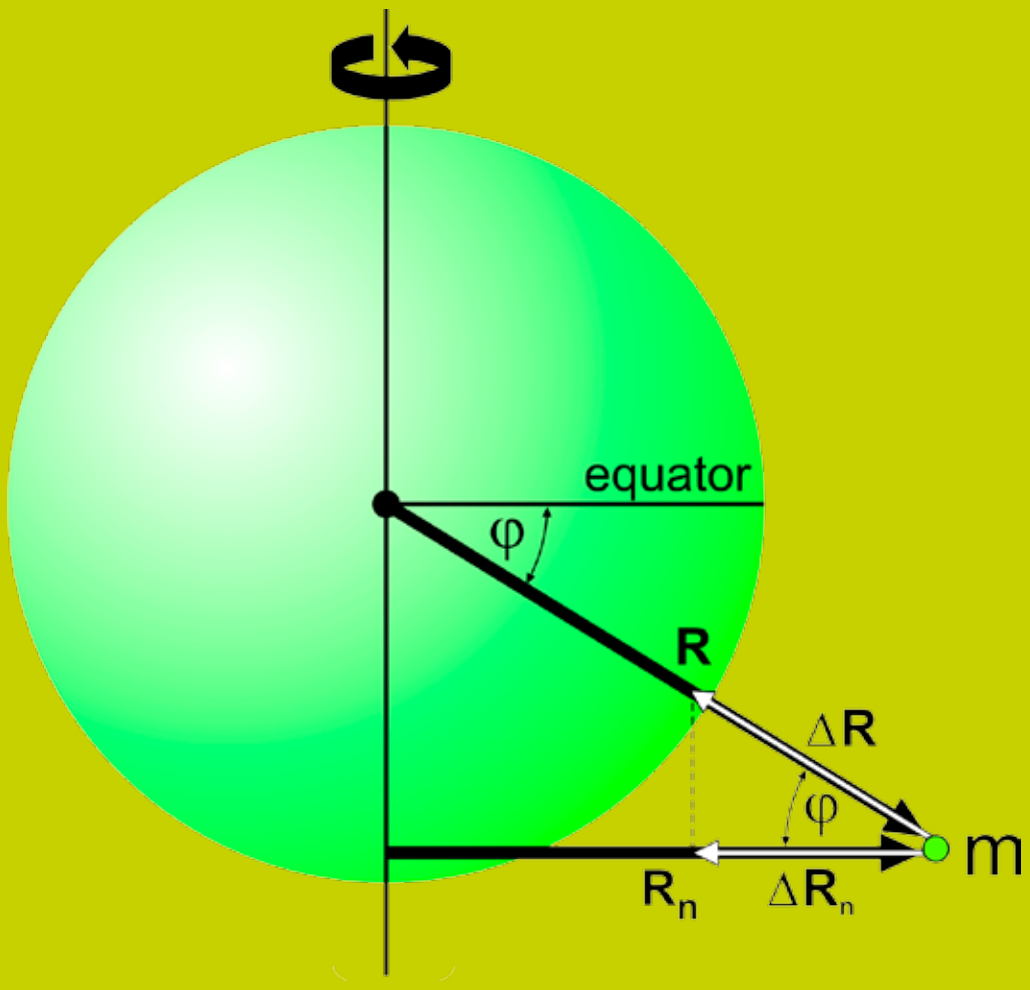
Jan Koziar

Shortening of the Length of Day (LOD) Caused by Big Tsunami Earthquakes on the Expanding Earth

extended abstract



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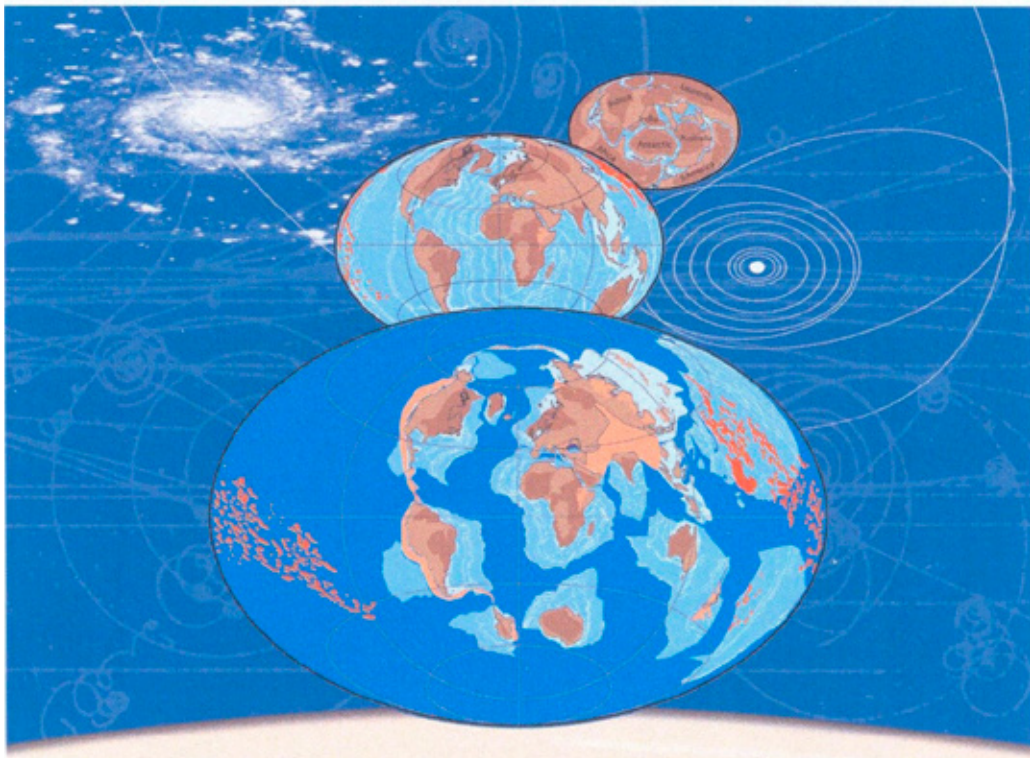

INTERNATIONAL SCHOOL of GEOPHYSICS

DIRECTOR ENZO **BOSCHI**

37TH INTERDISCIPLINARY WORKSHOP

THE EARTH EXPANSION EVIDENCE:

A challenge for Geology, Geophysics and Astronomy

DIRECTORS *Stefan* ***Cwojdzinski*** | *Giancarlo* ***Scalera***

4 | 9 October 2011 | Erice, Sicily, Italy

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Introduction (2018)

The present paper was published in the pre-conference book of the 37th Interdisciplinary Workshop of the International School of Geophysics at Erice, Sicily, 4-9 October 2011. A lecture was presented at the conference after my other topic "*Expanding Earth and space geodesy*" (www.wrocgeolab.pl/geodesy1.pdf and www.wrocgeolab.pl/geodesy2.pdf).

The calculation of the shortening of the length of day (LOD) at big tsunami earthquakes was made on the assumption that the whole change of the moment of inertia of the Earth is caused by gravitational collapse at the secondary tectogenesis of island arcs or active continental margins. After the conference, I learned that the precise measurements of the last of such earthquakes – the Tohoku earthquake of 11 March 2011 – demonstrated that part of the unloading rebound works simultaneously with gravitational collapse. It works, of course, in the opposite direction to gravitational collapse and reduces the rotational effect of the latter. Thus all the calculated values of the change of the LOD appeared to be too big. It stopped me from publishing the more extended text in the proceedings of the conference.

However I began to re-investigate the tensional-diapiric-gravitational mechanism of the island arcs and active continental margins intensively. I deciphered this mechanism generally and already lectured on it in 1980. But I was aware that single big blocks of oceanic lithosphere, sinking gravitationally under the oceanic trench (Fig. 1) are only a crude approximation and that the real process would be more complicated, though the principle should be the same. For years I made no progress, but now a breakthrough came when I realised that asymmetrical rifting, which works at island arcs and active continental margins, must reach deep into the upper mantle (Fig. 2).

In this system the oceanic lithosphere debris produced under the frontal part of island arcs and active continental margins does not sink freely in the less dense upper mantle but slides down along the huge and more rigid escarpment of the bottom wall of asymmetrical rifting. This immediately solves a big problem of the previous scheme which was the local gentle lowering of the Japan – Kurile and Chile – Peru Wadati – Benioff zones.

The seismically noisy sliding debris of oceanic lithosphere follows simply the more gentle lowering of the slope.

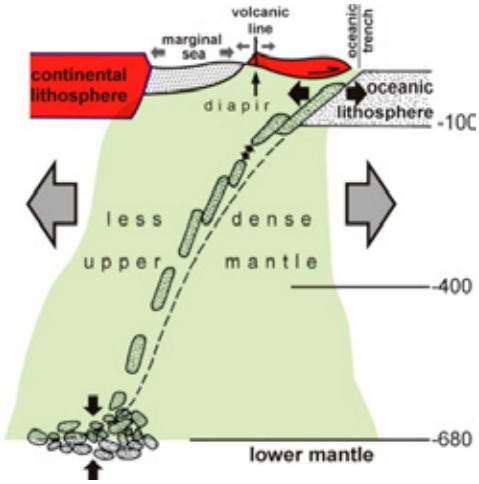

Fig. 1. *The old tensional scheme*

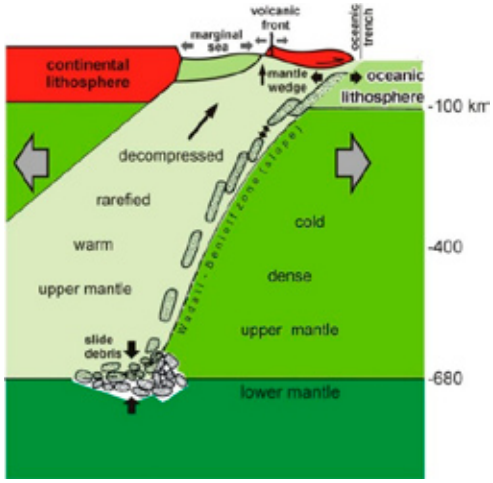

Fig. 2. *The new tensional scheme*

The scheme from Fig. 2 is elaborated in detail in Fig. 3 and Fig. 4

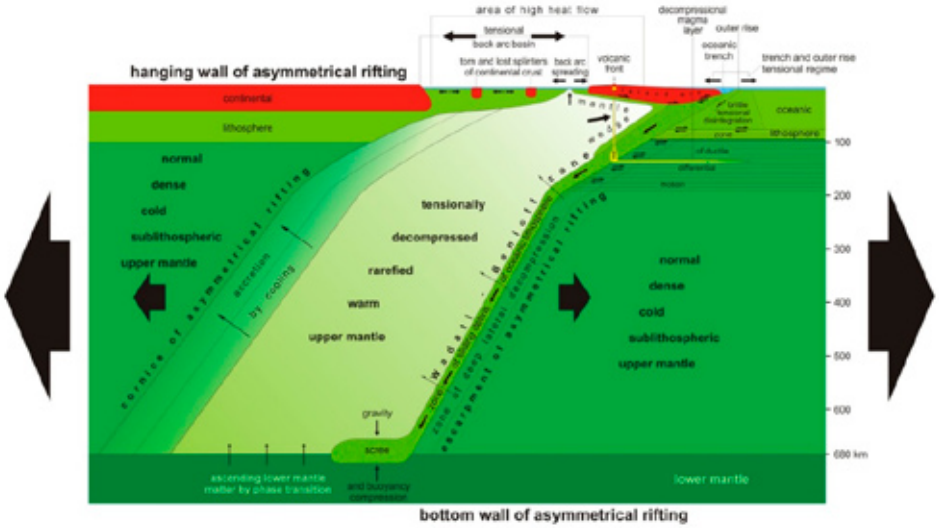

Fig. 3. *Elaborated scheme from Fig. 2.*

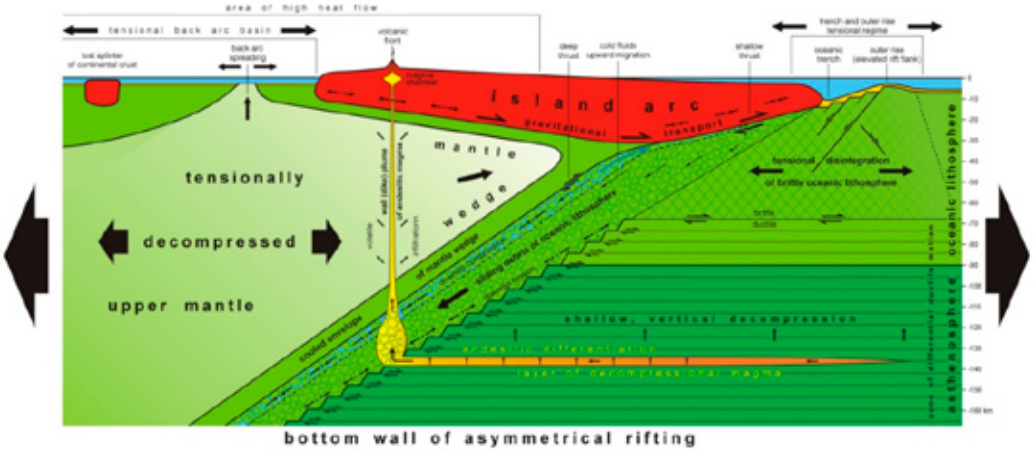

Fig.4. *The upper part of the scheme is presented in Fig. 3.*

The above schemes are also presented in my paper:
Plate tectonics: A theory founded on circular arguments
www.wrocgeolab.pl/falsification3.pdf.

The topic was presented in an expanded form at the XIX Meeting of the Society of Geologists Alumni of Wrocław University held on 28 January 2017 at Wrocław University. The title was: *Tensional development of island arcs and active continental margins. Detailed mechanism* (Figs. 5 and 6).

Fig. 5. *Advertisement of the lecture: Tensional development of island arcs and active continental margins. Detailed mechanism, at the XIX Meeting of the Society of Geologists Alumni of Wrocław University (28 January 2017)*

Fig. 6. *The author giving the lecture: Tensional development of island arcs and active continental margins. Detailed mechanism, in the* **Oratorium Marianum** *of the historical main building of Wrocław University*

The topic will be published after other items waiting for publication (see the introduction to my EE website). The deciphering of the detailed mechanism of island arcs and active continental margins is incomparably more important than the problem of shortening of the LOD caused by this mechanism.

* * *

Coming back to the *Shortening of the length of day caused by big tsunami earthquakes on the expanding Earth* – the calculations presented in this paper preserve (despite the earlier-mentioned reservations) their significance and can help in the future to estimate the size of coseismic gravitational unloading rebound caused by secondary tectogenesis at island arcs and active continental margins.

Formal remarks. The presented text is the same as published in the pre-conference book. Only the point III-3 ***"Exact meaning of the product mΔR"*** was added, but it had already been presented at the Erice conference. Apart from that contents and some actual Internet addresses were added.

Jan Koziar, April 2018

■ ***Acknowledgement:***

I would like to thank Professor Cliff Ollier for English correction of this brochure.

Contents

I. Plate tectonics calculations of the shortening of LOD caused by the big tsunami earthquakes

According to the plate tectonic paradigm the big tsunami earthquakes are caused by a sudden push of an oceanic plate under the opposite one. Because such a mechanism transports some rock mass towards the Earth's rotational axis it should speed up the rotation of our planet on the principle of conservation of angular momentum (the pirouette effect). The shortening of the length of day Δ(LOD), induced in this way, can be calculated. The suitable method was elaborated by Chao and Gross (1987) together with the method of calculation of the shift of the Earth-ball relative to its rotational axis. The shortening of LOD calculated in this way for the Sumatra 2004 earthquake was 2.68 microseconds (μs), and for the Chilean 1960 one was 8.0 μs (Chao, 2005). The first value was later enlarged to 6.8 μs (Buis, 2010). For the Japanese 2011 earthquake, the plate tectonic's Δ(LOD) was 1.8 μs.

All these calculated values are below the present detection level which is about 20 μs. Apart from that the calculations are very complex, based on computer simulation. The main part of the energy of an earthquake is treated in the plate tectonics paradigm not as the gravitational one but as the energy of elasticity of the plates, released at their sudden decoupling.

II. Tensional-diapiric-gravitational origin of the big tsunami earthquakes

1. Big tsunami earthquakes as a result of gravitational collapse

However, the plate tectonic model of the mechanism of the active continental margins is not the only explanation of this mechanism. The other one is based on the principles of gravitational tectonics. The whole energy of the big tsunami earthquake is here the energy of a gravitational collapse. This allows us to calculate the shortening of the LOD in a simple way which is much less "esoteric" – using the own word of Chao and Gross (Stroh, 2005). Apart from that the gravitational results are for all the big "tsunami" earthquakes above the present day detection level (this paper).

2. The scheme of the tension-diapir-gravitational mechanism of island arcs and active continental margins

The general mechanical solution for fold belts, an alternative to the plate tectonics model, was formulated by Carey (1976). The solution is

the tension-diapir-gravitational mechanism. The precise elaboration of this mechanism for active continental margins was done by Koziar and Jamrozik (1991), Koziar and Jamrozik1994; www.wrocgeolab.pl/margins1.pdf and Koziar 2003; www.wrocgeolab.pl/margins2.pdf and www.wrocgeolab.pl/margins2a.pdf– Fig. (1).

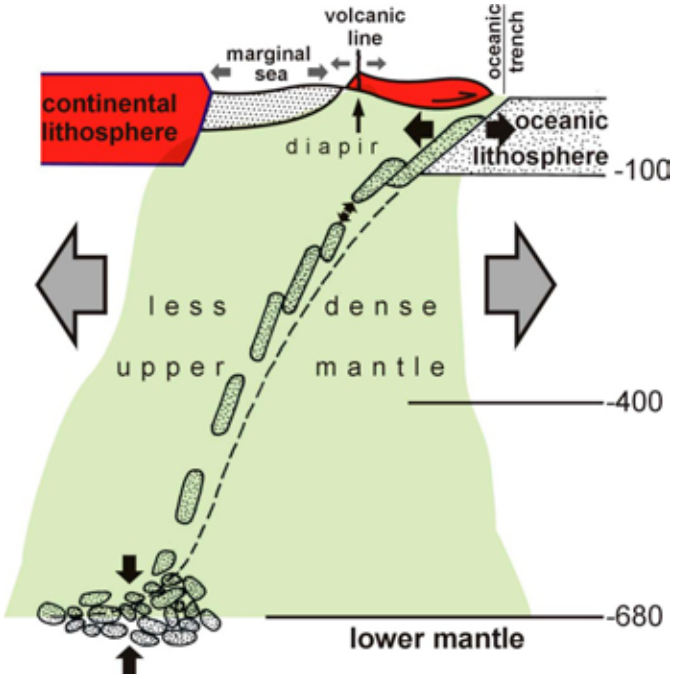

Fig. 1. *Tensional-diapiric-gravitational mechanism of island arcs (explanation in text)*

3. The inductive way of the deciphering of tensional scheme as opposed to assumptional way of the creation of the subduction model

The fundamental difference between the above scheme and the plate tectonics model of the so- called "subduction" consists not only in the opposite direction of plate movement but also in an opposite direction of reasoning leading to both schemes. The plate tectonics model is deduced in the speculative way from the unproved assumption that the Earth is not expanding (see Le Pichon, 1968). The scheme presented in Fig. (1) was built in the inductive way (without any global assumptions) by analyzing all the parts of an active continental margin and the underlying mantle and then putting them together. The expanding Earth is a conclusion resulting from this scheme. So, the above scheme itself is an independent proof of the expansion of the Earth, apart from other proofs (see Koziar, 2004[1]; Cwojdziński, 2005) which are beyond the scope of this paper.

[1] www.wrocgeolab.pl/handbook.pdf (supl. 2018)

4. Explanation of the tension-diapir-gravitational mechanism of island arcs

The explanation of the scheme in Fig. (1), should be done below in a causal (physical) sequence, opposite to the logical one applied at its deciphering. Thus, the general stretching of the lithosphere and upper mantle causes the subsidence on the lines of oceanic trenches and upwelling on the lines of volcanoes. These two neighboring and opposite vertical movements create the so called "primary tectogenesis" (Haarmann, 1933; van Bemmelen, 1952) – the fundamental mechanism of gravitational tectonics. The gravitational response to the gradually growing gravitational unbalance in the primary tectogenesis is the sudden secondary tectogenesis, that is the catastrophic gravitational transport of the whole region between the line of volcanoes and the oceanic trench towards the latter. This is the cause of the big tsunami earthquakes. The transport is performed by gravitational spreading and gravitational sliding. So, the whole earthquake's energy has a gravitational origin. This circumstance allows us to calculate the shortening of the LOD based on only two parameters of the earthquake: its total energy and its geographical latitude. The calculations are as follows.

III. Gravitational calculations of the shortening of LOD caused by the big tsunami earthquakes

1. Moment of inertia and its change at the gravitational collapse

Let us take into account the figure 2.

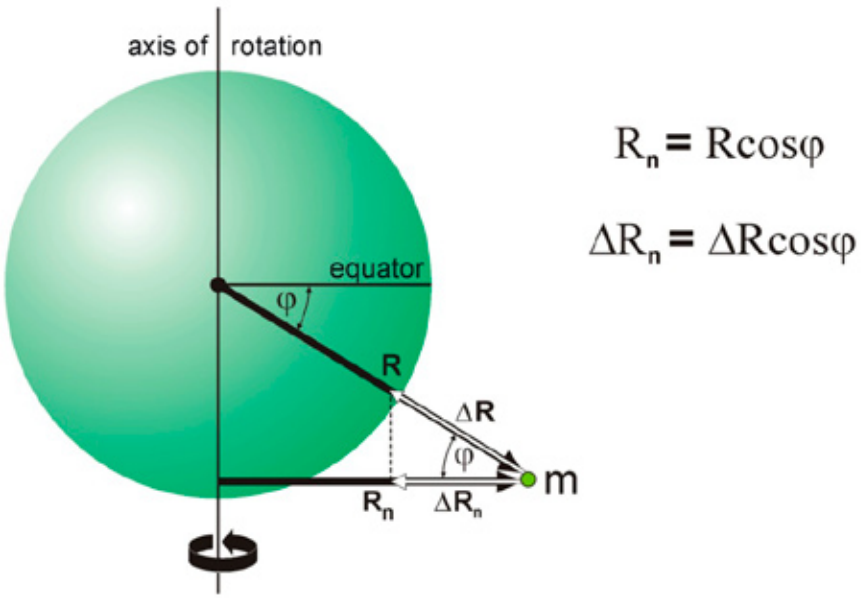

Fig. 2. *Rotational effect of the gravitational collapse (explanation in text)*

The moment of inertia I_m of the mass m is:

$$I_m = mR_n^2 = m(R\cos\varphi)^2,$$

where: φ is the geographical latitude of m.

The change of the moment of inertia, resulting from the change of distance from R_n to $R_n+\Delta R_n$ (in the discussed case ΔR and ΔR_n are negative), is:

$$\Delta I_m = I_{m2} - I_{m1}$$

where: $I_{m1} = m(R\cos\varphi)^2$;

$I_{m2} = m(R\cos\varphi+\Delta R\cos\varphi)^2$,

thus $\Delta I_m = m\cos^2\varphi(2R\Delta R + \Delta R^2)$.

Since ΔR^2 is very small ($\Delta R << R$), thus in the end:

$$\Delta I_m = 2R\Delta Rm\cos^2\varphi \quad (1).$$

2. Energy of the gravitational collapse and the importance of the product mΔR

The energy of the gravitational collapse is:

$$E = mg\Delta R \quad (2)$$

where g is the surface gravitational acceleration which dependence of the latitude is very small and can be omitted. In our case the E is the total energy of the big tsunami earthquake.

In the equation (2) there is the product $m\Delta R$ which appears also in the equation (1). This circumstance allows us to connect the process of changing of the moment of inertia, caused by the gravitational collapse with the energy of this collapse. We do not know separately the values of ΔR and m and what is more, we do not know their spatial distribution (the frontal part of the gravitational over-thrust is even uplifted as in the landslides) but fortunately we know the product of these values:

$$m\Delta R = E/g \quad (3)$$

which is the bridge between two aspects (rotational and energetic) of collapsing masses. This is the essence of the solution presented here.

3. Exact meaning of the product $m\Delta R$

Let us consider a gravitationally collapsing pile of mass (Fig. 3).

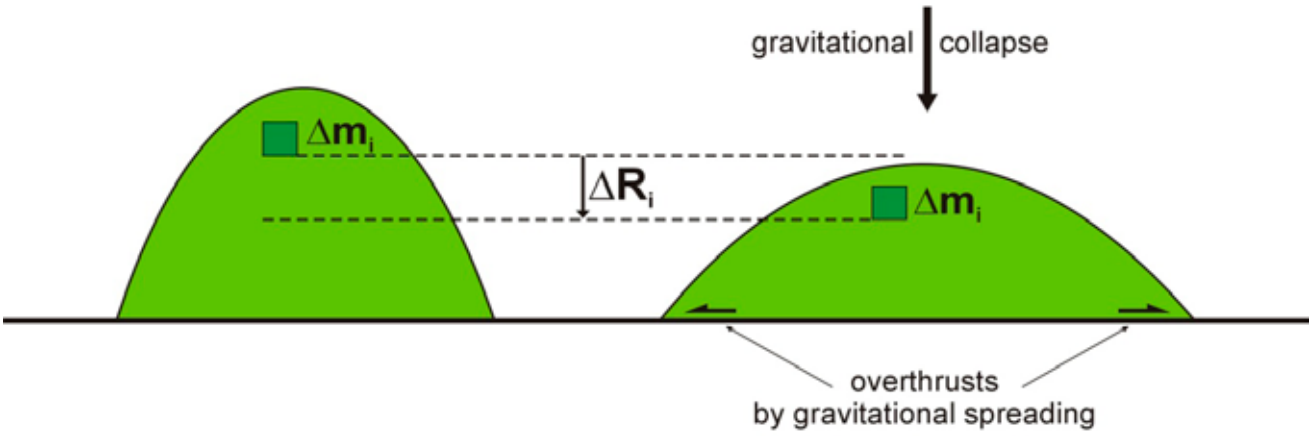

Fig. 3. *Gravitationally collapsed pile of mass (explanation in text)*

On above example the collapse is symmetrical for simplification. However, we should remember that in secondary tectogenesis the process is extremely asymmetric, directed towards an oceanic trench or a foredeep of a continental fold belt.

Let us separate an element of mass Δm_i (Fig. 3) from the whole pile of mass. This element collapses at the distance ΔR_i. Then let us make the product $\Delta m_i \Delta R_i$ and sum it after all *i*. The sum is equivalent to the product $m\Delta R$ (3) and equal to E/g which is given by known quantities.

$$m\Delta R = \sum_i \Delta m_i \Delta R_i = E/g$$

4. Angular momentum and the law of its preservation

Angular momentum L is equal to $I\omega$, where ω is an angular velocity $\omega = \Delta\alpha/\Delta t$. The law of preservation of angular momentum has a form $I_1\omega_1 = I_2\omega_2$. The angular velocity is tied with the period of rotation T (which applied to the Earth is our LOD) by the equation $\omega = 2\pi/T$. So, for our purpose it is convenient to express the law of preservation of angular momentum using the period of rotation T. Thus:

$$2\pi I_1/T_1 = 2\pi I_2/T_2,$$

that is:

$$I_1/T_1 = I_2/T_2,$$

and at the end:

$$I_1T_2 = I_2T_1 \quad (4)$$

5. The law of preservation of angular momentum expressed by the change of moment of inertia (ΔI) and the change of the period of rotation (ΔT)

Of course ΔT applied to the Earth is Δ(LOD) we are looking for. The equation (4) can be written in the form:

$$I(T+\Delta T) = (I+\Delta I)T$$

that is: $$IT+I\Delta T = IT+T\Delta I$$

at the end: $$I\Delta T = T\Delta I,$$

hence: $$\Delta T = T\Delta I/I \quad (5).$$

In our case I is now the moment of inertia of the whole Earth I_E and ΔI is its change ΔI_E equals to the change of the moment of inertia of the small collapsing mass m, because at the moment of the collapse $\Delta I_E = \Delta I_m$.

6. Shortening of the length of day (ΔT) expressed by the energy of the big tsunami earthquake (E)

Taking into account the equations (1) and (3) we obtain:

$$\Delta I = 2RE\cos^2\varphi/g.$$

Putting this expression in equation (5) we obtain:

$$\Delta T = 2RET\cos^2\varphi/I_E g \quad (6)$$

that is exactly what we were looking for.

The equation (6) can be written differently:

$$\Delta T = E(2RT/I_E g)\ \cos^2\varphi.$$

The expression in parenthesis is constant for all big tsunami earthquakes, called further "the coefficient of the shortening of LOD" and marked S. So:

$$S = 2RT/I_E g \quad (7)$$

In practice, it is enough to multiply the energy of the big tsunami earthquake E by this constant coefficient S and $\cos^2\varphi$ to obtain the looked-for shortening of the LOD. Thus:

$$\Delta T = ES\cos^2\varphi.$$

7. Calculation of the coefficient of the shortening of LOD

The constant parameters independent of the earthquakes and used here are:

$R = 6.38x10^8$ cm, $T = 8.64x10^4$ s, $I_E = 8.1x10^{44}$ gcm^2, $g = 9.81x10^2$cm/s^2

After putting them to the equation (7) we obtain:

$$S = 1.38x10^{-34}\ s^3/gcm^2$$

8. Energies and latitudes of the biggest tsunami earthquakes and the corresponding shortenings of LODs

Chile	**1960**	**$2.5x10^{30}$ ergs**	**$\varphi = 40^0$**	**Δ(LOD) = 200 μs**
Alaska	**1964**	**$7.5x10^{29}$ ergs**	**$\varphi = 60^0$**	**Δ(LOD) = 26 μs**
Sumatra	**2004**	**$4.0x10^{29}$ ergs**	**$\varphi = 0^0$**	**Δ(LOD) = 55 μs**
Japan	**2011**	**$2.8x10^{29}$ ergs**	**$\varphi = 37^0$**	**Δ(LOD) = 27 μs**

IV. Conclusions

All the results of the calculations exceed the present day detection level (ca 20 μs), so the space geodetic survey should be prepared for the precise measurement of the Δ(LOD) connected with every big tsunami earthquake before its rotational effect is dispersed in the bigger long-term changes of the LOD. The results of the measurements will test the alternative: plate tectonics – expanding Earth.

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