Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

Mountains Gravitational Pegs Stabilize the Earth's Rotation Motion

Bendaoud Saad
National School of Applied Sciences of Safi, Cadi Ayyad University, Morocco
b.saad@uca.ma (ESID 7158 2568 2023)

Abstract
Mountains and their usefulness for the terrestrial Globe are mentioned several times in the Quran. Especially, the Qur'an presents the mountains as pegs or stakes which ensure the equilibrium of the whole of the Globe and therefore its stability but it has not been reported anywhere in the Quran how they function to accomplish this extremely important role. According to the Quran, the role that mountains play as pegs should normally be miraculous, incredible, and even very great, far more important than the small role of stopping the movement of tectonic plates. If the mountains are made like pegs, it is to ensure the equilibrium of the whole of the Earth and probably not to stop parts of the Earth such in the theory of continental drift. The aim of this paper is to study the effect of Mountains as gravitational stabilizers pegs for the Earth's rotation motion. The physical system studied is a single Mountain selected among all the Mountains that exist on the globe. The application of *Newtonian mechanic's laws* to the forces that act on the Mountains system leads us to find out the equation of the Earth's rotation motion. As a result, the angular acceleration oscillates with an amplitude of $\sim 3.95 \times 10^{-21}$ rad.s^{-2}. The analyses of the obtained results show that a single Mountain, if it existed alone, will destabilize the Earth and hide all the Tide's effects on the Earth's rotation motion. The biggest obstacle that prevents us from seeing this phenomenon is the fact that the Mountains that exist on Earth are numerous, symmetrically distributed with respect to each other. There are several thousands of Mountains on Earth and the terrestrial crust also contains many other irregularities. Thus, the effects of Mountains and their antipode anomalies on the Earth's motion cancel out each other, achieving its stability. If Mountains didn't exist, the Earth would have vibrated from the initial instant of its existence and thus derived from its trajectory long time ago. As a result, the Mountains are for the Earth what are balancing corrective masses for rotating bodies like the wheel: They stabilize the Earth indeed. Without Mountains, the Earth's vibration can cause catastrophic failure, as well as noise and discomfort. Thus, the Mountains are gravitational pegs that stabilize the Earth's rotation motion while orbiting along its helical trajectory following the Sun's motion on its orbit.

Keywords:
Mountain, Earth rotation, Moment of the pressure force, Moment of inertia, Earth's irregularities, Earth's balancing corrective masses, Mountains stabilizing Earth's rotation, Mountain gravitational peg, Antipode anomalies.

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

1. Introduction

The rotation of the Earth is a fascinating subject which has retained the interest of geologists, geodesists, geophysicists and astronauts for a long time. The main works on the Earth's rotation are focusing on the study of its angular speed change, determining the change in the length of the day (LOD), the flattening and the inclination of Earth's spin axis with respect to the plane of the ecliptic. The most studied factors that have an effect on the Earth's rotation movement are both oceanic and solid tides, atmospheric wind, solar wind, ocean movements, plate motion, earthquakes and all anthropic activities that cause the Earth's global climate change. Studies of the effects of these factors on the Earth's rotation are often based on determining the change in the moment of inertia of the Earth and the conservation of angular momentum theorem. The Earth rotation is described by Eulere–Liouville equation, where the moment of inertia tensor plays a key role **[1]**. Mass redistribution within the Earth will result in changes in the inertia tensor, which contributes to the Earth's rotation motion change. Studying the physical mechanisms related to the Earth's rotation can help us better understand not only the complicated geophysical phenomena that govern the Earth's rotation motion in order to take preventive actions for their control them but also research advancements.

It's known that Mountains cover nearly 27 per cent of the Earth's land mass and are home to 15% of the world´s population. Among their usual known roles, the Mountains are reservoirs of fresh water, shelter forests and protect the Earth's crust from constant earthquake. It is also known that Mountains like pegs have deep roots under the surface of the ground and play an important role in stabilizing the Earth's crust. To our knowledge, there are no bibliographic resources on the roles that the Mountains play concerning the stability of the Earth's rotation motion from the start of their existence 4.5 billion years ago. The existence of the Mountains is to perform some functions which concern the Earth itself, and may be the whole of the solar system in the universe. In this regard, one might questions: What is the role of the Mountains that exist on the Earth with respect to the stability of our planet and why didn't the Earth exist without Mountains? Studying how and when Mountains were formed and what their shapes look like is very important and since they already exist, it is also interesting to find out the purpose of their existence. In addition to the tectonic plate stabilization, what are the other functions that Mountains perform on Earth?

Mountains appear motionless, but in reality, they are not because the Earth revolves around both itself and the Sun. Indeed, the Mountains that exist at Globe's Equator are moving at the tangential speed roughly equal to 1672.5 km/h due to the Earth's rotation movement. Mountains located between the Equator and the Earth's rotation axis move with different speeds but that does not exceed that value in all positions. Indeed, Mountains appear as if they are motionless for us but in reality, they move at the speed of clouds and supersonic airplanes. All these movements are governed as a first approximation by the classical Mechanics of Material point laws to which we will limit ourselves in this work. The purpose of this paper is to show that Mountains are gravitational pegs that stabilize the Earth's rotation motion. We will show in the case of a physical system formed by a Mountain, Moon and Earth that an angular momentum balance makes it possible to explain the role that Mountains play in stabilizing the planet Earth motion and how they stabilize it.

2. The theoretical background on the Mountains

In 1865, Delaunay had published an article on "The effect of the Tides on the Earth's rotation" in which he showed that the cause of the deceleration of the Earth's rotation movement was the friction of the Tides on the oceanic crust **[2]**. The hypothesis of Tides braking the Earth's rotation had been also mentioned by Kant in 1754 more than a century long before Delaunay **[3]**. According to Kant, due to the irregularities of the seabed, mainly islands and cliffs, Tides exert a slowing friction on the Earth's rotation.

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

In 1912, Wegener posed the hypothesis of "Continental Drift" **[4]**. In 1915, he published **"The Origin of Continents and Oceans" [5]**. He exhibited a theory based on a new conception of the terrestrial globe: the continents, floating on a more fluid layer, are mobile on the surface of the globe. Once united in a supercontinent, the continental masses have been separated by the interplay of fractures that become oceans, the continents will set adrift to their current position; the Mountains are thus formed. In their books published between 1920 and 1970, Wegener et al. relied on a thin, dense ocean crust and less dense Mountains with deep roots to support the theory of continental drift. They further postulated the permanence of the continental drift movement, the place of which is not permanently fixed, but this phenomenon occurs over a geological time scale. Nowadays, plate tectonics models, geophysical and GPS satellites measurements appear as if they confirm Wegener's theory.

Modern earth sciences have proven that mountains have deep roots under the surface of the ground and that these roots can reach several times their elevations above the surface of the ground. So the suitable word to describe mountains on the basis of this data is the word 'peg', since most of a properly set peg is hidden under the surface of the ground. The theory of Mountains having deep roots was introduced in the second half of the nineteenth century **[6]**. The Airy and Pratt models of isostasy are commonly used to explain the formation of the Mountains **[7]**. Airy model of isostasy tells us that Mountains have deep roots under the surface of the ground and that these roots can reach several times their elevations above the surface of the ground. Moreover, the modern theory of plate tectonics also states that Mountains have deep roots and play an important role in stabilizing the crust of the Earth **[8]** because they interfere with the shaking of the Earth. This is also found in many other bibliographic sources **[9,10]**. Airy estimated that the density of the crust is largely the same in all continental regions and therefore concluded that topographically, higher regions must be compensated by crustal roots at depth. Seismic studies in many Mountain belts show that most regions of high surface elevation are indeed compensated by significant roots at depth **[11,12]**. So many bibliographic resources rightly talking about Mountain roots give balance and stability to Earth's lithosphere.

Regarding the naming of Mountain roots by pegs, it is known that a bar or a stick, or generally any other object, whatever its shape and nature, cannot be called a peg unless it really plays the role of a peg, if it significantly contributes to prevent an object such as a tent from falling. It's useless to call an object a peg if it is not used to tie an animal or stabilize another object.

3. The force's gradient of the Sun and the Moon effect on a mass ▯ situated on the Earth's surface.

We will consider a simplified model based on Newtonian Mechanics. We leave the complex calculations to be done later. Our goal here is to vulgarize, for the first time, the phenomenon of Mountains balancing the Earth's rotation motion. To do this, we assume that the Earth as a solid and homogeneous sphere and the mass of the atmosphere is meaningless. We note M, the mass of the Earth, m, the mass of the Moon and r is the distance between the Earth and the Moon center to center.

The Earth-Moon system is kept in the dynamical equilibrium by two forces. One of them is the centripetal force, and the second one is the force of gravitational attraction between the Earth and the Moon. Moon and Earth are locked in the rotational motion. The Moon revolves around the Earth in an almost circular orbit, so we shall assume that the orbit is circular. In such motion, the mutual gravitational attraction is balanced by the centripetal force. Dynamical equilibrium of the Earth-Moon system will require that the sum of all centripetal and attraction forces should be zero. According to Newton's Second Law of motion, the equation of the Moon's orbital movement is written

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

$$\frac{mv^2}{r} = \frac{GMm}{r^2} \qquad \text{(eq. 1)}$$

where G is the universal gravitational constant.
The Moon's tangential velocity can be replaced by its angular velocity, Ω , with the relation $v = r\Omega$, so eq. 1 becomes:

$$r^3\Omega^2 = \text{Cste} \qquad \text{(eq. 2)}$$

The equation 2 is the Kepler's Third Law of planetary motion which means that if the angular velocity Ω changes due, for example, to a change in the moment of inertia of the terrestrial globe, then the radius r of the orbit must also change to adapt to the new value **[13]**. Any radius r leads to a stable orbit, the angular velocity Ω of the Moon, then adjust appropriately and vice versa. There would thus be the possibility of orbits of any angular frequency. The Moon would normally occupy orbits of any r radius. If r increases, the Moon moves away from Earth; but if r decreases, the Moon comes closer to the Earth. During the distance of the Moon or its approach towards the Earth, the frequency of revolution passes through an infinite number of values. If, moreover, r varies between two extreme amplitudes, then the Moon can oscillate around an equilibrium position. This oscillation will destabilize at first the Earth-Moon system.

The force of attraction which Sun exerts on a mass μ located on the Earth's surface is:

$$F_S = G\frac{M_S}{r_S^2}\mu$$

For the Moon:

$$F_L = G\frac{m}{r^2}\mu$$

and for the Earth:

$$F_L = G\frac{M}{R^2}\mu$$

where,

$M_S = 1{,}989 \times 10^{30}$ kg is the Sun's mass,
$M = 5{,}972 \times 10^{24}$ kg is the Earth's mass,
$m = 7{,}34 \times 10^{22}$ kg is the Moon's mass,
$r_S = 1{,}5 \times 10^{11}$ m is the distance between the Earth and the Sun,
$r = 3{,}8440\ 5 \times 10^{8}$ m is the distance between the Earth and the Moon,
$R = 6{,}371 \times 10^{3}$ m is the Earth's radius, and
$G = 6{,}674\ 8 \times 10^{-11}$ $m^3kg^{-1}s^{-2}$ is the gravitational constant.

The ratio of the Sun's force and the Earth's force is as follows:

$$\frac{F_S}{F_T} = \frac{M_S}{M}\left(\frac{R}{r_s}\right)^2 \approx \frac{1}{1000}$$

The ratio of the Moon's force and the Earth's force

$$\frac{F_L}{F_T} = \frac{m}{M}\left(\frac{R}{r}\right)^2 \approx \frac{1}{1\,000\,000}$$

The above values obtained for these two ratios show that the gravitational effect of the Sun and the Moon on the mass μ is about 1/1000 and 1/1000000 that of the Earth, respectively even if it is indeed the Earth that interacts gravitationally with the objects on its surface, such the Mountains more than the Sun and the Moon. But since each Mountain has a certain altitude, it is appropriate to make an analogy between ocean Tides and Mountains even though they are very high than Tides. The effect of the altitude of a Mountain is like the Tidal effect, is in $1/R^3$ due to the gradient (difference in strength) in gravitational force and not in $1/R^2$ due to Newton force, because the mass of a Mountain is distributed in altitude from the root to the summit. In fact, the force acting on the Mountains depends on the gradient of the gravitational field. Mountains undergo the gradient's action of the Moon's gravitational field across the diameter of the Earth. Hence, the use of the force's gradient is justified by the altitudes of Mountains and their roots which are very high than those of the Tides.

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

The Sun's force gradient is obtained by deriving the force F_S from the radial distance, we have

$$f_S = dF_S = -\frac{2GM_S}{R_{TS}^3}\mu dR_{TS}$$

The same derivation for the forces of the Moon and the Earth, the ratio of the force's gradients of the Sun and the Earth becomes:

$$\frac{f_S}{f_T} = \frac{M_S}{M_T}\left(\frac{R}{R_{TS}}\right)^3 \approx 2\times10^{-8}$$

and the ratio of the force's gradients of the Moon and the Earth becomes:

:

$$\frac{f_L}{f_T} = \frac{M_L}{M_T}\left(\frac{R_T}{R_{TL}}\right)^3 \approx 5\times10^{-8}$$

As we can see, the two ratios are of the order of 1/100.000.000.

The Sun and the Moon effects on a terrestrial Mountain are each almost 100 million times smaller than the Earth's effect on the same Mountain. The force gradients suggest that there isn't almost any interaction between the terrestrial Mountains on the one hand, and the Moon and the Sun, on the other hand. In addition, the ratio of the gradients of the Moon and the Sun forces is,

$$\frac{f_L}{f_S} = \frac{m}{M_S}\left(\frac{r_s}{r}\right)^3 \approx 2{,}6$$

As we see, the differential force due to the Moon is approximately 2.6 times greater than the differential force due to the Sun. Though the Moon and the Sun effects are extremely small in comparison to the Earth's one, the Moon still has an effect on the terrestrial Mountains and has more influence on them, than the Sun. To understand why such a small force has such a strong influence on the Earth's dynamics, it is enough to recall that the pressure force that exerts a mountain on Earth is very important because the air that it occupies is very vast **[14]**. So, we will limit ourselves in the following to the effect of the Moon's force on the Mountains.

4. The moment of the force that exerts the Mountains on the Earth

The Mountains that exist on our planet are essentially to maintain its dynamic equilibrium. To demonstrate how the Mountains stabilize the Earth's motion, the easiest way is to apply the laws of the classical Mechanics to the Earth-Moon-Mountain physical system. The components of the vector sum of forces acting on the rotating Mountain system in its dynamic equilibrium will allow us to establish the moment of the force that acts on it, with respect to the center of the Earth. To start our study on the interaction between the Mountains and the Earth, we need to select a single Mountain among all the Mountains that exist on Earth. To do this, imagine that all the Mountains that exist on Earth have been moved except one big Mountain, by some work, and that the displaced Mountains have been used to fill the irregularities that exist into the terrestrial crust such us hollows, valleys, anomalies and all the defects. This massive work, which is not impossible, will cause the Earth's surface to become a smooth one as a billiard ball and the water of oceans and seas to rise to the Earth's surface to form a single, uniform layer of water of a defined thickness. This layer of water would thus make the surface of the planet Earth uniform with a lump. The result of this massive displacement of the Mountains, except one of them, would make the Earth a perfect spherical object rotating on its rotation's axis having only one lump which is the unmoved Mountain. This "Earth" will therefore "limp" in the gravitational field! Next, we will study the unmoved Mountain which we will consider as our physical system. The chosen Mountains are the Himalaya Mountains range.

Sizes and masses of the Earth and the Moon are extraordinarily much greater than those of the Mountain, the distances between them is also

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

EMIRATES SCHOLAR

enormously very large. So we can consider the Mountain as a material point located on the Earth's surface that is because the Mountain range is fixed to the Earth's crust by its roots which can reach several times their altitudes above the surface of the ground. Let μ denote the mass of this material point. Therefore, the Moon exerts a gravitational force on μ and according to Newton's third law of motion; it is finally the Earth which undergoes the Moon's force by means of the Mountains. Let us assume, to simplify this hypothesis, that, without this action of the Moon, the Mountain does not undergo any lunar force of attraction and therefore neither does the Earth. The Moon is further assumed to be on the celestial Equator; by virtue of the lunar action and the Mountain is constantly attracted by the Moon. The Mountain assimilated to a material point turns on a circular trajectory with the same center as the Earth's globe. The Mountain's rotation direction on its supposedly circular trajectory is of course in the same orientation as that of the Earth and the Moon rotations. Designate by T, the Earth's center and by L, the Moon's center (Fig. 1). Suppose for the moment that the distance *r* between the Earth and the Moon center to center is constant, R, the Earth's radius, and *d*, the distance from the Moon to the Mountain center to center also. The distance *d* between the Mountain and the Moon varies continuously due to the Earth's rotation motion.

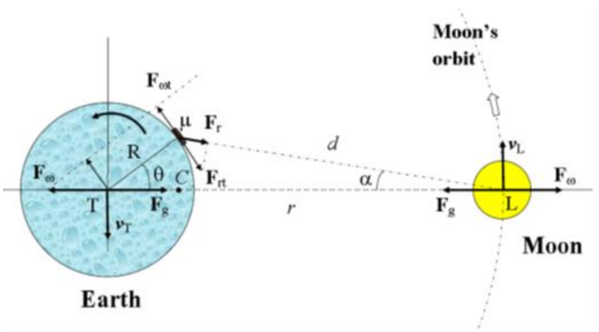


Figure 1: The Mountain, Earth and Moon system: Fr and F_ω are forces acting on the mass μ of the Mountains located on the surface of the Earth, T and L represent Earth and Moon gravity centers respectively. The point C is the barycenter of the Earth-Moon system.

For the moment, we question what are the forces acting on the mass μ located on the surface of the Earth. It is known that stability of the Earth-Moon system requires that the sum of all centripetal and attraction forces should be zero. While this statement is true for the centers of the Earth and Moon, the balance does not occur in every point of the Earth. Ignoring the altitude of the Mountains, the centripetal force F_ω is the same for the every point on the Earth and is equal to the force of attraction which the Moon exerts on the mass μ as if it is located at the center of the Earth;

$$F_\omega = F_g = G\frac{m\mu}{r^2}$$

The Moon's attraction force acting on the mass μ located on the Earth's surface (Fig. 1) is,

$$F_r = G\frac{m\mu}{d^2}$$

It is the sum of the two forces of which we have just given the expression that constitutes the action of the Moon on the mass μ of the Mountains and their roots. In this case, the Coriolis force does not exist because the Mountains are motionless on the Earth's surface. Projection of these forces on the tangential direction to the Earth's surface yield,

$$F_{\omega t} = G\frac{m\mu}{r^2}\sin(\theta)$$

And

$$F_{rt} = G\frac{m\mu}{d^2}\sin(\theta+\alpha)$$

where θ is zenith angle of the Moon.
Summing up these forces, we arrive at the Mountain's force F_t

$$F_t = F_{rt} - F_{\omega t} = Gm\mu\left(\frac{\sin(\theta+\alpha)}{d^2} - \frac{\sin(\theta)}{r^2}\right) \quad \text{(eq. 3)}$$

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

EMIRATES SCHOLAR

From the triangle T, μ, L we can find:

$$\frac{\sin(\theta)}{d} = \frac{\sin(\pi-\theta-\alpha)}{r} = \frac{\sin(\theta+\alpha)}{r}$$

Therefore in eq. 3, sin(θ + α) can be expressed by sin(θ) and

$$F_t = Gm\mu\sin(\theta)\left(\frac{r}{d^3}-\frac{1}{r^2}\right) \qquad \text{(eq. 4)}$$

Again, using the triangle T, μ, L the distance *d* is defined as

$$d^2 = r^2 + R^2 - rR\cos(\theta)$$

that can also be written in the form

$$\frac{1}{d^3} \approx \frac{1}{r^3}\left(1+\frac{R^2}{r^2}-\frac{R}{r}\cos(\theta)\right)^{-3/2}$$

Since the *R/r* ratio for the Moon is very small number (1/60,33). Developing the above equation into a power series up to first order considering that the R/*r* ratio for the moon is very small number (R/*r* ≈ 1/60,33 = 0,01657) then, the terms of the higher order $R^2/r^2 \approx$ 1/3600 will be neglected, we arrive at

$$\frac{1}{d^3} \approx \frac{1}{r^3}\left(1+\frac{3R}{2r}\cos(\theta)\right)$$

Introducing this result into the tangential component of the force acting on the Mountains, eq. 4 above yields to:

$$F_t = Gm\mu\frac{3R}{2r^3}\sin(2\theta) \qquad \text{(eq. 5)}$$

Repeating similar approach for the forces directed along the normal direction to the surface of the earth, we arrive at,

$$F_n = F_{rn} - F_{\omega n} = 3\frac{Gm\mu R}{r^3}(\cos^2(\theta)-\frac{1}{3}) \qquad \text{(eq. 6)}$$

The sum of the moments of these two components with respect to the center of the Earth is:

$$\tau = \frac{3}{2}\frac{Gm\mu R^2}{r^3}\sin(2\theta) \qquad \text{(eq. 7)}$$

The radial part has no momentum, so it does not deform the Earth.

Graph 1 shows the moment of the force, **τ**, acting on the mass μ as a function of time. As we see, the norm of the moment **τ** varies as a function of time. The remarkable fact is not only in the variation of the norm of **τ,** but rather in the fact that its orientation also changes cyclically with respect to the orientation of the Earth's rotation axis. Indeed, its sign is positive for the first quarter of a period ranging from 0 to π/2 and negative for the second quarter of a period between π/2 and π and so on. During the first quarter of a period, the sign of **τ** is positive, which means that this dynamic moment of the force tends to tilt the Earth towards the Moon, and for the second quarter of a period, the sign of **τ** is negative and the orientation of **τ** is reversed, thus the moment tends to tilt the Earth away from the Moon.

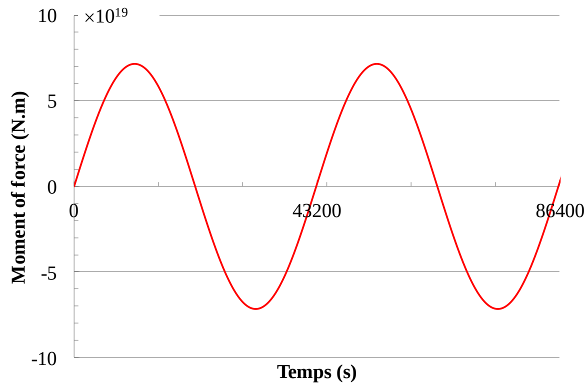
In general, if the sign of **τ** is positive, then the moment of the force tends to tilt the planet Earth towards the Moon, but if it sign is negative, it tends to tilt the Earth away from the Moon. The tangential speed of Mountains located at the Equator whose center of mass is at 6371 km from the center of the Earth, is ~ 1672,5 km/h. This value shows that the angular momentum of the Mountains is very big. The variation in the moment of the force vector is enough to cause the Earth's movement to cyclically move from right to left and vice versa due to the Mountains' range and the cyclically change of its orientation. Thus, the Mountains' range destabilizes the Earth's rotation motion. The moment of the force tends to modify instantaneously the angular momentum of the mass μ by dragging it towards the Moon or in the opposite direction, but since the Mountain's root is strongly fixed to the Earth, it is therefore the latter that undergoes its effect.

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

The moment of the pressure force that the Himalayas' Mountains range exerts on the Himalayas region cyclically oscillates and its sign changes. If the sign of the force's moment is positive, i.e. for the angle θ varying from 0 to $\pi/2$ or π to $3\pi/2$ and so on, then it tends to decelerate the Earth's rotation motion. However, if its sign is negative, i.e. for θ varying from $\pi/2$ to π and $3\pi/2$ to 2π then it tends to accelerate the Earth's rotation. The fact that the moment varies and its sign changes cyclically around 24 hours is a proof that the gravitational force destabilizes the Earth's motion due to the Himalayan Mountains range alone.

Recently, Na et al. reported that the global secular oceanic Tides exert on the Earth a decelerating torque of about -5.14×10^{16} Nm, the secular atmospheric Tide exerts an accelerating torque of $+ 1.55 \times 10^{15}$ Nm and the solid Earth Tide exerts a decelerating torque of -4.94×10^{15} Nm **[15]**. On one side, a Tide can be in the form of a flat layer with a circular base 1 meter thick and 675 km radius **[2]**. The surface of the oceanic Tides is about $2 \times 1.43 \times 10^{12}$ m^2. The factor 2 used here is to take into account the two opposed tidal bulges' areas. The moment of the pressure force that ocean Tides can exert on the Earth is $\sim 1.8 \times 10^4$ Pam (where 1 Pa = 1N/m^2). And on the other side, the moment of the force amplitude that the Himalaya Mountains range exerts on the Himalayas' region is $\sim 4.92 \times 10^{19}$ Nm. The total area of the Himalayas amounts to about 5.95×10^{11} m^2 [16]. Though, the corresponding moment of the pressure force is $\sim 1.2 \times 10^8$ Pam. Even if the surfaces of the Himalayas Mountains range and the Tides are of the same order, the pressure force that the area occupied by the Himalayas region exerts on the Earth is at less three orders of magnitude greater than those of oceanic and atmospheric Tides. As we see, if there were only one big Mountain on Earth like the Himalayas, then the effect of the Tides can be neglected, compared to its effect. These suggest that the Mountains have a role to play in the stability of the Earth's rotation motion.



Graph 1: The norm of the moment of force τ due to the Moon acting on the Himalaya Mountains range as a function of time for a period of 24 hours.

5. The effect of Mountains on the Earth's rotation motion

Applying the fundamental principle of dynamics ($\tau = I\alpha$), the differential equation of this rotational motion is

$$\frac{d\omega}{dt} = -\frac{3}{2}\frac{Gm\mu R^2}{Ir^3}\sin(2\theta) \qquad \text{(eq. 8)}$$

where ω is the angular speed of the Earth, and I the moment of inertia of the Earth's mass with respect to one of these diameters.

Based on the data published by Liu & al. **[17]**, and since $I/MR^2 \cong 0{,}33$ the Moment of inertia of the Earth and the mass μ is:

$$I = 0{,}33MR^2 + \mu R^2 \qquad \text{(eq. 9)}$$

The Himalaya Mountains are a Mountain range having some of the planet's highest peaks, including the highest, which is Mount Everest. The Himalayas abut or cross five countries: Bhutan, India, Nepal, China, and Pakistan (see Fig 2).

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

Figure 2: Photo of the Himalaya Mountains region taken from Google Earth map on 21 Sept. 2021, looking like a wheel balancing corrective mass.

Over 100 peaks exceeding 7200 m in elevation lie in the Himalayas. The length of the Himalayas Mountain range is 2400 km **[16,18].** The range varies in width from 200 to 400 km. Their total area amounts to about 600000 km^2. Mount Everest, the height of which is ~ 8849 m above ground, is a pyramidal pick and has deep root that can reach fourteen times its elevation above the surface of the ground. If we assume that the Mountains of this range have hexagonal pyramid shapes of $(\sqrt{3}/2) \times a^2 \times h$ volume where the a is the side of the base of the hexagonal pyramid and h, its height, and the roots of these Mountains as pegs with inverted volume conical shapes of $(1/3)\pi r^2 h$ volume where r is the radius of the base of the cone and h its height; if the average density of the Mountains is 5500 kg.m^{-3}, then the estimated mass of the range including the mountain roots well be $\mu \approx 9{,}35 \times 10^{18}$ kg. Otherwise, the mass of the Earth is always greater than that of any Mountains ($\mu/M = 9{,}35 \times 10^{18}$ kg $/ 5{,}972 \times 10^{24}$ kg ~ 1/1000000). So one can make approximation $M-\mu \approx M$. Then we have,

$$I \approx \frac{1}{3} \mathrm{MR}^2$$

If we substitute I by its expression in the previous differential equation, we have

$$\frac{d\omega}{dt} = -\frac{9}{2}\frac{Gm\mu}{M}\frac{\sin(2\theta)}{r^3} \qquad \text{(eq. 10)}$$

Note further that, by considering the Moon's rotation motion around the Earth's center, we have

$$G = \frac{4\pi^2 r^3}{T_L^2 M}$$

where: T_L is the Moon's period around the Earth.

If we substitute G by its expression in eq. 10, it will come

$$\frac{d\omega}{dt} = -18\frac{\pi^2}{T_L^2}\frac{m}{M}\frac{\mu}{M}\sin(2\theta) \qquad \text{(eq. 11)}$$

$\theta=\omega t=(2\pi/24h)t$, where $\omega=2\pi/24h$ and t the time, and T_L=27,32 days.

By simple integration of eq. 11, the expression of the angular speed change of the Earth's rotation is

$$\delta\omega = 9\frac{\pi^2}{\omega T_L^2}\frac{m}{M}\frac{\mu}{M}\cos(2\theta) \qquad \text{(eq. 12)}$$

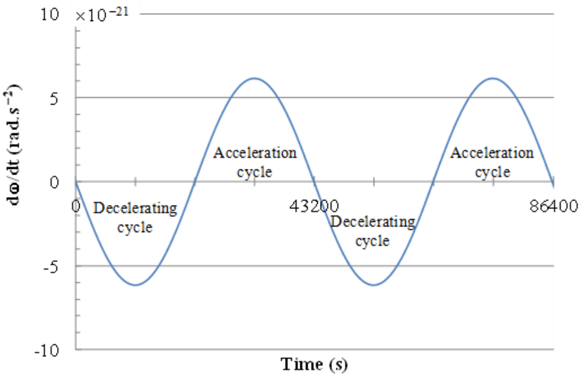
Then, the angular velocity of the Earth's rotation is $\omega(t)= \omega(t_0) + \delta\omega$.

As we see, the effect of Mountain's forces due to the Moon on the Earth's rotation motion is to increase or decrease instantaneously the angular velocity of the Earth by a quantity equal to $\delta\omega$. This variation in Earth's rotation angular speed will destabilize the Earth's rotation motion as it is shown.

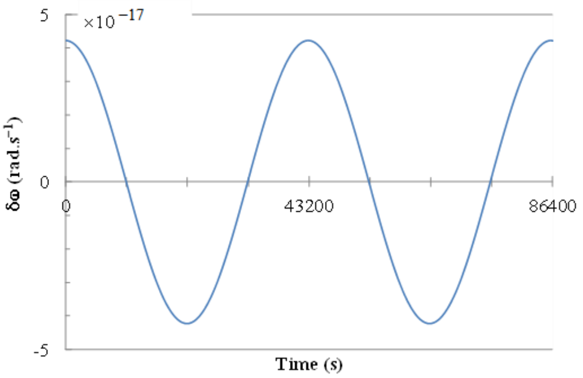
Graph 2 shows the angular acceleration of the Earth's rotation motion and Graph 3 its angular velocity change ($\delta\omega$) as a function of time.

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com



Graph 2 : The angular acceleration of the Earth's rotation due to the Moon forces on the Himalaya Mountains range. The rate dω/dt changes sign four times by day period. The Himalaya Mountains effect (if it existed alone on the surface of the Earth) would be to accelerate and decelerate the Earth's rotation motion twice a day which would cause destabilization of the Earth and consequently the destabilization of the Moon (1 cycle = 1 day / 4).



Graph 3 : The angular velocity change of Earth's rotation motion as a function of time due to the Moon forces on the Himalaya Mountains range. The angular speed of the Earth's rotation varies cyclically: it decreases during the decelerating and increases in the accelerating cycles

These two Graphs correspond to the moment of force presented in Graph 1. Sinusoidal curves on Graphs 2 and 3 show that if the sign of the angular acceleration (dω/dt: the cause) is negative corresponding to the decelerating cycles on Graph 2, then the angular speed change (δω: the effect) decreases. But, if the sign of the angular acceleration is positive corresponding to the accelerating cycles, then the angular speed change increases. The angular acceleration of the Earth's rotation, due to a Himalaya Mountains range, changes sign four times each day period and the force of the Mountains range (as they exist alone on the surface of the Earth), due to the Moon, would be to accelerate and decelerate the Earth's rotation movement twice a day which would cause the destabilization of its dynamical equilibrium.
To give a little more detail, the forces of the Mountains range will increase the brake's strength of the Earth's rotation movement during the first one-eighth of a daily period from 0 until t = T/8. At this instant, the angular acceleration reaches its minimum, which is $-6{,}14\times10^{-21}$ rad.s^{-2}. During this decelerating cycle, the angular velocity change progressively decreases towards its minimum, then the forces of the Mountain range exerted on the Earth will diminish the braking of the Earth during the second one-eighth of a period until t = T/4. At this instant, the angular acceleration is zero and during this decreased brake's cycle, the angular velocity change continues to progressively decrease until reaching its minimum which is equal to $-\ 4{,}22 \times 10^{-17}$ rad.s^{-1}. The force of the Mountains reverse the sign of the angular acceleration of the Earth's rotation motion to become positive and gradually increase it during the third one-eighth until t = 3T/8. At this instant, it reaches its maximum which is equal to $+\ 6{,}14 \times 10^{-21}$ rad.s^{-2}. During this increased acceleration cycle, the angular velocity change progressively increases towards its maximum; then the forces of the Mountain will cause the decrease of the angular acceleration during the fourth one-eighth of a daily period until t = T/2. At this instant, the angular acceleration is zero and during this decreased acceleration cycle, the angular acceleration change progressively increases until reaching its maximum which is $+\ 4{,}22 \times 10^{-17}$ rad.s^{-1} and so on.
Similar decelerating and accelerating cycles occurs during the proper Earth's rotation motion while "swimming" in the space along its helical trajectory

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

following the Sun's movement and depend also on the position of the Moon while orbiting along its helical trajectory following the Earth's movement. The fact that the angular speed of the Earth's rotation oscillates between two extremes – values as small as they are – will disturb the dynamic equilibrium of the Earth's rotational leading to its destabilization.

5.1. Himalaya Mountains, if it existed alone, can induce change in the length of the day

It is known that the forces generated by the tidal bulges cause a gradual decelerating of the Earth's rotation motion, and thus produce a noticeable apparent acceleration in the orbital mean motion of the Moon **[2]**. One of the big differences between the tidal wave and a Mountain's motion is that the tidal wave always remains pointed towards a direction defined by the gravitational forces orientations of the Moon and the Sun, while the Mountain rotates with the Earth because it is fixed to it. In the hypothetic case of the existence of a Mountain alone like the Himalaya Mountains range, the angular speed of the Earth's rotation varies. The amount by which the Earth's angular speed is decreased during the decelerating cycles and increased in the accelerating one is,

$$\delta\omega = \pm 8.44 \times 10^{-17} \text{rad.s}^{-1}$$

where the minus sign (–) is used for the decelerating cycles and the plus sign (+) for the accelerating cycles. Moreover, if we consider the variation of the angular speed change as being roughly linear as a function of time during the accelerating and decelerating cycles, then the positive and the negative short-term slopes that must correspond to its ascending and descending lines as a function of time would roughly equal the mean value of the angular acceleration of the Earth's rotation motion which is:

$$\frac{d\omega}{dt} = \pm 3.95 \times 10^{-21} \text{rad.s}^{-2}$$

which is comparable to the decelerating rate ~ 8.8×10^{-20} rad.s^{-2} due to magnetic braking of the Earth's rotation motion **[19]**. The minus sign is used for decelerating Earth's rotation and the plus sign for accelerating cycle. This deceleration is small, but the Earth's mass is ~ 5.97 × 10^{24} kg. A brake that achieves this deceleration would release ~ 500 GW, the equivalent of 514 GW nuclear power plants. Tides, volcanos, Coriolis-generated ocean currents and winds cannot absorb this much power.

On the other hand, because the norm of the angular momentum of the Earth system is conservative, then we have,

$$L = J\omega = \text{const} \qquad \text{(eq. 13)}$$

where $\omega = 7.292115 \times 10^{-5}$ rads^{-1} **[20]** is the mean Earth rotation rate.

It follows that a change of the angular velocity of the Earth's rotation speed should inevitably cause a change of the moment of inertia J of the Earth and should cause a change of the length of the day **[21]**:

$$\frac{\delta\omega}{\omega} = -\frac{\delta J}{J} = -\frac{\delta\tau}{\tau} \qquad \text{(eq. 14)}$$

where J and δJ are the moment of inertia and its change, and τ and δτ are the length of the day and its change respectively. Then, we have,

$$\delta\tau = -\tau\frac{\delta\omega}{\omega} \qquad \text{(eq. 15)}$$

Therefore, the change of the length of the day, due to the angular acceleration of the Earth's rotation movement should reach,

$$\frac{\delta\tau}{\tau} = \pm\frac{8.44\times10^{-17}\,\text{rad/s}}{7.29\times10^{-5}\,\text{rad/s}} \approx \pm 1.16\times10^{-12}$$

Here 1 cycle = T/4 and τ = 8.64 × 10^4 s is the length of a standard day.

Then, the length of the Earth day will increases by the rate of ≈ 25 ns per decelerating cycle and decreases by 25 ns per accelerating cycle due to the action of Mountain's pressure forces on the Himalayas area on the Earth and so on. The obtained value is comparable to the LOD change rate induced by tropospheric and

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

stratospheric wind contributions to Earth's variable rotation of ~356 µs/yr **[22]** and ~358 µs/yr ocean tides and the Anelasticity of the Mantel **[23]** which is equal to ~ 243.6 ns/cycle. A cyclically increase and decrease in the Earth's rotation speed therefore leads to a periodically increase and decrease in the angular momentum of lunar revolution movement.

One can imagine that the Moon is fixed and that the Earth spins like a wheel from west to east, in its diurnal rotation. A Mountain on the Earth's surface, on approaching the Moon's meridian, is, as it were, laid hold off by the Moon, forms a kind of handle by which the earth is pulled more quickly round. But when the meridian is passed the pull of the Moon on the Mountain would be in the opposite direction, it now tends to diminish the velocity of rotation as much as it previously augmented it, and thus the action of all fixed bodies on the Earth's surface is neutralized **[24]**. See Fig. 3.

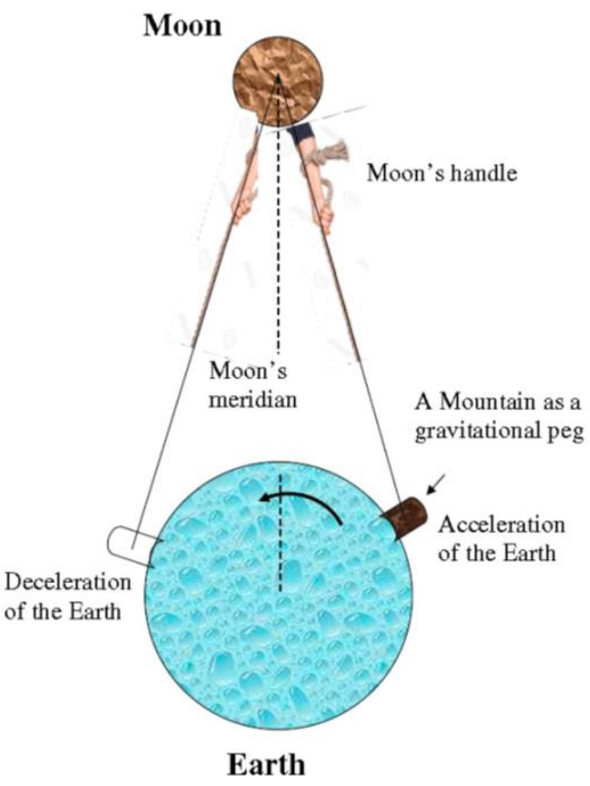


Figure 3: On the right: The Moon pulls on the Mountain accelerating the Earth's rotation motion, and on the left, the Moon pulls on the Mountain decelerating the Earth's rotation.

Nevertheless, this is not quite true because there are two different findings. Such reasoning without any supporting calculation suggests that there are only one acceleration cycle and one braking cycle of 12 hours each per day. But the calculation above shows that there are two accelerating and two decelerating cycles by day and there are therefore two findings. The first one is that the sum of the durations by which the LOD is increased and decreased during two successive accelerating and decelerating cycles or vice versa neutralize each other and the length of the day remains approximately the same. The second is that the Earth's rotation is accelerated during accelerating cycles and decelerated during braking cycles. The acceleration or deceleration of the Earth's rotation is an instantaneous and irreversible process. If the Earth's rotation is destabilized, then it is destabilized and this destabilization is irreversible us one cannot go backwards. That is to say that the acceleration or equally the deceleration of the Earth's rotation occurs instantly and it is also transferred instantly from the Earth to the Moon according to the angular momentum conservation theorem. If the angular speed of the Earth is instantly decreased by a certain amount, then it is decreased by that amount and this decrease is irreversible, but if the angular speed of the Earth is increased instantaneously, then it is increased. The instantaneous decrease or increase in the speed of rotation of the Earth, if it has occurred, is then irreversible. These successive accelerating and decelerating movements are the cause that pushes the Earth to vibrate. Consequently, a single Mountain destabilizes the Earth's rotation motion. We are therefore starting to see the role that Mountains play in the Earth's stability. If there were only one big Mountain, then several measuring instruments such as GPS satellites, clocks and gravimeters will be affected by the destabilization of the Earth's rotation motion

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

5.2. The Himalaya Mountains range, if it existed alone, can induce change in the distance between the Earth and the Moon

Mountains are fixed on the surface of the Earth unlike the Moon which revolves around itself while orbiting like "swimming" along its helical path following the Earth's movement around the Sun and also contrary to the tidal waves that propagate across the oceans and the earth's crust. From this point of view, the Moon's interaction with the Tides is quite different from what the Moon's interaction with the Earth's Mountains should normally be. If we assume that the Earth-Moon system is isolated, then its angular momentum is conserved (eq. 13). Therefore, as the angular momentum of the Earth's rotation on itself varies, i.e. decreases and increases cyclically, due to the forces of the Himalaya Mountains range, the Moon's orbital angular momentum also vary, that is to say, when the angular speed of the Earth's axial rotation varies between its two extremes while increasing and decreasing continuously, the angular speed of "orbital" rotation of the Moon increases and decreases cyclically following the Earth's angular velocity variations and, therefore, its angular momentum. The distance from the Earth to the Moon should normally vary causing the destabilization of the Earth-Moon system.

In order to demonstrate this imminent dependence, let us consider the simple case of the Earth's axial rotation. Suppose the Earth-Moon system as isolated and denote by *C*, its babycenter, T and L, the centers of gravity of the Earth and the Moon considered solid (see Fig. 1). The barycenter, due to the difference of the mass of Earth and Moon, is located approximately 3/4 of the Earth's radius from the Earth center T. In the inertial frame of reference, the rotational motion around the barycenter is somewhat different from the motion described by a wheel **[14]**. Earth and Moon revolves around the common center without rotation through a simple translation**.** For the system Earth-Moon to be in equilibrium, the vector sum of the two momentums of all forces should be zero. The system being isolated, then the angular momentum of the Earth-Moon system is constant. The sum of the angular momentums vectors of the Earth and the Moon in the Galilean reference frame centered in *C* (see Fig. 1) are written then,

$$L = \frac{m}{1+\frac{m}{M}} r^2\Omega + I\omega + J\Omega \qquad \text{(eq. 16)}$$

where Ω is the angular speed of revolution of the Moon witch is equal to its angular velocity of its proper rotation and *I* and *J* are the moments of inertia of the Earth and the Moon, respectively. The expressions of those moments are :

$$I = \frac{1}{3}MR^2 \quad \text{and} \quad J = \frac{2}{5}MR_L^2$$

To estimate rough orders of magnitude, we have furthermore $m/M \sim 1/81{,}3$ and $\Omega = 2{,}66 \times 10^{-6}$ rad/s. It follows that

$mr^2\Omega = 2{,}88 \times 10^{34}$ kg.m².s⁻¹;

$I\omega = 5{,}87 \times 10^{33}$ kg.m².s⁻¹; and

$J\Omega = 2{,}36 \times 10^{29}$ kg.m².s⁻¹.

As we see, the mass and angular momentum of the Earth, being larger than that of the Moon. Moreover, angular momentums of revolution are generally much more important than those of planet's proper rotation. Then, we can approximate the expression of the angular momentum of the Earth-Moon system through by:

$$L = mr^2\Omega + I\omega \qquad \text{(eq. 17)}$$

Now we can determine the amplitudes by which the distance between the Earth and the Moon oscillates. One uses to determine it, because the angular momentum of the Earth-Moon system is constant, the derivation of angular momentum with respect to time gives zero,

$$m\frac{d(r^2\Omega)}{dt} + I\frac{d\omega}{dt} = 0 \qquad \text{(eq. 18)}$$

Using again eq. 1 introduced above for the Moon's physical system, we have,

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

$$G\frac{Mm}{r^2} = m\Omega^2 r \qquad \text{(eq. 19)}$$

By substituting eq. 19 in the eq. 18, we find

$$m\frac{d}{dt}\left(\sqrt{GMr}\right) + I\frac{d\omega}{dt} = 0$$

That is

$$-\frac{1}{2}\frac{dr}{dt}m\sqrt{\frac{GM}{r}} = I\frac{d\omega}{dt}$$

Using once again $GM = r^3\Omega^2$ from eq. 19 and after some arrangements, we obtain

$$\frac{1}{r}\frac{dr}{dt} = -2\frac{I}{mr^2\Omega}\frac{d\omega}{dt} = 2\frac{I}{MR^2}\frac{M}{m}\left(\frac{R}{r}\right)^2\frac{T_L}{T}\frac{dT}{Tdt} \qquad \text{(eq. 20)}$$

Substitute each physical quantity by its value in eq. 20, we obtain,

$$\frac{1}{r}\frac{dr}{dt} = 2\times 0{,}33\times 81{,}3\times\frac{1}{60^2}\times 27{,}32\times(\pm)100\ \text{ns/cycle/d}$$

$$= \pm 2{,}18\times 10^{-17}s^{-1}$$

We finally get the following result:

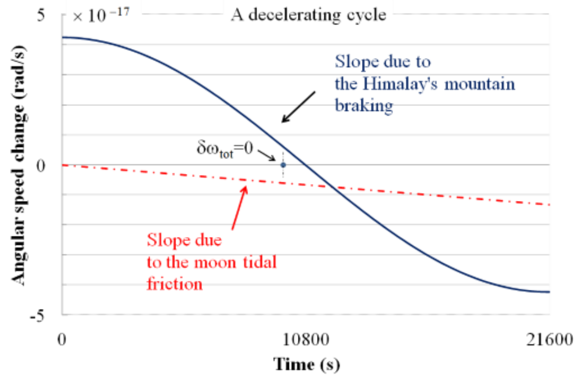
$$\frac{dr}{dt} = \pm 181{,}35\,\mu\text{m/cycle}$$

The minus sign indicates that the Moon will approach the Earth by a rate of ~181.35 µm/cycle each accelerating cycle and the plus sign means that the Moon is moving away from the Earth by the same rate each decelerating cycle.

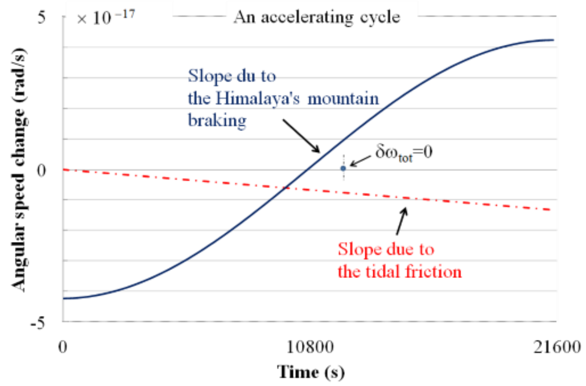
Those kinds of oscillations phenomenon let us discover, for the first time, that Earth-Moon system vibrates along the TL axis passing by its barycenter C (see Fig. 1) with amplitude peak to peak of ~ 181,35 µm. The Earth and the Moon oscillate like two masses attached to an "invisible" spring. The short-term angular acceleration of the Earth's rotation of our calculus is ±3.95 × 10–21 rad.s–2. To compare, the long-term in angular acceleration of the Earth's rotation motion that Groten et al. brought back is –4.5 × 10–22 rad.s–2 **[20]**. Stephenson et al. reported that the rate of change in the length of the day is +1.78 ms.cy–1, due to the global deceleration of the Earth's rotation with a long-term angular acceleration of ~ –4.7 × 10–22 rad.s–2 of the Earth's rotation motion **[25]**. The lunar Tide friction alone contributes by ~ –6.2 × 10–22 rad.s–2 at this value. There is, therefore, an acceleration of +1.6 × 10–22 rad.s–2 whose origin is unknown. This positive angular acceleration is probably due to a sustained decrease of the Earth's moment of inertia change, such as the Earth's flattening. Recently, Adhikari et al. reported that the position of Earth's spin axis drifted through the solid crust towards Labrador, Canada at an average speed of 10.5 ± 0.9 cm/yr during the 20th century **[26]**, and this phenomenon can also induce a gyroscopic effect. According to our calculations, the quadratic mean value of the angular acceleration is ~ 2.8 ×10^{-21} rad.s^{-1}. Then, using the left term and the central term of eq. 20 above, we found that the Moon is approaching the Earth at a rate of about 18,73 cm/yr due to the effect of the Himalaya Mountains range on the Earth and the day is getting shorter. However, this calculation is deficient. That's why we must compare rates that are comparable. The long-term rate by which the Moon is moving away from the Earth due to all effects (ocean and solid Tides, atmospheric wind, etc.) acting on the Earth's rotation motion is 3.82 cm/yr **[27]**. The short-term rate corresponding to this rate is 26 µm/cycle. Then, the ratio of the amplitude by which the Moon vibrates due to the pressure forces of the Mountains on the Earth to the distance by which it is moving away from the Earth is 181.35 µm/26 µm ≈ 7, and the ratio of absolute values of the corresponding accelerations is 3.95 × 10^{-21} rad.s^{-2}/4.7 × 10^{-22} rad.s^{-2} ≈ 8,4. The value of the last ratio shows that the angular acceleration, due to the Himalayan Mountains range, is greater enough than the acceleration due to the all other effects acting on the Earth's rotation. As we see, the effect of a single range of Mountains on the Earth's rotation can hide the ocean Tide effect over a decelerating or an accelerating cycle or can dominate it, as shown on Graphs 4 and 5.


Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com



Graph 4 : The angular acceleration change $\delta\omega$ as a function of time due to the forces of the tidal friction and the Himalayan Mountain range on the Earth's rotation. The Mountain's effect cancels the Tide on the first half of the decelerating cycles, it is as if the tide does not exist; but the two effects add up during the second half of the decelerating cycle.



Graph 5 – The angular acceleration change as a function of time due to the braking forces of the tidal friction and the Himalayan Mountain range on the Earth's rotation. The effect of the Mountain is added to that of the Tide on the first half of the accelerating cycles, but the Mountains cancel the Tide during the second half of accelerating cycles, it is as if the Tide does not exist.

In fact, the slope of the dashed lines on Graphs 4 and 5 is the angular deceleration, due to the ocean Tides cited by Stephenson et al. in **[25]** and continuous curves that are corresponding to decelerating and accelerating cycles due to the Himalayas' Mountains range. Except the point where $\delta\omega_{tot} = 0$ and its vicinity, the slope of the dashed line, due to the oceanic Tide is very small compared to the curve of angular speed change, due to the Mountain's forces. At point $\delta\omega_{tot} = 0$, the Mountain's effect cancels completely that of the Tide. Moreover, in the vicinity of this singular point, the two effects are comparable. In these circumstances, the effect of the Tides appears as background noise in comparison to that of the Himalayas' Mountains. At short-time scale, the Mountain's effect cancels the Tides; it is as if the Tide does not exist. Therefore, if the Mountains exist, they exist only to fill some important roles concerning the stability of the Earth's rotation motion.

5.3. Cyclically change in the angular speed of the Moon

Using again eq. 1 we deduce the expression for kinetic energy:

$$\frac{GMm}{2r} = \frac{mv^2}{2} = E_K \qquad \text{(eq. 21)}$$

As the Moon takes falls toward the Earth (*orbit's radius* decreases), then the left term of the eq. 21 increases and, therefore, the orbital tangential velocity v in the central term also increases, with kinetic energy E_K and vice-versa. It follows that angular speed ($v = r\Omega$) also varies so that we have:

$$\frac{d\Omega}{dt} = -\frac{3}{2}\frac{\Omega}{r}\frac{dr}{dt} \qquad \text{(eq. 22)}$$

Substitute each physical quantity by its value in eq. 22, we have:

$$\frac{d\Omega}{dt} = \pm\frac{3}{2}\times\frac{2{,}66\times10^{-6}\,\text{rad.s}^{-1}}{3{,}84\times10^{8}\,\text{m.s}^{-1}}\times181{,}35\,\mu\text{m/cycle}$$

$$\cong \pm8{,}72\times10^{-23}\,\text{rad.s}^{-2}$$

Thus, for decelerating cycles, we have $dr/dt > 0$ i.e., the angular speed Ω of the Moon decreases, and for

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

accelerating cycles dr/dt < 0, the angular speed of the Moon increases.

6. The Himalaya Mountains effect versus global climatic warming on the Earth's moment of inertia.

The warming of our planet and the melting of Ice Mountains could dilate the Earth's globe and thus decelerate its rotation motion because its moment of inertia changes like the ballet dancer or the skater, lifting their arms, decelerates. The consequence of this would be to lengthen the length of the day, knowing that it was measured in relation to the Sun, which was an independent "standard".

Suppose all the irregularities in the earth's crust (Mountains, bumps, hollows, etc.) have been flattened so that the Earth becomes a perfectly smooth sphere, since the Earth is a "very smooth" sphere like a "bed", water therefore covers the entire Earth's surface. It is assumed that the thickness of the water's layer thus formed is uniform. The physical system formed by Earth and water is also in the form of a sphere of radius R_M (maximum radius). The depth of the water layer will therefore be everywhere $R_M - R_t$ where $R_t = 6{,}371\times 10^3$ m. Let's ignore the effect of ocean tides and the mass of the atmosphere, the coefficient of the volume thermal expansion of water (soft) at a reference temperature 20°C is $\beta_v \sim 0{,}21 \times 10^{-3}$ K^{-1}. The initial volume of water is estimated at $V_0 = 1{,}35 \times 10^{18}$ m^3 which is equal to $1{,}35 \times 10^{21}$ kg at T = 20 °C. Using the known empirical dilatation formula $\Delta V = \beta_v V_0 \Delta T$, at T we have, $V = V_0$, and the volume for a global warming of the Earth of 5 °C, i.e., at T + 5 °C, we have V = 1,35122 × 10^{18} m^3**.** This volume will therefore be contained between the spheres of radius R_t (the smallest) and of radius R_M (the largest). The volume of a sphere of radius R is $4/3\pi R^3$. Then, at T, $R_M = 6{,}373645625 \times 10^6$ m and at T+5 °C, $R_M = 6{,}373648006 \times 10^6$ m. We therefore observe a depth of the oceanic water layer of 2645,625 m for T at 2648,006 m at T + 5 °C. So, the rise in sea level due to the planet's temperature increase of 5 °C is 2.38 m. The oceans occupy about 2/3 of the Earth's surface, and therefore the sea level should normally exceed this value. The moment of inertia J_0 of a hollow homogeneous sphere of small radius R_t, large radius R_M and density ρ with respect to one of its diameters is:

$$J_0 = \frac{8}{15}\pi\rho\left(R_M^5 - R_t^5\right)$$

At T, ρ = 1000 kg/m^3, the moment of inertia is equal to 3,6545850851 ×10 ^{34} kg.m^2. At T+5 °C, ρ = 999,1008093 kg/m^3, the moment of inertia is equal to 3,6545864507 ×10 ^{34} kg.m^2.

The moment of inertia J_t of a full homogeneous sphere of radius R_t, with respect to one of its diameters is $2/5MR^2$, and expressing there as a function of the density ρ of the earth, it becomes:

$$J_t = \frac{8}{15}\rho\pi R_t^5$$

The density of the earth will be taken as 5500 kg/m^3 and the moment of inertia of solid sphere is equal to 9,6727355744 × 10 ^{37} kg.m^2.

The sum of the moments of inertia of the earth and the spherical layer of ocean water is J_{tot} = 9,6763901595 × 10 ^{37} kg.m^2 at T and J_{tot} = 9,6763901608 × 10 ^{37} kg.m^2 at T + 5°C. In addition, the global mean surface temperature has increased by about 1 °C during the last two decades **[28]**. The moment of inertia change of the Earth is δJ = 2,7311560991 × 10 ^{27} kg.m^2 per 1°C. The positive sign of δJ means that the moment of inertia of the Earth increases with global warming. Substitute each physical quantity by its value once again in eq. 14, we obtain,

$$\frac{\delta\tau}{\tau} = \frac{2{,}7311560991\times 10^{27}}{9{,}6763901595\times 10^{37}} = 2{,}82\times 10^{-11}$$

The rate by which the length of the day is increased is δτ ~ 2.44 µs per 20 years or ~ 83.5 ps/cycle. As we can see, the rate due to global climate change is negligible compared to the rate due to the force's action of the Himalaya Mountains on the Earth which is 25 ns/cycle. Therefore, the effect of the Himalayan Mountains range alone can also hide the effect of global warming.

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

7. Discussion

Our hypothesis concerning the existence of a single Mountain on the Earth clearly shows (as it has never been done) that the forces of attraction between the Moon and a Mountain alone as small as it may be, would continually force the Earth's rotation to accelerate and decelerate twice a day and the Earth therefore vibrates; the Earth is destabilized by the Mountain's pressure force. Those perturbations of the Earth's rotation are instantly communicated to the Moon according to the conservation of angular momentum of the Earth-Moon system. On the short-time scale, the Moon will also vibrate. Thus, those lunar vibrations will retroactively destabilize the Earth's rotation. In the long term, these can cause the Earth to deviate far away from its orbit.

7.1 The Himalayas' Mountains cancels the effect of their antipode anomalies on the Earth's rotation motion

We have demonstrated above that the Himalaya Mountain range exerts a pressure force on the Earth and the existence of these Mountains alone destabilizes the Earth's rotation motion.

We have found that the distance between the Earth and the Moon varies making the Earth and the Moon vibrate. This vibration phenomenon of the Earth's rotation motion due to the pressure force of a single Mountain is not easy to detect by our sense organs. The biggest obstacle that prevents us from seeing the effect of a single Mountain is the fact that the Mountains that exist on Earth are numerous. There exists several thousands of Mountains on Earth and the sum of their effects on the Earth's rotation renders invisible the effect of any Mountain alone. Moreover, the shape of the Earth is not spherical, nor flat, not even ellipsoid, it is geoidieal. Anyhow, the matter is that Earth's crust also contains thousands of irregularities such bumps, valleys, hollows and fracture zones. Obviously, there should be an antipode mass for each Mountain that exists to balance the Earth's motion to keep it dynamically stable. In fact, the effects of all Mountains and their antipodes anomalies on the Earth's rotation motion almost cancel each other out. The sum of the Mountains and the anomalies effects on the Earth's rotation renders invisible the effect of any Mountain alone. This is the reason why the effects of Mountains are invisible to us. In this perspective, the Mountains play the role of the Earth's balancing corrective masses. The gravity center of the anomalies is the phase shifted by π on the location of the Mountain's center. The gravity center of the Himalaya's Mountains as Earth's balancing corrective masses is located at a position ($\theta + \pi$) from the antipode anomalies center, so that the sum of their angular momentums is constant as a function of time. In other words, the angular momentum of the system formed by the Mountains and their antipode anomalies remains conservative. Since all of the Earth's particles rotate at the same angular speed, the moment of inertia of the antipode anomalies must be equal to that of the Himalaya Mountains range even though their masses are not equal. Hence, the moment of forces of antipode anomalies should be written like eq. 7 above as:

$$\tau = \frac{3}{2}\frac{Gm\mu R^2}{r^3}\sin(2\theta + \pi) \qquad \text{(eq. 23)}$$

It follows therefore that the torque acting on the Earth which is the sum of the moments of the forces of the Himalayas' Mountains (eq. 7) and their antipode anomalies (eq. 23) is equal to zero. So we can write:

$$\tau_{tot} = 0$$

Therefore, a mass canceling out the effect of the Himalayan Mountain range on the Earth's rotation must exist somewhere in the Earth's crust. This mass is the Earth's balancing correcting mass like a wheel. The two masses, the Himalaya's Mountains range and its antipode anomalies, form a couple of two moments of their pressure forces whose effect of one cancels the effect of the other. As a result, we may state that Mountains have a decisive role in the stability of our planet.

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

7.2 The Mountains are gravitational pegs that stabilize the Earth's rotation motion

Our results allow us to postulate that, in general, the effects of the Mountains cancel the effects of their antipodes anomalies that exist in the Earth's crust, so the Earth's rotation movement appears relatively stable. In fact, for each anomaly or defect, there should be a compensation antipode Mountain somewhere in the earth's crust, which acts as the Earth's corrective balancing mass like a wheel which cancels out its disturbing effect. Nevertheless, the effects of Earth's irregularities on its rotation motion are not completely neutralized and their studies continue even today **[29,30].**

In general, the Earth's moment of inertia depends on the spatial masses distribution of Mountains and anomalies in the Earth's crust. To clarify more, let us imagine that a single Mountain among all the Mountains that exist on Earth is completely moved from a region where it exists, to another region of the earth's crust. Due to the displacement of this mass, the Earth's moment of inertia is changed a little bit. A uniform sea level decrease has been assumed in order to conserve water mass. If a second Mountain is moved from one region where it exists to another region, the Earth will be unbalanced a little more. If a third Mountain is moved; the Earth will be destabilized a little more strongly than before. If all the Mountains are moved one after another from the regions where they exist to some place on the earth's crust, and then the Earth will be greatly destabilized because those massive Mountain movements will change the Earth's moment of inertia very much. If the Mountains do not exist, then the Earth will remain without balancing masses and their antipodes anomalies will not be balanced and, as a result, the Earth will vibrate too much like an unbalanced wheel and in consequence, the Earth will fall to the Sun as it can move infinitely away from it. That's why the existence of Mountains on Earth is essential for the stability of the Earth's rotation movement even though their masses are very small compared to the mass of the Earth like wheel balancing corrective weights. There are thousands of Mountains on Earth. There are at least 108 Mountains with elevations of 7200 meters above sea level **[31]**. The vast majority of these Mountains are located on the edge of the Indian and Eurasian plate namely, in China, Pakistan, Nepal and India. The center of impact of the Himalaya Mountains range is located at (27° 59' 8.5" N, 86° 54' 58.8" E) and its impact antipode center is located at *(40° 41' 54.5" S, 106° 2' 54.8" E)*, near the Sala y Gomez Valvidia Fracture Zone (Fig. 4) **[32]**.

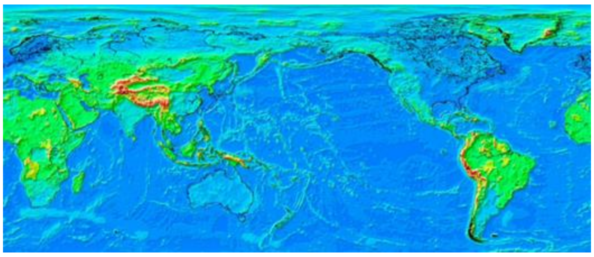


Figure 4 – The Himalayan Impact Antipode is placed at 40° 41' 54.5" S, 106° 2' 54.8" E, near the center of the Valvidia Fracture Zone.

The circle whose center this impact point and radius 20 km curves through Chile and Argentina Mountain range (see Fig. 5). Otherwise, if the Himalaya Mountain range exists where it exists, it is to play an extremely important role, the Himalayas play essentially the role of the Earth's balancing corrective masses like all other Mountains that exist on Earth. The moments of the forces of the Himalayas Mountains nullify out those of the Valvidia Fracture Zone and the Mountains of Chilie and Argentina. In addition, there are also 13000 seamounts taller than 1.5 km **[33,34]**. There are almost 33452 seamounts and 138412 knolls (height between 200 and 1000 m) **[35,36]**. Besides their role like any other irregularity of the seabed, such as islands and cliffs in the oceans acting as brakes that prevent the Tides from moving westward by a friction mechanism **[3]**, seamounts can also contribute as compensation antipode irregularities to the stability of the Earth's rotation motion.

Let us imagine then, that all the Mountains were brought together in a single region of the Earth's surface to form one, and then the Earth's center of


Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

gravity will no longer coincide with the axis of rotation, the Earth's moment inertia will no longer be the same and the Earth will skid. If the Earth presented a dynamic imbalance, this shows that the sum of the moments of the forces with respect to its center is not zero. As the position of the big Mountain changes each every half rotation, the Earth will swing diagonally left and right during its rotation. This imbalance communicates oscillations to the Earth which make it unstable. The Earth is outside of its dynamic equilibrium; it slows down then oscillates like a pendulum, under the effect of gravity, then finally stops. The large Mountain thus formed will stop at the point where the magnitude of the sum of all gravitational forces is greater.

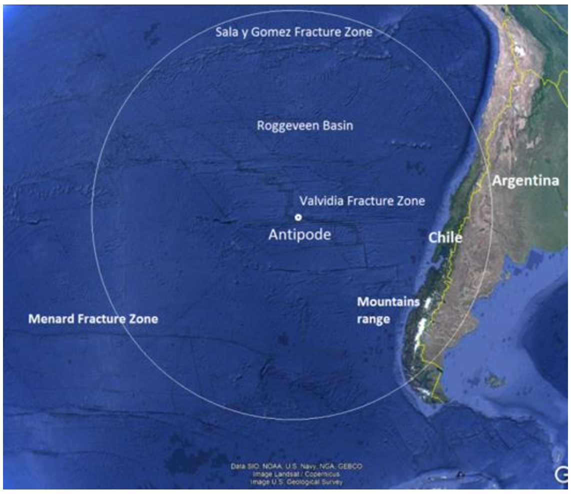


Figure 5: At 20 kilometers from the center of impact, this circle is formed. In the North is the Sala y Gomez Fracture Zone. The circle then curves through Chile and Argentina Mountains. The Himalayan Impact Antipode is placed at 41° 17.295'S 89° 59.304'W, near the center of the Valvidia Fracture Zone.

Anomalies and defects existed in the Earth's crust and the Mountains are the corrective masses which balance the Earth's anomalies and defects. Mountains are for the Earth what are balancing small corrective weights for a vehicle wheel. In this regard, an analogy between the Earth and the wheel of a vehicle is evident: the Earth's crust is the analogue of the tire, the continental mantle of the Earth and its core are the analogue of the wheel's rim, and the Mountains are the analogue of small wheel balancing masses, and the axis of rotation of the Earth is the analog of the vehicle hub. The role of the wheel balancing corrective weights is to eliminate vibrations of the vehicle's wheel. Various forces that perturb the Earth's rotation **[37,38]** are analogous of the friction of the wheel with rolling, asphalt and air. From this point of view, the Mountains thus, play the role of the small balancing masses of the dynamic equilibrium movement of the Earth, like the small balancing masses which used to balancing a wheel. The center of the mass of each Mountain, whether small or large, has its own trajectory which is in the form of a circle around the Earth's gravity center. It follows that circular paths of Mountains above the Earth's surface are greater than those of Mountains below sea level. Hence, the higher the height of a Mountain, the greater the moment of force, and its action on Earth is important. In addition, Mountains and their antipode anomalies centers of masses must always be diametrically opposite to each other about the center of masse of the Earth. Usually, the Earth is in a dynamic equilibrium because the sum of all dynamic moments due to all Mountain forces and their antipodes anomalies is zero. That is,

$$\sum_{i=1}^{N} \mathbf{L}_i = \sum_{i=1}^{N} \mathbf{r}_i \wedge m_i \mathbf{v}_i \approx \mathbf{Cste}$$

and hence, by using the Angular Momentum Theorem, the total torque

$$\sum_{i=1}^{N} \boldsymbol{\tau}_i \approx \mathbf{0}$$

The Mountains are the gravitational stakes of the Earth. They keep it in equilibrium because the sum of their angular moments with respect to the Earth's center of mass is constant, resulting in a dynamic global torque of zero.

Finally, the calculation that we have made in this paper is simplified. In a complete calculation, it is necessary to take into account the inclination of the Earth's rotation axis with respect to the perpendicular to the plane of the ecliptic which actually equals to ~

Emirati Journal of Space Science
Vol 1 Issue 1 (2023) 4 - 25
DOI: 10.54878/EJSS.287

Available at www.emiratesscholar.com

23°26', the action of the Sun's effect on the Mountains, the fact that the Earth revolves around the Sun and the Moon is moving on an opened helicoidally orbits following the Earth motion. We do not know how all the physical magnitudes that we have calculated will become when the calculation will be complete.

8.Conclusion

The aim of this paper was to study the Mountain's effects on the Earth's rotation motion. The prove related to the mountains as pegs stabilizers for the Earth that was being mentioned in the Quran was already reported in these papers**[39,40]**. Here in our article however, it was established that Mountains like gravitational pigs stabilize the Earth's rotation movement. The calculation is based mainly on the laws of the classical Mechanics. The physical system studied is the Himalayas' Mountains range. The obtained results show that the angular acceleration of the Earth's rotation varies as a function of time due to the moment of the pressure force of the Himalaya Mountains range. This acceleration variation led us to divide the LOD into four cycles of equal duration: two accelerating cycles of Earth's rotation motion and two decelerating cycles. The Earth's rotation is accelerated during accelerating cycles and decelerated during braking cycles.

The obtained amplitude of the angular acceleration which is $\sim 3.95 \times 10^{-21}$ rad.s^{-2} is much greater than that of the Earth's rotation due to the ocean Tides ($\sim -6.2 \times 10^{-22}$ rad/s^2). The distance between the Earth and the Moon varies also with an amplitude rate peak-to-peak of 181.35 μm/cycle, which means that the Moon will approach the Earth during accelerating cycles and moving away from it during decelerating cycles. The corresponding rate change in the length of day is 25 ns/cycle. Therefore, the Moon, like the Earth, can vibrate due to a single big Mountain. The obtained amplitude rate is about ~ 10 times greater than the short-term rate (~ 26 μm/cycle or equally 3,82 cm/yr) due to the global braking of the Earth's rotation motion. The short-term rate of the LOD due to global climatic warming (~ 83.5 ps/cycle) is also negligible compared to that, due to the pressure force's action of the Himalaya Mountains on the Earth (~25 ns/cycle). Therefore, the effect of the Himalayan Mountains range alone can hide equally the effect of global warming.

Our results show that a single Mountain, if it existed alone, will destabilizes enough the Earth and can hide completely the effects of all causes that affect the Earth's rotation motion. The biggest obstacle that prevents us from seeing the role that a single Mountain plays is the fact that the Mountains that exist on Earth are numerous. There exist several thousands of Mountains on the earth's crust and under the seas. The irregular Earth's crust contains also many anomalies and defects. The sum of the effects of Mountains and anomalies on the Earth's rotation motion renders invisible the effect of any Mountain alone. Thus, the Mountains and anomalies the one's effects cancel the others. If the Mountains did not exist, the Earth vibrated too much from the initial time of its existence like an unbalanced wheel that has many defects or like a tent without stakes, and then it fell on the Sun a long time ago. Mountains are therefore for the Earth what are balancing corrective weights for a wheel. Mountains are Earth's balancing corrective masses that cancel the Earth's antipode anomalies. Without the stabilizing role of Mountains, the dynamic equilibrium of the Earth will not exist. In summary, the Mountains with their roots are like gravitational pegs that stabilize the Earth's rotation motion. If it weren't for mountains, our planet wouldn't exist on its present orbit and could be an inert body orbiting far away somewhere in the Universe like many others.

References

[1] W. Zhang and W. Shen. New estimation of triaxial three-layered Earth's inertia tensor and solutions of Earth rotation normal modes. Geodesy nd Geodynamics **11**(**5**) (2020) 307-315.

[2] C.-E. Delaunay. Sur l'existence d'une cause nouvelle ayant une influence sensible sur l'équation séculaire de la Lune ». Comptes rendus des séances de l'Académie des Sciences, t. 61 (1865) 1023-1032.

[3] W. Hastie (tr. & ed. I. Kant, 1754). Examination of the Question whether the Earth has undergone an Alteration of its Axial Rotation. Kant's Cosmogony, Glasgow (1900) 1-11.

[4] A.Wegener. Die Entstehung der Kontinente. Geol. Rundschau, **3**(**4**) (1912) 276-292.

[5] A. Wegener. Die Entstehung der Kontinente und Ozeane. Braunschweig: Friedr. Vieweg & Sohn 1915.

[6] W. Bowie. Notes on the 'Roots of Mountains' Theory. Science, **63**(**1632**) (1926) 371-374.

[7] B. Gutenberg. Seismological evidence for roots of Mountains. Bulletin of the Geological Society of America **54** (**4**) (1943) 473-498.

[8] A. Cailleu. Anatomy of the Earth. New York: McGraw-Hill Book Company 1968.

[9] B. J. Skinner and S. C. Porter. The Dynamic Earth: An Introduction to Physical Geology. John Wiley & Son, New York 1992.

[10] K. Stuwe. Geodynamics of the Lithosphere. Springer-Verlag Berlin Heidelberg 2007.

[11] G. Hills. The Roots of Mountains. Geological Magazine, 81(2) (1944) 77-80.

[12] A. Whitchurch. Dense mountain roots. Sci. Lett. **361** (2013) 195-207.

[13] L. E. J. Evans, D. Cherrie, A. Tyler and L. Ingram. The Lunar Recession. J Phys Spec Top (2014) 1-2.

[14] Z. Kowalik and L J. John. Modern Theory and Practice of Tide Analysis and Tidal Power. Eden Hills, South Australia (2019).

[15] S.-H. Na, W. Shen, J. Cho, K. Seo, Y.-H. Shin, K.-D. Park, K. Youm and S.-M. Yoo. Earth rotation deceleration/acceleration due to semidiurnal oceanic/atmospheric tides: Revisited with new calculation. Geod. Geodyn. **10** (2019) 37-41.

[16] D. N. Wadia. The syntaxis of the northwest Himalaya: its rocks, tectonics and orogeny. Record Geol. Survey of India. **65**(**2**) (1931) 189-220.

[17] C. Liu, C. Huang and M. Zhang. The principal moments of inertia calculated with the hydrostatic equilibrium figure of the Earth. Geodesy and Geodynamics **8**(**3**) (2017) 201-205.

[18] J. H. Pratt. On the Attraction of the Himalaya Mountains, and of the Elevated Regions beyond Them, upon the Plumb-Line in India. Philosophical Transactions of the Royal Society of London **145** (1855) 53-100.

[19] H. Oman. Magnetic Braking of the Earth's Rotation. IEEE Aerosp. Electron. Syst. Mag. **4**(**4**) (1989) 3-10.

[20] E. Groten. Fundamental Parameters and Current (2004) Best Estimates of the Parameters of Common Relevance to Astronomy, Geodesy, and Geodynamics. J. Geod. **77** (2004) 724-797.

[21] Yu. V. Belashov. Changes of velocity of rotation of the Earth and its figure's deformation associated with them. Phys. Earth Planet. Inter. **307** (2020) 1-5.

[22] Y. H. Zhou, J. L. Chen and D. A. Salstein. Tropospheric and stratospheric wind contributions to Earth's variable rotation from NCEP/NCAR reanalyses (2000-2005) Geophys. J. Int. **174** (**2**) (2008) 453-463.

[23] R. D. Ray and G. D. Egber. Fortnightly Earth rotation, ocean tides and mantle anelasticity. Geophys. J. Int. **189** (2012) 400-413.

[24] J. Tyndall. Heat considered as a mode of motion. D. Appleton and Company, New York. (1867) 495-496

[25] F. R. Stephenson, L. V. Morrison and C. Y. Hohenkerk. Measurement of the Earth's rotation: 720 BC to AD 2015. Proc. R. Soc. A **472** (2016) 1-29.

[26] S. Adhikari, L. Caron, B. Steinberger, J. T. Reager, K. K. Kjeldsen, B. Marzeion, E. Larour and E. k R. Ivins. What drives 20th century polar motion. Earth Planet. Sci. Lett. **502** (2018) 126-132.

[27] L. Riofrio. Calculation of lunar orbit anomaly. Physics. Planetary Science **1,** 1 (2012) 1-4.

[28] C. Tian, X. Yue, H. Zhou, Y. Lei, Y. Ma, Y. Cao. Projections of changes in ecosystem productivity under 1.5 °C and 2 °C global warming. Glob Planet Change **205** (2021) 1-11.

[29] Z. Xu, K.-S. Chen and G. Zhou. Effects of the Earth's Irregular Rotation on the Moon-Based Synthetic Aperture Radar Imaging. IEEE Access **7** (2019) 155014 - 155027.

[30] F. Ambrosino, L. Thinová, M. Briestenský and C. Sabbarese. Anomalies identification of Earth's rotation rate time series (2012-2017) for possible correlation with strong earthquakes Occurrence. Geod. Geodyn. **10** (2019) 455-459.

[31] Wikipedia. List of highest Mountains on Earth. https://en.wikipedia.org/wiki/List_of_highest_Mountains_on_Earth**, visited in April 1, 2022.**

[32] Antipods Map, https://www.antipodesmap.com/ Consulted in April 10, 2022.

[33] S.-S. Kim and P. Wessel. New global seamount census from altimetry-derived gravity data, Geophys. J. Int. **186** (2011) 615-631.

[34] P. Wessel, D.T. Sandwell and S.-S. Kim. The global seamount census. Oceanography, **23**(**1**) (2010) 24-33.

[35] C. Yesson, M. R. Clark, M. L. Taylor and A. D. Rogers. The global distribution of seamounts based on 30 arc seconds bathymetry data. Deep Sea Research Part I: OceanoGraphic Research Papers, **58**(**4**) (2011) 442-453.

[36] S.D. Iyer, C. M. Mehta, P. Das and N. G. Kalangutkar. Seamounts - characteristics, formation, mineral deposits and biodiversity. Geological Acta 10(3) (2012) 295-308.

[37] K. Lambeck. Changes in length-of-day. N*ature*, vol. 286 (1980) 104-105.

[38] K. Lambeck, The Earth's variable rotation: geophysical causes and consequences. Cambridge University Press, (1980).

[39] MA Ibrahim**.** The mountain as stabilizers for earth from the quranic perspective. Proc. SOCIOINT 2019. 1231-1237.

[40] MA Ibrahim**.** Mountains as Stabilizers for Earth from the Quranic and Modern Science Perspectives. **IJASOS- I**nternational E-Journal of Advances in Social Sciences **5**(**15**) (2019), 1287-1292.

OTHOR'S BREIF BIBLIOGRAPHY.

Bendaoud SAAD, Ph.D. from Faculty of Science and Engineering-Laval University (Canada) in 1999 and M. Sc. & DEA from Liège Space Center and Institute of Physics - University of Liège (Belgium) in 1993-1995 and M. Sc. ès-sciences form Rabat sciences faculty - Mohammed V University in 1993 (Morocco). Professor and searcher from 1999 to 2007 at COPL-Laval university and CSTPQ-CEGEP de La Pocatière (Canada). Professor since 2007 until now at National School of Engineering Applied Sciences of Safi, Cadi Ayyad University (Morocco) .