# Mechanism for an all around crust equatorial shear

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## Abstract

Some geology and geophysics investigators have proposed, at the end of the 19th century (BIB. 1 and 2) disclosing evidences for it, that the Earth's crust had experienced, during the Mesozoic, an all around equatorial shear, that displaced the northern hemisphere westward relatively to the southern. During the 20th century, Prof. S. Carey (BIB. 3) and others (BIB. 4 and 5) reaffirmed the same proposition. However, no internal mechanism global-scale in range, has so far been advanced, to this author's knowledge, to justify it. This paper is an attempt, founded on the very effects of the Earth's rotation, respecting fundamentals, to prove that an equatorial shear stress, hence created, may account for the phenomenon, therefore providing an answer.

## Introduction

Mechanical effects of Earth's rotation, as evaluated by the tensor field it generates at the near surface atmosphere and at the oceans are long known. Through extrapolations depthwise this tensor field may also be evaluated at the base of the crust and at any Mantle level.

The field comes, at each level, from the tensor component along a meridian plane projected down by the centrifugal repulsion and the likewise component along a parallel plane linked to the Coriolis backward drag.

Due to the huge masses that can deeply be mobilized, very high forces enter the picture and shear stress concentrations in the thin Crust naturally arise. Tensors moduli are computed, their resultant paths plotted and global-scale shear locations justified.

## Parameters selection and evaluation

For an Earth shaped as an oblate ellipsoidal body, any meridian will have roughly for equation, the elipse

$$\left[\frac{R_\phi . \cos\phi}{6378}\right]^2 + \left[\frac{R_\phi . \mathrm{sen}\,\phi}{6357}\right]^2 \approx 1 \qquad (1)$$

(in kilometers, where $R_\phi$ is the radius vector and $\phi$ the latitude) and a parallel at latitude $\phi$, the circumference

$$x^2_\phi + y^2_\phi \approx R^2_\phi . \cos^2\phi \qquad (2)$$

The slow Earth's rotation, $w \approx 73 \cdot 10^{-6}$ rad/s, projects at its surface (h=0) or at any depth (h>0), the following pair of tensors: one, tangent to a meridian line, confined to the respective radial plane, directed from the poles to the equator ($M_{0,\phi}$, $M_{h,\phi}$) and the other, tangent to a parallel line, confined to the respective orbital plane, directed retrogradely to the planet's rotation, I.e. westwards, ($P_{0,\phi}$ , $P_{h,\phi}$).

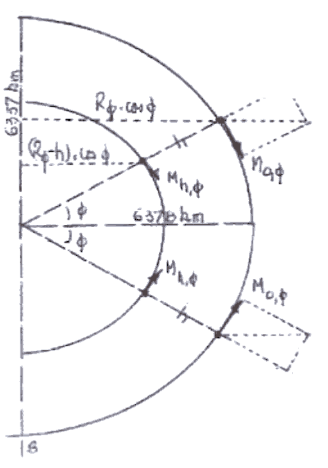



**Figure 1 : $M_{0,\phi}$ and $M_{h,\phi}$ loci in the Meridian plane**

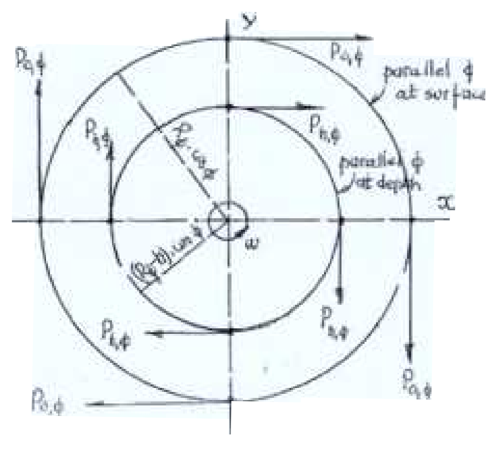



**Figure 2 : $P_{0,\phi}$ and $P_{h,\phi}$ loci in two parallel planes**

These tensors have for expression, respectively, $M_{0,\phi} = w^2 . R_\phi . \cos_\phi . \text{sen}_\phi = ½ w^2 . R_\phi . \text{sen}2\phi$

$M_{h,\phi} = ½ w^2 . (R_\phi - h) . \text{sen}2\phi$ (3)

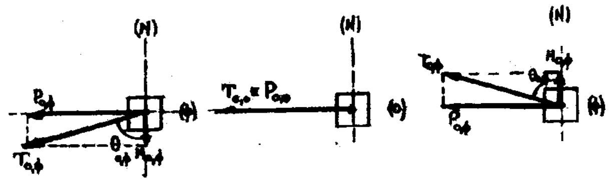
as tangencial components of the respective centrifugal repulsion, and

$P_{0,\phi} = 2w^2 . R_\phi . \cos\phi$

$P_{h,\phi} = 2w^2 . (R_\phi - h) . \cos\phi$ (4)

in accordance with the original Coriolis deduction.

They yield, then, at each point the resultant tensor $T_{0,\phi}$ whose construction is shown (vector-like, since $M_{0,\phi}$ and $P_{0,\phi}$ can only act on a common area, therefore in a shear fashion: see proof).



(at the N'ern hemisphere) (at the equator) (at the S'ern hemisphere)

Figure 3

Proof: if $M_{0,\phi}$ and $P_{0,\phi}$ where normal to their respective infinitesimal areas, then

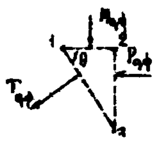


Figure 4

$T_{0,\phi} . \overline{13} = M_{0,\phi} . \overline{12} . \text{sen}\theta + P_{0,\phi} . \overline{23} . \cos\theta$, or

$T_{0,\phi} = M_{0,\phi} \overline{12}/\overline{13} . \text{sen}\theta + P_{0,\phi} \overline{23}/\overline{13} . \cos\theta =$

$= (M_{0,\phi} + P_{0,\phi}) . \frac{\text{sen } 2\theta}{2}$. It is known that at $\phi = 0$, $M_{0,0} = 0$ and $P_{0,0} = T_{0,0}$; in the above expression this would lead to sen2θ=2, which is impossible.

The following Table of Results summarizes, at 15° steps in latitude, tensors moduli and azimuths, at the surface and at 30, 700 and 3000 km in depth. The unit system is the CGS for tensors: they are in gals (or dynes/gram), instead of $cm/s^2$, to emphasize the fact that no free movements take place.

**Table of Resuts**

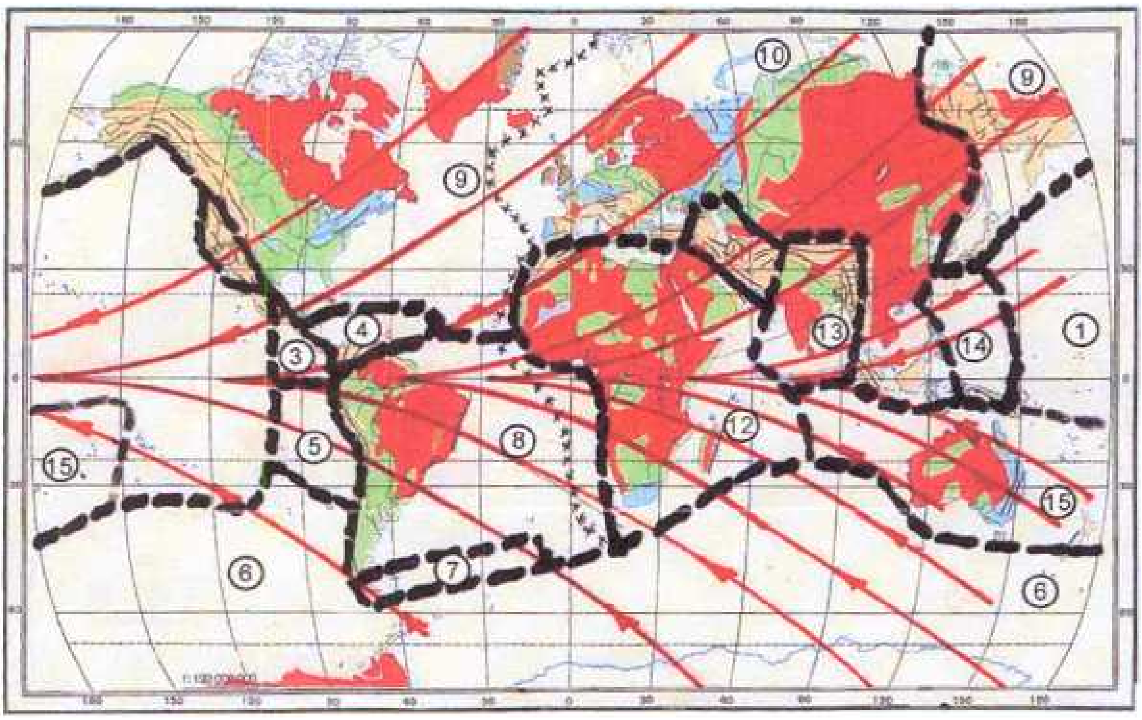
| | | at h=0 | | | | at h=30km | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (km) $R_\phi$ | (gal) $M_{0,\phi}$ | (gal) $P_{0,\phi}$ | (gal) $T_{0,\phi}$ | (°) $\theta_{0,\phi}$ | (gal) $M_{30,\phi}$ | (gal) $P_{30,\phi}$ | (gal) $T_{30,\phi}$ | (°) $\theta_{30,\phi}$ |
| 90 | 6357 | 0 | 0 | 0 | 63.4 | 0 | 0 | 0 | 63.4 |
| 75 | 6358 | 0.841 | 1.741 | 1.93 | 64.2 | 0.837 | 1.732 | 1.92 | 64.2 |
| 60 | 6362 | 1.457 | 3.365 | 3.67 | 66.6 | 1.450 | 3.338 | 3.64 | 66.6 |
| 45 | 6367 | 1.684 | 4.754 | 5.04 | 70.5 | 1.676 | 4.739 | 5.03 | 70.5 |
| 30 | 6373 | 1.459 | 5.838 | 6.02 | 76.0 | 1.453 | 5.810 | 5.99 | 76.0 |
| 15 | 6377 | 0.843 | 6.515 | 6.57 | 82.6 | 0.839 | 6.484 | 6.54 | 82.6 |
| 0 | 6378 | 0 | 6.746 | 6.75 | 90 | 0 | 6.714 | 6.71 | 90 |

| | | at h=700 km | | | | at h=3000 km | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\phi$ | (km) $R_\phi$ | (gal) $M_{700,\phi}$ | (gal) $P_{700,\phi}$ | (gal) $T_{700,\phi}$ | (°) $\theta_{700,\phi}$ | (gal) $M_{3000,\phi}$ | (gal) $P_{3000,\phi}$ | (gal) $T_{3000,\phi}$ | (°) $\theta_{3000,\phi}$ |
| 90 | 6357 | 0 | 0 | 0 | 63.4 | 0 | 0 | 0 | 63.4 |
| 75 | 6358 | 0.748 | 1.549 | 1.72 | 64.2 | 0.444 | 0.919 | 1.02 | 64.2 |
| 60 | 6362 | 1.297 | 2.994 | 3.26 | 66.6 | 0.770 | 1.778 | 1.94 | 66.6 |
| 45 | 6367 | 1.498 | 4.238 | 4.49 | 70.5 | 0.890 | 2.518 | 2.67 | 70.5 |
| 30 | 6373 | 1.299 | 5.196 | 5.36 | 76.0 | 0.772 | 3.090 | 3.18 | 76.0 |
| 15 | 6377 | 0.751 | 5.800 | 5.85 | 82.6 | 0.446 | 3.450 | 3.48 | 82.6 |
| 0 | 6378 | 0 | 6.006 | 6.01 | 90 | 0 | 3.573 | 3.57 | 90 |

Remarks: in this table, $\vec{T}_{h,\phi} = \vec{M}_{h,\phi} + \vec{P}_{h,\phi}$ ,or $T_{h,\phi}=(M^2_{h,\phi}+P^2_{h,\phi})^{1/2}$,is the resultant tensor and $\theta_{h,\phi}=\tan^{-1}.(P_{h,\phi}/M_{h,\phi})$; being $\theta_{h,90^\circ} = \tan^{-1}2 = 63.4^\circ$, its azimuth.

**Interpretation of Results– Final Remarks**

On the Geoid's surface (coordinates $0,\phi$) $T_{0,\phi}$ can be represented by the family of lines shown below (drawn unavoidably distorted due to the map's projection). At each line the azimuths ($\theta$) vary from 63.4° (at $\phi$ = 90°) to 90° (at $\phi$ = 0°) and the tensors moduli, respectively, from zero (0) to 6.75 gal; that pattern ought to repeat itself, undistorted, on the spheroidal surfaces below at 30,700 and 3000 km, since $T_{h,\phi}$ is, with due approximation, a lineal function of depth (h). At the near surface atmosphere and at the oceans being both fluid, free within limits to move, they do so accordingly to an imprint of $T_{0,\phi}$ on a broad scale. Deviations and discrepancies arise, due to temperature anomalies and physiographic irregularities both above and below sea level. This known correlation is, at this point, recalled to fundament what follows.




| | |
|---|---|
| Tensor $T_{0,\phi}$ loci continental plates;<br>➔ $T_{0,\phi}$'s paths<br>– – Plates approx. boundaries<br>* * * Mid Atlantic ridge | ① Pacific Ocean; ② Juan de Fuca; ③ Cocos; ④ Caribean;<br>⑤ Nazca; ⑥ Antarctic; ⑦ Scotia; ⑧ South American;<br>⑨ North American; ⑩ Eurasian; ⑪ Arabian;<br>⑫ African; ⑬ Indian; ⑭ Phillipinean; ⑮ Australian |

**Figure 5**

The map below is a reproduction of a set of major shears proposed by several authors The name "megashear" was used originally by S.Carey (BIB 3 ) to designate "a strike-slip fault whose horizontal displacement exceeds significantly the thickness of the crust" (sic); the largest would be the "Tethyan Shear System", near equatorially located and all around the Globe:

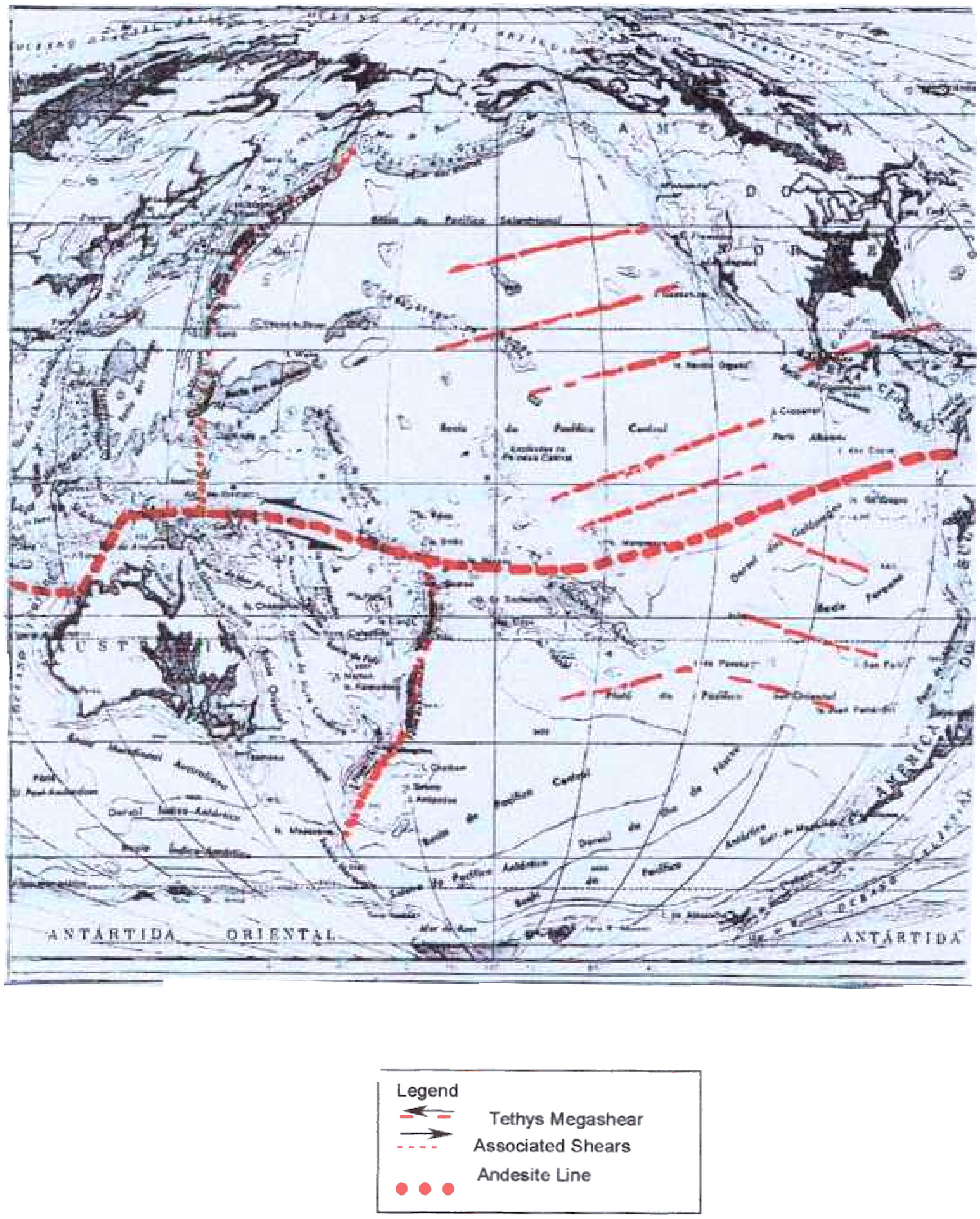
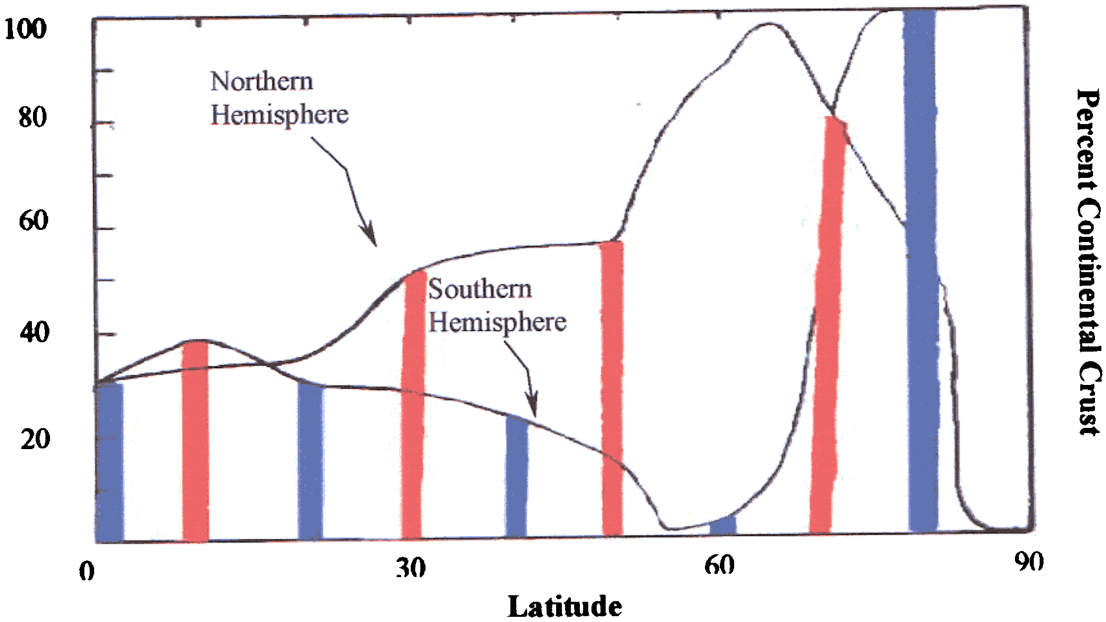



**Figure 6**

We concur with the assumption that continents are welded to their own Mantle: continental drifts are Mantle drifts. Tensors $T_{30,\phi}$ , $T_{700,\phi}$ or $T_{3000,\phi}$ line patterns are those of $T_{0,\phi}$, and they act drift-like, not push-like. It becomes, than, striking the fact that the most extensive shear be equatorial located, where $T_{h,0}$'s are maxima: being tensors, $T_{h,0}$ immediately at the northern side of the equator does not interfere either construtively-or not with $T_{h,0}$ at the southern surroundings; they should coexist. However, if the intervening masses differ, as apparently they do (see figure), the ensuing forces will also differ, and hence a shear stress, on a near 90° dip surface across the thin Crust, trending equatorially, would prevail. This fits the megashear geometry and justify it.




Figure

The magnitude of the associated stress, equatorially aligned, can be evaluated from the following fundamental relations:

➢ Driving forces ($f_N$ ,$f_S$) at each hemisphere, projectd at the equator,

$f_N \approx 2\pi * \bar{R}^2 * t_N * \delta * \bar{T}_{0,\phi} * \cos 70°$

$f_S \approx 2\pi * \bar{R}^2 * t_S * \delta * \bar{T}_{0,\phi} * \cos 70°$ (5)

where R is an average radius ≈ 6367 km ≈ 6367x $10^5$ cm; $t_N$ and $t_S$, average crust thicknesses at each hemisphere; δ, estimated crust mean density ≈ 2.8 g/cm$^3$; $\bar{T}_{0,\phi}$, average value for the resultant tensor at each hemisphere ≈ 3.5 cm/s$^2$; 70°, approximate mean angle between $\bar{T}_{0,\phi}$ and the equator line.

These forces act along the same westward direction at the equator, but being different in value (since $t_N > t_S$), the force differential $\Delta f = f_N - f_S$, divided by the common equatorial contact area(assumed with 90°dip), $S \approx 2\pi * R_0 * t_S$ will yield the acting differential shear,

$$➢ \quad \tau_s \approx (\Delta f/S) \approx \frac{2\pi * (6367*10^5)^2 * 2.8 * 3.5 \text{x} 0.342 * (t_N - t_S)}{2\pi * 6378 * 10^5 * t_S} \approx 2.13 * ((t_N/t_S) - 1) * 10^9 \text{ dynes/cm}^2 \qquad (6)$$

Now, from the geophysical literature (BIB.5) the average shear resistance of the rock-forming crust at depth may be taken between the limits

$0.14*10^9 \text{dynes/cm}^2 \leq \tau_r \leq 0.42 * 10^9 \text{ dynes/cm}^2$

and by assigning any of these possible ratios

$t_N/t_S = 1.10$ $\quad \tau_s \approx 0{,}21*10^9$ dynes/cm

$t_N/t_S = 1.15$ $\quad \tau_s \approx 0.32*10^9$ dynes/cm$^2$

$t_N/t_S = 1.20$ $\quad \tau \approx 0.43*10^9$ dynes/cm$^2$.

a favourable numerical credibility is achieved in support of this paper's thesis. Finally, it should be remarked that the equator line, as can be deduced by inspection of $T_{0,\phi}$ geometrical pattern, represents a hiatus in the N-S, or meridian transmission of $T_{0,0}$: this would indicate that the N'em hemisphere does not push against the S'em, or vice-versa, independently of any rock continuity they may possess.

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