Table 5. Cont'd 1.

Plate-pair	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AME-ANT					
Observed	3.30		-64	-73	
GB2M	2.60	0.79	-79.65	11.26	26.87
GB3M	0.35	0.10	-79.65	11.13	26.86
COC-AME					
Observed	17.3		27	-119	
GB2M	110.17	6.37	2.89	104.87	128.34
GB3M	21.96	1.27	2.28	104.78	128.66
NAZ-PAC					
Observed	14.6		59	-97	
GB2M	86.93	5.95	64.94	-56.08	48.05
GB3M	16.55	1.13	71.70	-56.40	47.97
EUA-PAC					
Observed	8.85		63	-90	
GB2M	29.41	3.32	51.44	-63.96	18.01
GB3M	5.87	0.63	50.60	-63.73	18.75
PAC-IND					
Observed	12.9		-58	174	
GB2M	49.39	3.38	-56.50	166.51	4.32
GB3M	9.86	0.76	-56.50	166.51	4.32

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LA THÈSE A ÉTÉ
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DRIVING MECHANISMS OF PLATE TECTONICS :

THE FORWARD PROBLEM

by

SIONG-SUI TIONG, B.S.E.

A thesis submitted to the Faculty of Graduate
Studies and Research in partial fulfilment
of the requirements for the degree of Master of
Science

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Ottawa, Ontario

March, 21 1980

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Siong-Sui Tiong, B.S.E., in partial fulfilment of the requirement
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Abstract

A simplified drag function with uniform viscosity (η) and asthenospheric thickness (δ), $F_d = -\frac{\eta}{\delta} V_p$, has been tested for the solution of the forward problem, using an eight-plate global model.

Preliminary testings show that the model based on $\eta = 10^{21}$ poise and $\delta = 400\text{km}$ gives the best agreement between the calculated and observed plate movements. Refinement of this model by including Arabia in the Eurasian plate and by reducing δ leads to significant improvement of the speed factors but not the pole positions. Further refinement involving a 20° clockwise rotation of the azimuths of the forces acting on Antarctic, Africa and Eurasian plates yields significant improvement of the pole positions of the all-continental plate-pairs. Thus the asthenospheric drag is not necessarily anti-parallel.

This study shows that the simplified drag function is a sufficiently good approximation for the solution of the forward problem.

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LIST OF SYMBOLS

dA	Area element of a plate.
$\vec{B}$	Net vertical body force acting on the slab due to gravity.
d	Depth of the tongue of a slab.
F	Total driving force.
F_{di}	Total drag force.
f_{di}	Drag force per unit area of the underside of a plate.
F_i	Force.
F_M	Force component along the tangential line of a latitudinal small circle.
F_P	Force component along the tangential line of a longitudinal great circle (or Meridian).
$\vec{F}_r$	Total ridge-push.
$\vec{F}_s$	Total slab-pull.
$\vec{f}_r$	Ridge-push per unit degree length of mid-ocean ridge.
$\vec{f}_s$	Slab-pull per unit degree length of subduction zone.
g	Acceleration of gravity.
h	Thickness of a plate.
I_{ij}	Inertia tensor.
I_{ij}^{-1}	Inverse of inertia tensor.
L_i	Angular momentum.
M_i	Moment of force.

SYMBOLS Cont'd

M_{di}	Drag moment.
r_i	Radius vector of F_i , drawn from the centre of the Earth.
V_{pi}	Plate velocity.
dV	Volume element of a plate.
Z	Misfit.
ϕ	Latitude.
λ	Longitude.
η	Viscosity.
ω_i	Absolute angular velocity.
ω_{Ai}	Absolute angular velocity of plate A
ω_{Bi}	Absolute, angular velocity of plate B.
ω_{Ci}	Absolute angular velocity of plate C.
ω_{AB}	Relative angular velocity between plates A and B.
ρ	Density.
θ	Azimuth of a force.
Θ	Dip of slab.
δ	Thickness of the asthenosphere.

CHAPTER I

Introduction

1. 1 Plate kinematics: Observed plate motion

The theory of plate tectonics regards the outermost shell of the Earth as consisting of a number of rigid lithospheric plates, bounded by mid-ocean ridges, transform faults, and trench-arc and orogenic systems. The plates are generated at mid-ocean ridges, and move slowly toward oceanic trenches where they sink into the upper mantle.

The relative motion of plates can be described in terms of simple rotations in accordance with Euler's theorem dealing with motion of rigid elements on the surface of a sphere (Bullard, Everett and Smith, 1965). A detailed kinematics of relative plate motions has been described by McKenzie and Parker (1967), Morgan (1968), LePichon (1968), Chase (1972), and Minster et al. (1974), among others. We can also consider plate movements in terms of absolute displacements with respect to a fixed frame of reference such as a supposedly stationary plate or a network of "hotspots" (Wilson, 1965; Morgan, 1971, 1972, 1973; Knopoff and Leeds, 1972; Burke and Wilson, 1972; Solomon and Sleep, 1974; Solomon et al. 1975, 1977). In such a system, the plates are moving with respect

to the underlying rigid lower mantle.

1. 2 Plate dynamics: The driving mechanism

Forces of two major types have been proposed driving the plates: convection currents in the mantle, and plate boundary forces.

In the convection hypothesis, a plate is carried passively on the top of a convection cell. The condition for the onset of thermal convection was derived by Rayleigh in 1916, when discussing Benard's observation that paraffin, when heated on top of an iron cylinder, did not start convecting until the depth of the liquid and the temperature gradient reached certain values. Rayleigh's conclusion was that the quantity R

$$R = \alpha \beta g H / K \eta$$

where H = depth of the liquid

α = coefficient of thermal expansion

β = temperature gradient (superadiabatic)

g = acceleration of gravity

K = thermal diffusivity

η = viscosity

must first reach a critical value before convection can begin.

As applied to the Earth, the nature of convection has come into sharper focus, as the views first expressed by Holmes (1928) and Griggs (1939) were modified by those of Dietz (1961), Hess (1962), Wilson (1963) and Runcorn (1962), leading finally to those presented by the proponents of plate tectonics (Mckenzie and Parker, 1967; Morgan, 1968, LePichon et al., 1968, and others).

Our attempts to understand plate dynamics in terms of mantle convection are hampered, however, by the intrinsic complexity of thermal convection and by our lack of knowledge of the relevant material parameters and boundary conditions. Takeuchi and Sakata (1970) have described mantle-wide convection in a model where the mantle is composed of a low-viscosity asthenosphere overlying a high-viscosity lower mantle. In their model, there is a one-way transport in the upper, less viscous layer of the mantle, while the return flow occurs, in a more diffuse way, in the underlying high-viscosity layer. In a more recent study, based on consideration of chemical differences, phase-transitions, the rheology of the mantle and seismological evidence, Davies (1977) concluded that the whole mantle has approximately constant viscosity and therefore is involved in motions related to plate tectonics.

The two most important plate-boundary driving forces are slab-pull and ridge-push. In the steady state, they are postulated to be in equilibrium with the viscous drag exerted on the plate by

the underlying asthenosphere. The origin of slab-pull and ridge-push forces is essentially gravitational (Jacoby, 1970). There must be a return flow in the mantle, resulting in a mass transport from trench to ridge, to counterbalance the mass transport from ridge to trench represented by the motion of the lithospheric plate and a certain volume of asthenospheric material dragged along by the plate.

Chapple and Tullis (1977) have recently made quantitative estimates of the pull exerted on the moving plate by the relatively cool, and thus dense, slab of lithosphere descending into the mantle underneath an oceanic trench (McKenzie, 1969; Minear and Toksöz, 1970). Various authors have also assessed this force (e.g. Lliboutry, 1969; Jacoby, 1970; Artyushkov, 1973; Richter, 1973 ; Forsyth and Uyeda, 1975; Harper, 1975).

Ridge-push (i.e., the force due to the topographic elevation of a mid-oceanic ridge and to the gravitational sliding of young lithosphere off the flanks of the ridge) has been evaluated by such authors as Orowan (1964), Hales (1969), Lliboutry (1969), Jacoby (1970), Morgan (1970, 1972), Artyushkov (1973), Harper (1975), and Chapple and Tullis (1977).

1. 3 Objective of the present study

Attempts have been made to assess the relative importance of these boundary forces, and of the thermal convection, by solving the inverse and forward problems (Solomon and Sleep, 1974; Harper, 1975; Forsyth and Uyeda, 1975; Solomon et al., 1977; Chapple and Tullis, 1977). The forward and the inverse problems will be defined in the next chapter of this thesis. In his solution of the forward problem, Harper (1975) achieved a reasonably good fit between his results and the available observations, by assuming a large slab-pull, a much smaller ridge-push, and a viscosity-dependent value for the antiparallel asthenospheric drag.

The purpose of this thesis is to try to improve on Harper's (1975) model of plate-driving forces by solving the forward problem under various hypothetical force-systems and by comparing the computed plate velocities with the observed values. The same basic assumptions as in Harper are used.

CHAPTER II

Analysis2. 1 The inverse and the forward problem

There are two procedures to try to gain an understanding of the driving mechanisms of plate tectonics. One is the solution of the inverse problem, the other the solution of the forward problem. Idealised flow sheets for both types of problem are presented in Figure 2-1.

Basically, the inverse problem deals with the derivation of a system of driving forces from the observed relative motions of lithospheric plates. For this purpose, certain geometrical and mechanical assumptions are made, such as a fixed frame of reference and a global balance of moments. The observed relative velocities used in the solution of the inverse problem are derived from data such as those shown in Figure 2-1.

The forward problem refers to the derivation of predicted plate velocities from physical force models. To solve the forward problem, the expected (absolute or relative) velocities of the plates are calculated from a set of mechanical assumptions, including a global balance of moments, and using one or more force models. The calculated absolute or relative velocities are

Figure 2-1. An illustration of the inverse and forward problem.

then checked against the available observational data (Fig. 2-1). Many force models have been proposed; see for instance the works of Orowan (1965), Elsasser (1969), Lliboutry (1969), Jacoby (1970), Artyushkov (1973, 1974), Solomon and Sleep (1974), Harper (1975), Solomon et al. (1975, 1977), who based their estimates on the geometrical and geophysical properties of the plates and of the asthenosphere.

Forsyth and Uyeda (1975) solved the inverse problem by using a twelve-plate model. For reference they used the observed relative angular velocities according to Morgan (1973) and assumed the position of the Mid-Atlantic ridge to be fixed. They predicted the driving forces by correlating the absolute velocity and geometrical characteristics of each plate. A correlation was found between the absolute velocity and length of trench with subducted slab. This, however, does not imply that slab-pull is the only driving force of plate motions, because plates without downgoing slabs are also moving. Another of their conclusions is that the plates with the larger continental areas have the lowest absolute velocities. This inverse relationship between the velocity of a plate and its relative continental area was also noticed by Minster et al. (1974). Solomon et al. (1975), basing their calculation on one of the models of Minster et al and the relative angular velocities given by Chase (1972), found the same correlation. Perhaps the continental lithosphere is subject to a greater

mantle drag than oceanic lithosphere.

Chapple and Tullis (1977) used a hotspot reference frame and a twelve-plate model. Their conclusion is similar to that of Forsyth and Uyeda: a strong slab-pull is counterbalanced by a strong local resisting force, but little can be said about the magnitudes of the weaker forces acting on the plates.

Solomon and Sleep (1974), and Solomon et al (1975, 1977) solved the forward problem for absolute plate motions in an eleven-plate model, assuming the Pacific plate to be stationary. Solomon and Sleep (1974) proposed force models involving slab-pull and various linear combination of basal drag, sub-continental basal drag, and drag on the sinking slab. For the observed relative angular velocities they used as sources Chase (1972), Fitch (1972), and McKenzie and Sclater (1971). As it turns out, the absolute angular velocities calculated from these force models are very similar to one another and to the observed rates obtained by assuming a hotspot reference frame (Morgan, 1972, 1973; Minster et al., 1974). Therefore, little can be learned from them when it comes to the testing of various proposed driving mechanisms.

As the assumption of a linear rheology for the asthenosphere did not lead to solutions with good fits for the forward problem (Solomon and Sleep, 1974; Solomon et al., 1975), Solomon et al (1977) attempted

to use a non-linear relationship between stress and strain rate, namely

$$\dot{\epsilon} = \sigma A^n \quad (n > 1)$$

For a wide range of values of the exponent n ($1 < n \leq 5$; $-10 \leq n < -1$; $0 < n < 1$; $n \rightarrow \pm \infty$), angular velocities were predicted for each plate in a number of force models. However, in checking the results against the data of paleomagnetism, the computed angular velocities were found to conflict with those derived from observations.

Harper (1975) solved the forward problem to arrive at relative plate motions in an eight-plate model adopted from Chase (1972). In Harper's model, the controlling forces are slab-pull, ridge-push, and an asthenospheric drag force anti-parallel to the resultant of the former two. The magnitude, per unit of length, of the slab-pull is assumed to be approximately seven times that of the ridge-push in the case of a "typical" subduction zone. Harper's results - especially those of this "second approximation" which includes some modifications of the slab-pull for certain plates - when compared with observational data such as those of Chase (1972), show a fit which is tolerably good for the magnitudes of the plate velocities, but a much poorer fit for the pole position.

2.2 Harper's approach to the forward problem and some modifications

In this thesis, Harper's (1975) approach is followed with some modifications to be discussed later. The purpose of the work is to check whether this approach is sensitive enough to provide a useful means to test the proposed driving mechanism of plate tectonics.

First of all, Harper's analysis is reviewed in detail. We shall assume that the Earth is spherical, and use a Cartesian system of coordinates with the origin at the centre of the Earth. The axes X_1 and X_2 lie in the equatorial plane: X_1 pierces the surface of the globe at the intersection of the equator and the meridian of Greenwich; X_2 intersects with the surface in the equatorial plane at the longitude 90° east of Greenwich. The axis X_3 exits at the North Pole. The standard force of slab-pull per degree length of subduction zone is indicated by $\vec{F}_s$, while $\vec{F}_r$ represents the standard force of ridge-push per degree length of mid-ocean ridge. L_s is the length of the subduction zone and L_r the length of the mid-ocean ridge (both in degrees). $\vec{F}_s$ is the total slab-pull exerted on a plate, and $\vec{F}_r$ the total ridge-push. Hence

$$\begin{aligned}\vec{F}_s &= L_s \vec{F}_s \\ \vec{F}_r &= L_r \vec{F}_r\end{aligned}\tag{1}$$

(where the right-hand terms must be interpreted as summations if the plate boundary contains more than one segment of subduction and/or spreading). The total driving force acting on a plate is therefore,

$$\vec{F} = \vec{F}_s + \vec{F}_r \quad (2)$$

For any given plate boundary i (either ridge or trench), it will be assumed that the force acts at approximately the mid-point of the ridge or trench segment on the Earth's surface. Then the moment vector of the driving force acting on a given plate with respect to the centre of the Earth is given by

$$M_i = \sum r_i \times F_i \quad (3)$$

where r_i is the radius (or position) vector of F_i , as drawn from the centre of the Earth, and the summation is extended over the whole boundary of the plate.

The drag force, f_{di} , per unit area of the underside of a plate is defined by Harper (1975) as

$$f_{di} = -\eta v_{pi} \frac{6h + 4\delta}{\delta^2} \quad (4)$$

where η is the Newtonian viscosity of the asthenosphere, h the thickness of the plate, δ the thickness of the asthenosphere, and V_{pi} the velocity of the plate. In the derivation of equation (4) the velocity profile in the asthenosphere under a moving plate is considered to be parabolic, with the velocity of the layer in contact with the plate itself equal to that of the plate. The asthenospheric velocity will be zero at a certain depth below the plate, and below that depth a return flow is assumed.

The vector V_{pi} , representing the absolute linear velocity of the plate with respect to the rigid lower mantle, has the magnitude $\omega_i \times r_i$, where ω_i is the absolute angular velocity of the plate with respect to the deep mantle. Thus the total drag exerted on a plate is

$$F_{di} = \int_A \frac{\eta (6h + 4\delta)}{\delta^2} (\omega_i \times r_i) dA \quad (5)$$

where dA is the typical area element at the point $P_{(ri)}$ where the drag force acts, and the integral is extended over the area of the plate.

Because the model is based on the assumption that η , h and δ are constant, we can rewrite equation (5) as

$$F_{di} = \frac{\eta (6h + 4\delta)}{\delta^2} \int_A (\omega_i \times r_i) dA \quad (6)$$

The drag moment can be derived from the above:

$$\begin{aligned} M_{di} &= r_i \times F_{di} \\ &= \frac{\eta (6h + 4\delta)}{\delta^2} \int_A r_i \times (\omega_i \times r_i) dA \quad (7) \end{aligned}$$

Plate motions are steady over time scales of a few million years; therefore the moments of the driving and of the resisting forces must be equal, i.e.,

$$M_i = M_{di} \quad (8)$$

To express equation (7) in a more manageable form, use must be made of the concepts of angular momentum and of moment of inertia tensor (Thewlis, 1962). The total angular momentum of a lamina of unit density about the centre of the Earth can be defined as

$$L_i = \int_V [r_i \times (\omega_i \times r_i)] dV \quad (9)$$

where dV is a volume element of the plate. Expanding equation (9), the Cartesian components of angular momentum are seen to be

$$L_1 = \omega_1 \int (r_2^2 + r_3^2) dV - \omega_2 \int r_1 r_2 dV - \omega_3 \int r_1 r_3 dV \quad (10a)$$

$$L_2 = -\omega_1 \int r_2 r_1 dV + \omega_2 \int (r_3^2 + r_1^2) dV - \omega_3 \int r_2 r_3 dV \quad (10b)$$

$$L_3 = -\omega_1 \int r_3 r_1 dV - \omega_2 \int r_3 r_2 dV + \omega_3 \int (r_1^2 + r_2^2) dV \quad (10c)$$

Recalling the definition of inertia tensor (Thewlis, 1962)

$$I_{ij} = \begin{pmatrix} I_{11} & I_{12} & I_{13} \\ I_{21} & I_{22} & I_{23} \\ I_{31} & I_{32} & I_{33} \end{pmatrix} \quad (11)$$

where

$$I_{11} = \int_V \rho (r_2^2 + r_3^2) dV \quad (12a)$$

$$I_{22} = \int_V \rho (r_1^2 + r_3^2) dV \quad (12b)$$

$$I_{33} = \int_V \rho (r_1^2 + r_2^2) dV \quad (12c)$$

$$I_{12} = I_{21} = - \int_V \rho r_1 r_2 dV \quad (13a)$$

$$I_{13} = I_{31} = - \int_V \rho r_1 r_3 dV \quad (13b)$$

$$I_{23} = I_{32} = - \int_V \rho r_2 r_3 dV \quad (13c)$$

It is seen that equations (10) can be rewritten as

$$L_1 = I_{11}\omega_1 + I_{12}\omega_2 + I_{13}\omega_3 \quad (14a)$$

$$L_2 = +I_{21}\omega_1 + I_{22}\omega_2 + I_{23}\omega_3 \quad (14b)$$

$$L_3 = +I_{31}\omega_1 + I_{32}\omega_2 + I_{33}\omega_3 \quad (14c)$$

that is, in matrix notation with summation convention,

$$L_i = I_{ij} \omega_j \quad (15)$$

For a thin lamina of unit density, the angular momentum is

$$L_i = \int_A r_i \times (\omega \times r_i) dA \quad (16)$$

and, comparing equations (7), (15) and (16) we can write

$$M_{di} = \frac{\eta (6h + 4\delta)}{\delta^2} I_{ij} \omega_j \quad (17)$$

and equation (8) becomes

$$M_i = \frac{\eta (6h + 4\delta)}{\delta^2} I_{ij} \omega_j \quad (18)$$

In the following, we shall refer to (18) as Harper's equation.

Using this equation to predict the absolute angular velocity of a plate, we get

$$\omega_i = \frac{\delta^2}{\eta (6h + 4\delta)} I_{ij}^{-1} M_j \quad (19)$$

Harper (1975) and Jacoby (1970) assumed that the mantle return flow, necessitated by the mass transport in the form of the moving plate and the portion of the asthenosphere dragged along with it, would result in a parabolic velocity profile in the asthenosphere. A simplified form of the drag function is

$$F_{di} = - \frac{\eta}{\delta} V_{pi} \quad (20)$$

which has the advantage of containing one parameter (δ) less than equation (4) and which, for the same values of plate velocity, and of asthenospheric viscosity and thickness, gives values differing only slightly from those obtained from equation (4)

Equation (20) represents the drag in the simplest of the models proposed by Solomon et al (1975). If η and F_{di} are held constant, V_{pi} will show a linear decrease with depth. Below the depth of zero absolute velocity in the asthenosphere, return flow will occur, as shown in Figure 2-2. The return flow is assumed to be affecting the lower mantle and therefore involves a lower strain rate than the flow in the asthenosphere.

Thus, using equation (20) we arrive at the following expression for the angular velocity ω_1 of a plate:

Figure2-2. Velocity profiles within the upper mantle provided by Eq. 20.
The dotted line indicates the velocity profiles after Harper
(1975).

$$\omega_i = \frac{\delta}{\eta} I_{ij}^{-1} M_j \quad (21)$$

In this thesis, the computation of expected (or computed) absolute angular velocities will be based on the above equation. By definition, the expected relative angular velocity of a plate-pair A-B is

$$\omega_{ABi} = \omega_{Ai} - \omega_{Bi} \quad (22)$$

where ω_{Ai} and ω_{Bi} are the computed absolute angular velocities of plates A and B, respectively.

Comparisons will be made between computed and observed relative angular velocities of plate-pairs, and between the computed and actual positions of the pole of rotation of the plate-pair under consideration. The result of a velocity comparison will be expressed as a speed factor

$$SF = \frac{V_c}{V_o} \quad \left(\begin{array}{l} V_c \text{ computed velocity} \\ V_o \text{ observed velocity} \end{array} \right)$$

The differences in expected and observed pole positions will be referred to as the pole misfit and will be expressed in degrees of arc.

2. 3 Methods of solution

To solve equation (21) for ω_i , it is first necessary to calculate M_j and I_{ij}^{-1} for each plate. The procedure is outlined in the sequel.

The magnitudes of the two principal forces, $\vec{F}_s$ and $\vec{F}_r$, which we assume to be the only driving forces acting on a plate, can be calculated according to the following procedure.

If we seek to know the magnitude of the horizontal pull exerted on the plate by the sinking slab, then, according to Jacoby (1970), this pull per unit breadth of subduction zone is

$$\vec{F}_s = \vec{B} \sin\theta \quad (23)$$

where θ is the dip of the slab (measured from the horizontal), and $\vec{B}$ the net vertical body force acting on the slab due to gravity:

$$\vec{B} = h \frac{d}{\sin\theta} \Delta\rho g \quad (24)$$

In the above equation, $\Delta\rho$ is the density contrast between lithosphere and asthenosphere, g is gravity, h is the thickness of the slab, and d is the depth to which the tongue of the slab has gone down into the asthenosphere. Harper (1975), basing his estimate on work by Isacks and Molnar (1969) and Hatherton (1970), assumed $\Delta\rho$ to be 0.05 g cm^{-3} , h to be 50 Km, and d to be 300 Km

(see also Forsyth and Uyeda, 1975). The acceleration of gravity is approximately 10^3 cm sec^{-2} over the depth range where the slab-pull is generated. Thus, Harper arrived at his standard value of slab-pull of $7.5 \cdot 10^{15} \text{ dyne cm}^{-1}$ per unit width of subducting plate margin. Mackenzie (1969) and other authors arrived at similar values, Jacoby (1970), at a slightly higher value. We thus adopt the value given by Harper and others, as a good order of magnitude.

The ridge-push, $\vec{f}_r$, per unit length of active mid-ocean ridge, can be calculated in different ways. For instance, Jacoby (1970) and Artyushkov (1973) have used an inclined and flat bottom of ridge, respectively, to calculate it. The ridge-push is due to two factors: (1) the topographical elevation of the ridge above the rest of the ocean floor, and (2) the sliding of young lithosphere off the flanks of the bulge in the upper mantle caused by the locally higher temperature, and therefore lower density of the mantle material. Harper (1975), working on the assumption that the density contrast between lithosphere and asthenosphere varies linearly from 0 at the bottom of the lithosphere to 0.1 g cm^{-3} at the top, obtained the value of $1.07 \cdot 10^{15} \text{ dyne cm}^{-1}$ for the ridge-push per unit width of spreading plate margin. This is the value adopted in this thesis.

Once unit slab-pull, $\vec{f}_s$, and unit ridge-push, $\vec{f}_r$, are known,

we can obtain the total slab-pull, $\vec{F}_S$, and the total ridge-push, $\vec{F}_R$, on any plate by application of equation (1), using the values of L_S and L_R that we calculate by studying the geometry of the plate boundaries.

The computation of the absolute angular velocity ω_i of a plate requires knowledge of the resultant moment vector M_i of the driving forces (see equation 3).

From the definition of a vector cross-product we obtain the expressions

$$M_1 = r_2 F_3 - r_3 F_2 \quad (25a)$$

$$M_2 = r_3 F_1 - r_1 F_3 \quad (25b)$$

$$M_3 = r_1 F_2 - r_2 F_1 \quad (25c)$$

where r_i and F_i are the Cartesian components of radius vector and force.

To find r_1 , r_2 , r_3 , and F_1 , F_2 , F_3 , we introduce a spherical coordinate system where r_i is defined by the radius r , the latitude ϕ , and the longitude λ (see Figure 2-3). The Cartesian components of r_i are

Figure 2-3. Cartesian (X_1, X_2, X_3) and spherical (r, ϕ, λ) coordinate system.

$$r_1 = |r_i| \cos\phi \cos\lambda \quad (26a)$$

$$r_2 = |r_i| \cos\phi \sin\lambda \quad (26b)$$

$$r_3 = |r_i| \sin\phi \quad (26c)$$

where $|r_i| = 6,371$ Km, and ϕ, λ are obtained from the geometry of plates (forces are assumed to act at the centre of the relevant plate boundary).

To derive F_1, F_2, F_3 , we assume that the ridge-push or the slab-pull acts on the boundary of the plate in a direction tangential to the surface of the Earth, and perpendicular to the strike of the plate boundary with which it is associated. Figures 2-4 to 2-7 illustrate the way in which the three components of such a force in the Cartesian coordinate system can be expressed in terms of r, ϕ, λ , and the azimuth angle θ . The sign convention for azimuth is that a force in a direction due north is assigned the azimuth 0, any westerly deviation is positive, and any easterly deviation is negative.

The expressions for the three components of F_i are:

$$F_1 = |F_i| (\sin\theta \sin\lambda - \cos\theta \sin\phi \cos\lambda) \quad (27a)$$

$$F_2 = -|F_i| (\sin\theta \cos\lambda + \cos\theta \sin\phi \sin\lambda) \quad (27b)$$

$$F_3 = |F_i| \cos\theta \cos\phi \quad (27c)$$

Figure 2-4. An illustration of the exertion of a driving force (F) on a plate boundary, where λ is longitude, ϕ latitude, and θ the azimuth.

Figure 2-5. An illustration of the distribution of the force components over the tangential plane of the acting point $P(r)$.

Figure 2-6. An illustration of the distribution of the force components over the longitudinal plane of the acting point $P(r)$.

$$\begin{array}{l}
 F_1 = F_1' + F_1'' \\
 F_1' = F_p \sin(-\lambda) = F \sin \theta \sin \lambda \\
 F_1'' = F_{12} \cos(-\lambda) = -|F| \cos \theta \sin \phi \cos \lambda \\
 F_2 = F_2' - F_2'' \\
 F_2' = F_p \cos(-\lambda) = -|F| \sin \theta \cos \lambda \\
 F_2'' = F_{12} \sin(-\lambda) = F \cos \theta \sin \phi \sin \lambda
 \end{array}$$

Latitudinal
small circle ($-\phi$)

Figure 2-7. An illustration of the distribution of the force components over the latitudinal plane of the acting point $P(r)$.

The appropriate multiplications (eqns 25, a, b, c) now yield the components of moment of the driving forces.

The next step is the calculation of the inertia tensor, I_{ij} , for each of the plates. This is done by numerical integration. We consider the plate as a thin lamina, since lithospheric density and thickness do not enter the basic equation, while area does. Accordingly, equations (12) and (13) can be simplified to:

$$I_{11} = \int_A (r_2^2 + r_3^2) dA \quad (28a)$$

$$I_{22} = \int_A (r_1^2 + r_3^2) dA \quad (28b)$$

$$I_{33} = \int_A (r_1^2 + r_2^2) dA \quad (28c)$$

and

$$I_{12} = -\int_A r_1 r_2 dA \quad (29a)$$

$$I_{13} = -\int_A r_1 r_3 dA \quad (29b)$$

$$I_{23} = -\int_A r_2 r_3 dA \quad (29c)$$

For our calculation, we used area elements measuring 10×10 degrees. For the large plates, most of these elements would fall entirely within the boundaries of the plate concerned. Where elements were straddling a boundary, an estimate was made of the fractions of the element belonging to either plate, and of the position of the mass centres of both fractions. (The mass centre is the endpoint of the

position vector for a given element.) Then the nine components of the inertia tensor are calculated for each element or fractional element belonging to a plate, and the inertia tensor of the plate is obtained by addition. Subsequently, the inverse of the inertia tensors, for use in equation (21), are calculated leading to the three components of the angular velocity of the plates. A more detail description of this procedure is given in Appendix A.

The boundaries of the plates, as used in the calculation of their inertia tensors, are those by Harper (1975). Complicating circumstances are the small-scale maps used, the absence of a sufficiently closely spaced latitude-longitude grid, and the rather arbitrary partition of Arabia between the African and the Eurasian plates. The first two difficulties were overcome by consulting large-scale maps of the oceans and continents; the third problem will be discussed in the next chapter.

After computation of the expected absolute angular velocity of each plate by means of the modified Harper equation (21), the relative angular velocities of the various relevant plate-pairs can be found by vector subtraction. Once the three orthogonal components of the relative velocity are determined in this way, the magnitude of the resultant relative angular velocity is

$$|\omega_{ABi}| = (\omega_{AB1}^2 + \omega_{AB2}^2 + \omega_{AB3}^2)^{1/2} \quad (30)$$

The latitude ϕ_{AB} and longitude λ_{AB} of the relative pole of opening are calculated from

$$\sin \phi_{AB} = \frac{\omega_{AB3}}{|\omega_{ABi}|} \quad (31a)$$

$$\sin \lambda_{AB} = \frac{\omega_{AB2}}{|\omega_{ABi}| \cos \phi} \quad (31b)$$

$$\text{or} \quad \cos \lambda_{AB} = \frac{\omega_{AB1}}{|\omega_{ABi}| \cos \phi} \quad (31c)$$

Figure 2-8 illustrates the way in which equations (31a,b,c) are derived. (The same is valid for the absolute poles of openings, derivable from computed absolute velocities rather than relative ones.)

Calculation of the speed factor is now a matter of dividing the computed relative angular velocity, $|\omega_{ABi}|$, of the plate-pair A-B, by the observed relative angular velocity

$$SF = \frac{|\omega_{ABi}|}{|\omega_{ABi}|_{\text{obs.}}} \quad (32)$$

Finally, the misfit between the position of the computed pole of opening and the observed pole position can be expressed as an angle Z , with its vertex at the centre of the Earth, and subtended

Figure 2-8. An illustration of the way in which equations 31 (a,b,c) are derived.

by the arc between the two pole position, which is calculated as follows (Maling, 1973):

$$\cos Z = \sin \phi_o \sin \phi_c + \cos \phi_o \cos \phi_c \cos(\lambda_c - \lambda_o) \quad (33)$$

where the subscripts o and c stand for observed and computed, respectively.

2. 4 Asthenospheric models

The physical properties of the asthenosphere make this layer the most important unit when studying the global dynamics. We have therefore focussed our study on the uppermost 400 Km of the mantle, although the possibility of a mantle-wide mass transport is by no means ruled out. Therefore, in most models consideration of the mantle is restricted to the uppermost 400 Km. Viscosities in the asthenosphere are assumed to range from 10^{19} to 10^{21} poise, and for the whole mantle a value of 10^{22} poise will be adopted. The estimate for the asthenosphere is based on studies of post-glacial rebound phenomena and on extrapolation of the rheological properties of olivine (Artyushkov, 1971; Lliboutry, 1971).

According to Knopoff (1972), Alexander (1974) and Ranalli (1979), the viscosity of the asthenosphere under continents may be higher

than that under oceanic plates. Also, the thickness of sub-oceanic asthenosphere may be different from that of sub-continental asthenosphere. These differences are reflected in some types of models to be presented.

The models designed may be grouped into two main types, here designed as group GA and group GB. The models of group GA involve uniform asthenospheric drag on all moving lithospheric plates. This group is made up of models based on varying combination of η and δ , as shown in the following table:

Model	η , poise	δ , Km
GA1	10^{19}	100
GA2	10^{20}	200
GA3	10^{21}	400
GA4	10^{22}	1000

We have used the combinations of low η associated with low δ , since the viscosity is proportional to the thickness of the asthenosphere as can be seen from glacial rebound studies.

Group GB is characterized by a thinner asthenosphere of higher viscosity under continental plates, compatible with the greater

thickness of the continental lithosphere and lateral variations in the geothermal gradient. This group consists of the following models:

Model	η_o , poise	η_c , poise	δ_o , Km	δ_c , Km
GB1	10^{19}	10^{20}	100	100
GB2	10^{20}	10^{21}	300	100
GB3	10^{21}	10^{22}	400	200

(Several more refined models will be discussed in Chapter 3.)

In our study we adopt the eight-plate global model as used by Harper (1975) after Chase (1972) (see Figure 2-9). The eight major plates are

Antarctic (ANT)	The Americas (AME)
Pacific (PAC)	Eurasian (EUA)
Indian (IND)	Nazca (NAZ)
African (AFR)	Cocos (COC)

The force controlling the motions of these plates are slab-pull and ridge-push, balanced by the antiparallel asthenospheric drag force.

Figure 2-9. Major plates considered in this study, on Mercator projection.

Plate boundaries marked by heavy lines: double for spreading centres, single for transform faults, cross-hatched for subduction zone. After Chase (1972).

CHAPTER III

Results, Discussion and Conclusions3. 1 Results and discussion for model GA and GB

The inertia tensors of the eight plates and the inverses of these tensors are shown in Table 1. They have been calculated according to equations (28a,b,c) and (29a,b,c). Also shown there are moments of force on the various plates as calculated from equation (25a,b,c). These moments are normalized by the given units of $5.3 \cdot 10^{31}$ dyne cm so that a "square" $10^\circ \times 10^\circ$ centred at the equator has unit moment about the polar axis. Since some plates are small, and a small error in the positions of the forces acting on it will cause a large error in the computed angular velocities, some calculated moments have been modified (e.g. halved for IND, NAZ, the Caribbean and South-Sandwich components of AME plates, and reduced for COC plate). The modifying procedure is based on the relationship between slab-pull per unit breadth and the thickness, length, velocity of a plate, depth to which the subduction zone extends as well as the times required for a point on the plate to cross it. As a result, the driving force per unit breadth is proportional to $L^{2/3} d^{2/3}$, where L is the length of plate, d depth of subduction zone. Thus, for instance, since L for the Cocos plate is about one-tenth of the Pacific plate, while

d has similar values, and so the driving force on Cocos plate would be only $10^{-2/3} = 0.217$ times as strong. Consequently, moments for COC, IND, NAZ as well as AME plates must be changed (Harper, 1975).

Table 2 summarizes the components of the absolute angular velocities as computed from equation (21). Table 3 shows the components of relative angular velocities of plate-pairs as computed from equation (22).

Table 4 is a comparison between relative angular velocities derived from equations (30) and (33) for all plate-pairs, and the observed relative velocities obtained by Chase (1972) for plate-pairs for which he had a reasonable number of measurements of displacement rates as well as of directions. A comparison between observed and calculated pole positions is also shown. The stability of pole misfit, no matter how different the expected velocity, is a consequence of the fact that the various combinations of η and δ affect every component of velocity in the same way, so that the magnitude of ω changes but not its direction.

Since, on tectonic grounds alone, it is difficult to decide whether the Arabian peninsula belongs to the African or to Eurasian plate, we have made two series of calculations (Table 1 to Table 4). The final choice

between the two was based on the goodness of fit between computed and observed values (the latter from Chase, 1972), as obtained for models of the groups GA and GB. It turns out that incorporation of Arabia into the African plate, with a northeastern boundary in the Zagros mountains, gives an improved fit of the relative velocities for only two plate-pairs. Incorporation of Arabia into the Eurasian plate leads to improvement for five plate-pairs. We will therefore consider Arabia to be part of the Eurasian plate with a southwestern boundary through the middle of the Red Sea.

From Table 4 it can be seen that the discrepancies between observed and calculated positions of pole of rotation for plate-pairs are different for group GA and group GB, although, of course, they remain unchanged where all-oceanic or all-continental plate-pairs are involved. (A plate was assigned " oceanic " or " continental " parameters according to the type of lithosphere occupying its major part.) For the mixed oceanic-continental pairs, however, the discrepancies are larger in group GB, with the single exception of the pair AME-PAC where the discrepancies in the GA models are some 60% larger than those in the corresponding GB models. The generally worse fit of the GB models is particularly obvious in pairs where larger oceanic plates, such as PAC or IND, are matched with large continental plates.

All in all, these results indicate that the assumption $\eta_o < \eta_c$ and $\delta_o > \delta_c$ (underlying group GB) generally results in a deterioration of the fit between theoretical results and observed, as far as pole position are concerned. The implication seems to be that the assumption of an uniform viscosity distribution in the asthenosphere is the better one.

We shall now review the computed relative velocities in more detail.

1. For models GA1, GA2 and GB1, the computed relative angular velocities are obviously much greater than the observed values. For GA1, the speed factor ranges from 20.99 (in the pair AFR-ANT) to 107.21 (for COC-NAZ). For GA2 the speed factor ranges from 4.19 to 21.44 , and for GB1 it ranges from 2.09 to 107.21. Thus, the assumptions of the uniform viscosity being equal to 10^{19} and 10^{20} poise for the asthenosphere as well as $\eta_o = 10^{19}$ poise and $\eta_c = 10^{20}$ poise for the sub-oceanic and sub-continental asthenosphere lead to poor results.
2. For the GB models, the relative angular velocities of all-continental plate-pairs are much lower than those of the mixed or the all-oceanic pairs, especially in models GB2 and GB3. For these two, the average speed factor in all-continental pairs is 0.30 (ranging from 0.49 to 0.20) in GB2, and 0.06 (ranging from 0.09 to 0.04) in GB3. In the all-oceanic pairs we find an

average speed factor of 18.16 (ranging from 9.98 to 32.16) for GB2, and 2.55 (ranging from 1.53 to 4.28) for GB3. In the mixed plate-pairs, we find an average speed factor of 14.47 (ranging from 9.06 to 29.67) for GB2, and 2.11 (ranging from 1.20 to 3.95) for GB3.

These excessive relative velocities of all-oceanic and mixed plate-pairs also point to the conclusion that the assumptions $\eta_o < \eta_c$ and $\delta_o > \delta_c$ are unsatisfactory. However, one could perhaps say that, admitting that $\eta_o < \eta_c$, the sub-oceanic asthenosphere is most sharply defined and therefore narrower ($\delta_o < \delta_c$). This of course would imply that the base of the asthenosphere is not at constant depth everywhere. The results based on this assumption (see Table 5, model GBM) show a relative improvement. Thus we may say that the basic equation (21) under the assumptions ($\eta_o < \eta_c$, $\delta_o < \delta_c$) generates better results but is still not satisfactory since the average speed factors range from 0.63 to 10.72 (i.e. model GB2M) and 0.08 to 2.14 (i.e. model GB3M). Furthermore, there is naturally no improvement in pole position discrepancies.

3. Model GA3 (the closest to Harper's model) shows the most reasonable rates of relative motion. The speed factors of all-continental plate-pairs, with the exception of EUA-AME, range from 0.84 to 1.26 (on the average, 1.06). It therefore seems that a viscosity of 10^{21} poise and an asthenospheric thickness of 400 Km are tenable.

In all-oceanic plate-pairs, the fit for the small pair COC-NAZ is excellent and the fit for PAC-IND is fair. Mixed plate-pairs also show satisfactory rates of relative motion. For instance, the speed factor of IND-ANT is 1.17 .

From the above consideration, we conclude that the assumption of $\eta = 10^{21}$ poise for the viscosity of the sub-continental asthenosphere is reasonable. The viscosity of the asthenosphere under the Pacific and Indian plates may also be 10^{21} poise but the thickness of the asthenosphere under the Indian plate may have to be modified somewhat in order to improve the fit of the relative velocities of that plate. Further, the viscosity and the thickness of the asthenosphere underneath the Cocos and Nazca plates are in accordance with the assumption.

3. 2 Other models

To improve the computed velocities, we modified our models by leaving viscosity constant and varying the thickness to obtain a satisfactory fit. The assumptions are as follows:

- (a) Arabia is included in the Eurasian plate.
- (b) Viscosity and thickness of the asthenosphere underneath the ANT, PAC, AFR, AME and EUA plates are assumed to be uniformly $\eta = 10^{21}$ poise, $\delta = 400$ Km.
- (c) The asthenosphere under the NAZ and COC plates is also assumed to have a viscosity of 10^{21} poise but is more

sharply defined, with a thickness of 100 Km, in accordance with the relative youth of these small plates.

- (d) Viscosity and thickness of the asthenosphere under the Indian plates are assumed to be $\eta = 10^{21}$ poise, and $\delta = 200\text{Km}$.

The model incorporating these new assumptions will be referred to as GC1. Table 6 lists the computed components of absolute angular velocities for this model, and Table 7 lists the relative angular velocities for the various plate-pairs. Table 8 gives the comparison between the computed and the observed values of relative angular velocity components.

As can be seen from Table 8, the relative rates of motion and also the pole positions show an improved fit where the Cocos, Nazca and Indian plates are involved. The average speed factors of model GC1 range from 0.73 to 1.18. The average disagreement in positions of the poles of rotation, as computed for model GC1 against the observed positions given by Chase (1972) is 36° .

The process of additional adjustments can be carried further, although of course there is no unique solution to the problem. As a further example, we introduce model GC2, with the following asthenospheric thickness (since there is an inverse relation between

computed angular velocities and asthenospheric thickness):

- (a) 100 Km for the asthenosphere underneath the EUA, NAZ and ANT plates;
- (b) 150 Km for that under the Cocos plate;
- (c) 200 Km for that under the Indian plate;
- (d) 300 Km for that under PAC and AME plates;
- (e) 400 Km for that under the African plate.

The viscosity of the asthenosphere is assumed to be uniformly 10^{21} poise, except for the Antarctic plate, for which it is set to 10^{20} poise. Although it would be difficult to justify the above values in geophysical terms, the model is introduced to show that the fit of the speed factor can be improved at will.

For model GC2, Table 9 lists the absolute angular velocities of individual plates, and Table 10 gives the relative velocities of plate-pairs.

From Table 11, which is again a listing of comparisons, we note that model GC2 has resulted in significant improvements over model GC1. The range of average speed factors is now between 0.87 and 1.17; as compared with that of 0.73 to 1.18 for GC1. If we disregard the pairs COC-PAC and COC-NAZ, the average speed factor for all excess velocities becomes 1.09 and the average speed factor for pairs showing velocity deficiencies 0.90 .

The previous results show that, while the speed factor can be made to approach unity, the misfit in pole position hardly varies, regardless of modifications in viscosity and asthenospheric thickness - a problem also faced by Harper (1975). The solution to the problem must, therefore, be sought in another area: that of force direction. Theoretically, the azimuth of a driving force is found by taking the normal to the plate boundary on which it acts. All our models are based on this assumption. Chase (1978) points out that only at fast-spreading boundaries (more than 3 cm year^{-1}) the direction of motion is more or less perpendicular (within 6.5°) to the trend of the boundary (i.e. the strike of the mid-oceanic ridge and magnetic anomalies). At more slowly spreading boundaries, associated with the slow-moving continental plates, deviations from this trend can reach about 20° . According to Chase, this is due to the oblique spreading in several segments of the world's rift system, which has been observed with regard to the trends of the magnetic anomalies. It is, therefore, clear that we can not hope to improve our computed pole positions by merely implementing modifications in asthenospheric properties, without involving force direction.

By assuming varying azimuths of the forces driving the four continental plates (viz. ANT, AFR, AME and EUA), and corresponding

resisting forces, we can obtain another sets of force models derived from model GC2. We shall designate this group as GD. Eight new models have been tried; starting from the azimuths assumed by Harper (1975), we have modified the directions of the driving forces in steps of 5 degrees at a time, counterclockwise as well as clockwise. The new models are numbered from GD1 through GD8, as illustrated in Figure 3-1.

Table 12 shows the recalculated moments of force on each plate for each of the GD models. Tables 13 and 14 list the corresponding absolute and relative angular velocities, and Table 15 gives the usual comparisons with the observed values as given by Chase (1972). A slight improvement in pole positions can be noted, as well as a slight further improvement of the velocities for ANT, AFR and EUA, when the azimuths of the driving forces are modified by 20° in a clockwise sense. For the Americas plate, no significant improvement in the pole positions can be achieved.

By starting from model GC and the new GD models, we finally try model GE1. This model is based on the same parameters as GC2, with exception of the driving forces acting on the plates ANT, AFR and EUA; these have all been rotated clockwise by an amount of 20° .

Figure 3-1. Directions of the acting forces for models GD1 to GD8.

Moments of force and computed absolute angular velocities for model GE1 are listed in Table 16. Table 17 shows the corresponding relative velocities for plate-pairs, and Table 18 demonstrates that these relative angular velocities do not significantly depart from the good values obtained on model GC2, but that the pole positions of the all-continental plate-pairs have been improved. As the azimuths of driving forces acting on oceanic plates were not modified, there is little improvement in the pole positions for oceanic-continental plate-pairs, with the exception of the pair IND-AFR.

3. 3 Conclusions

The simple theoretical models considered in this thesis provide a satisfactory goodness of fit between the magnitude of predicted and observed plate velocities. It appears that $\eta = \text{constant}$ and $\delta = \text{constant}$ are sufficiently good approximations; furthermore, the simplified relationship between the asthenospheric drag and the velocity of a plate, namely,

$$F_d = - \frac{\eta}{\delta} V_p$$

is acceptable, and therefore return flow in the upper mantle does not contradict the observations.

From the best-fitting results it is concluded that the viscosity of the asthenosphere can be assumed to be 10^{21} poise throughout; and that the thickness of the asthenosphere is 400 Km or less, throughout. The assumption of laterally varying η ($\eta_0 < \eta_c$) does not improve the fit.

Under the assumption that the driving forces are normal to the strike of plate boundary, viscosity and thickness of the asthenosphere affect only the magnitude of the relative velocity components but not the pole positions. Chase (1978) pointed out that the azimuth of the forces driving the slow-moving continental plates may deviate by some 20° from the normal to the boundary with which they are associated. Therefore, it is probable that the asthenospheric drag is not anti-parallel, at least in some cases. Further study along these lines may result in an improvement of pole fits.

The inherent limitations of the model are constant η and δ under each plate, and Newtonian viscosity in the asthenosphere. While it is possible to adjust these parameters, the remaining discrepancies require a new approach that would eliminate the need for the restrictive assumptions used in this study.

Table 1. Calculated inertia tensors (I), inverse tensors- (I⁻¹), and moment of force (M) on the various plates. Note: (i) and (ii) denote the results of incorporation of Arabian plate into the AFR or EUA plate, respectively.

Plate	I	I ⁻¹	M (5.3 · 10 ³¹ dyn cm)
ANT	$\begin{pmatrix} 44.2 & -1.4 & 2.0 \\ -1.4 & 39.0 & 2.4 \\ 2.0 & 2.4 & 12.1 \end{pmatrix}$	$\begin{pmatrix} 0.0228 & 0.0011 & -0.0041 \\ 0.0011 & 0.0260 & -0.0054 \\ -0.0041 & -0.0054 & 0.0845 \end{pmatrix}$	$\begin{pmatrix} 0.42 \\ -0.46 \\ 0.33 \end{pmatrix}$
PAC	$\begin{pmatrix} 42.6 & -11.9 & 3.4 \\ -11.9 & 69.1 & -3.1 \\ 3.4 & -3.1 & 72.7 \end{pmatrix}$	$\begin{pmatrix} 0.0247 & 0.0042 & -0.0010 \\ 0.0042 & 0.0152 & 0.0005 \\ -0.0010 & 0.0005 & 0.0138 \end{pmatrix}$	$\begin{pmatrix} -30.12 \\ 63.19 \\ -78.43 \end{pmatrix}$
IND	$\begin{pmatrix} 35.7 & 5.9 & -7.9 \\ 5.9 & 22.2 & 7.5 \\ -7.9 & 7.5 & 39.9 \end{pmatrix}$	$\begin{pmatrix} 0.0317 & -0.0112 & 0.0084 \\ -0.0112 & 0.0519 & -0.0120 \\ 0.0084 & -0.0120 & 0.0290 \end{pmatrix}$	$\begin{pmatrix} 26.33 \\ 21.56 \\ 26.79 \end{pmatrix}$
AFR	(i) $\begin{pmatrix} 24.6 & -10.2 & 1.0 \\ -10.2 & 52.8 & 3.0 \\ 1.0 & 3.0 & 57.8 \end{pmatrix}$	$\begin{pmatrix} 0.0441 & 0.0086 & -0.0012 \\ 0.0086 & 0.0207 & -0.0012 \\ -0.0012 & -0.0012 & 0.0174 \end{pmatrix}$	$\begin{pmatrix} 2.64 \\ -13.29 \\ 2.04 \end{pmatrix}$
	(ii) $\begin{pmatrix} 22.3 & -8.7 & 1.9 \\ -8.7 & 50.7 & 4.0 \\ 1.9 & 4.0 & 54.7 \end{pmatrix}$	$\begin{pmatrix} 0.0483 & 0.0084 & -0.0023 \\ 0.0084 & 0.0213 & -0.0018 \\ -0.0023 & -0.0018 & 0.0185 \end{pmatrix}$	$\begin{pmatrix} 2.64 \\ -13.29 \\ 2.04 \end{pmatrix}$

Table 1. Cont'd

Plate	I			I ⁻¹			M(5.3·10 ³¹ dyn cm)		
AME	64.3	14.4	6.3	0.0167	-0.0045	-0.0014	2.74		
	14.4	50.9	7.6	-0.0045	0.0213	-0.0027	-1.60		
	6.3	7.6	49.4	-0.0014	-0.0027	0.0209	-17.38		
EUA	48.7	3.7	-4.8	0.2090	-0.0009	0.0029	-5.58		
	3.7	38.7	-14.2	-0.0009	0.0313	0.0146	3.08		
	-4.8	-14.2	30.2	0.0029	0.0146	0.0404	2.70		
NAZ	51.1	2.2	-4.7	0.0200	0.0003	0.0035	-5.58		
	2.1	40.7	-15.2	0.0003	0.0296	0.0135	3.08		
	-5.7	-15.2	33.4	0.0035	0.0135	0.0367	2.70		
COC	11.9	-0.3	-0.1	0.0853	0.0379	0.0135	2.97		
	-0.3	2.0	-3.5	0.0379	1.2369	0.4192	-9.71		
	-0.1	-3.5	10.5	0.0135	0.4192	0.2376	27.90		
	2.7	-0.2	0.03	0.5097	1.9460	-0.2850	-4.38		
	-0.2	0.1	0.4	1.9460	26.9403	-3.8753	0.81		
	0.03	0.4	2.7	-0.2850	-3.8753	0.9305	2.17		

Table 2. Computed absolute angular velocity components of each plate for model A and model B. ($\omega \cdot 10^{-7} \text{ deg/yr}$)

Plate	GA1	GA2	GA3	GA4	GB1	GB2	GB3
ANT	$\begin{pmatrix} 1.549 \\ -2.889 \\ 6.233 \end{pmatrix}$	$\begin{pmatrix} 0.310 \\ -0.578 \\ 1.247 \end{pmatrix}$	$\begin{pmatrix} 0.062 \\ -0.116 \\ 0.249 \end{pmatrix}$	$\begin{pmatrix} 0.015 \\ -0.029 \\ 0.062 \end{pmatrix}$	$\begin{pmatrix} 0.155 \\ -0.289 \\ 0.623 \end{pmatrix}$	$\begin{pmatrix} 0.015 \\ -0.029 \\ 0.062 \end{pmatrix}$	$\begin{pmatrix} 0.003 \\ -0.006 \\ 0.012 \end{pmatrix}$
PAC	$\begin{pmatrix} -87.063 \\ 172.925 \\ -222.068 \end{pmatrix}$	$\begin{pmatrix} -17.413 \\ 34.585 \\ -44.414 \end{pmatrix}$	$\begin{pmatrix} -3.483 \\ 6.917 \\ -8.883 \end{pmatrix}$	$\begin{pmatrix} -0.871 \\ 1.729 \\ -2.221 \end{pmatrix}$	$\begin{pmatrix} -87.063 \\ 172.925 \\ -222.068 \end{pmatrix}$	$\begin{pmatrix} -26.119 \\ 51.878 \\ -66.620 \end{pmatrix}$	$\begin{pmatrix} -3.483 \\ 6.917 \\ -8.883 \end{pmatrix}$
IND	$\begin{pmatrix} 178.030 \\ 109.354 \\ 189.775 \end{pmatrix}$	$\begin{pmatrix} 35.606 \\ 21.871 \\ 37.955 \end{pmatrix}$	$\begin{pmatrix} 7.121 \\ 4.374 \\ 7.591 \end{pmatrix}$	$\begin{pmatrix} 1.780 \\ 1.094 \\ 1.898 \end{pmatrix}$	$\begin{pmatrix} 178.030 \\ 109.354 \\ 189.775 \end{pmatrix}$	$\begin{pmatrix} 53.409 \\ 32.806 \\ 56.932 \end{pmatrix}$	$\begin{pmatrix} 7.121 \\ 4.374 \\ 7.591 \end{pmatrix}$
AFR	(i) $\begin{pmatrix} -0.069 \\ -55.449 \\ 10.504 \end{pmatrix}$	$\begin{pmatrix} -0.014 \\ -11.090 \\ 2.101 \end{pmatrix}$	$\begin{pmatrix} -0.003 \\ -2.218 \\ 0.420 \end{pmatrix}$	$\begin{pmatrix} -0.001 \\ -0.554 \\ 0.105 \end{pmatrix}$	$\begin{pmatrix} -0.007 \\ -5.545 \\ 1.050 \end{pmatrix}$	$\begin{pmatrix} -0.001 \\ -0.554 \\ 0.105 \end{pmatrix}$	$\begin{pmatrix} -0.00012 \\ -0.109 \\ 0.021 \end{pmatrix}$
	(ii) $\begin{pmatrix} 2.433 \\ -57.565 \\ 12.095 \end{pmatrix}$	$\begin{pmatrix} 0.487 \\ -11.513 \\ 2.419 \end{pmatrix}$	$\begin{pmatrix} 0.097 \\ -2.303 \\ 0.484 \end{pmatrix}$	$\begin{pmatrix} 0.024 \\ -0.576 \\ 0.121 \end{pmatrix}$	$\begin{pmatrix} 0.243 \\ -5.756 \\ 1.209 \end{pmatrix}$	$\begin{pmatrix} 0.024 \\ -0.576 \\ 0.121 \end{pmatrix}$	$\begin{pmatrix} 0.005 \\ -0.115 \\ 0.024 \end{pmatrix}$

Table 2. Cont'd

Plate	GA1	GA2	GA3	GA4	GB1	GB2	GB3
AME	$\begin{pmatrix} 16.817 \\ 0.113 \\ -78.928 \end{pmatrix}$	$\begin{pmatrix} 3.363 \\ 0.023 \\ -15.786 \end{pmatrix}$	$\begin{pmatrix} 0.673 \\ 0.005 \\ -3.157 \end{pmatrix}$	$\begin{pmatrix} 0.168 \\ 0.001 \\ -0.789 \end{pmatrix}$	$\begin{pmatrix} 1.682 \\ 0.011 \\ -7.893 \end{pmatrix}$	$\begin{pmatrix} 0.168 \\ 0.001 \\ -0.789 \end{pmatrix}$	$\begin{pmatrix} 0.034 \\ 0.00022 \\ -0.158 \end{pmatrix}$
EJA	(1)	$\begin{pmatrix} -24.273 \\ 30.644 \\ 29.996 \end{pmatrix}$	$\begin{pmatrix} -4.855 \\ 6.129 \\ 5.999 \end{pmatrix}$	$\begin{pmatrix} -0.971 \\ 1.226 \\ 1.200 \end{pmatrix}$	$\begin{pmatrix} -0.243 \\ 0.306 \\ 0.300 \end{pmatrix}$	$\begin{pmatrix} -2.427 \\ 3.064 \\ 3.000 \end{pmatrix}$	$\begin{pmatrix} -0.243 \\ 0.306 \\ 0.300 \end{pmatrix}$
	(11)	$\begin{pmatrix} -22.024 \\ 27.402 \\ 26.358 \end{pmatrix}$	$\begin{pmatrix} -4.405 \\ 5.480 \\ 5.272 \end{pmatrix}$	$\begin{pmatrix} -0.881 \\ 1.096 \\ 1.054 \end{pmatrix}$	$\begin{pmatrix} -0.220 \\ 0.274 \\ 0.246 \end{pmatrix}$	$\begin{pmatrix} -2.202 \\ 2.740 \\ 2.636 \end{pmatrix}$	$\begin{pmatrix} -0.220 \\ 0.274 \\ 0.246 \end{pmatrix}$
NAZ	$\begin{pmatrix} 57.002 \\ -43.962 \\ 565.430 \end{pmatrix}$	$\begin{pmatrix} 11.400 \\ -8.792 \\ 113.086 \end{pmatrix}$	$\begin{pmatrix} 2.280 \\ -1.758 \\ 22.617 \end{pmatrix}$	$\begin{pmatrix} 0.570 \\ -0.439 \\ 5.651 \end{pmatrix}$	$\begin{pmatrix} 57.000 \\ -43.962 \\ 565.430 \end{pmatrix}$	$\begin{pmatrix} 17.100 \\ -13.189 \\ 169.629 \end{pmatrix}$	$\begin{pmatrix} 2.280 \\ -1.758 \\ 22.617 \end{pmatrix}$
COC	$\begin{pmatrix} -277.436 \\ 106.705 \\ 27.957 \end{pmatrix}$	$\begin{pmatrix} -55.469 \\ 212.741 \\ 5.591 \end{pmatrix}$	$\begin{pmatrix} -11.094 \\ 42.548 \\ 1.118 \end{pmatrix}$	$\begin{pmatrix} -2.773 \\ 10.637 \\ 0.280 \end{pmatrix}$	$\begin{pmatrix} -277.346 \\ 1063.705 \\ 27.957 \end{pmatrix}$	$\begin{pmatrix} -83.204 \\ 319.112 \\ 8.387 \end{pmatrix}$	$\begin{pmatrix} -11.094 \\ 42.548 \\ 1.118 \end{pmatrix}$

Table 3. Computed relative angular velocity components of each plate-pair for model GA and model GB. ($\omega \cdot 10^{-7}$ deg/yr)

Plate-pair	GA1	GA2	GA3	GA4	GB1	GB2	GB3
AME-PAC	$\begin{pmatrix} 103.880 \\ -172.812 \\ 143.140 \end{pmatrix}$	$\begin{pmatrix} 20.776 \\ -34.562 \\ 28.628 \end{pmatrix}$	$\begin{pmatrix} 4.156 \\ -6.912 \\ 5.726 \end{pmatrix}$	$\begin{pmatrix} 1.039 \\ -1.728 \\ 1.432 \end{pmatrix}$	$\begin{pmatrix} 88.745 \\ -172.914 \\ 214.175 \end{pmatrix}$	$\begin{pmatrix} 26.287 \\ -51.877 \\ 65.831 \end{pmatrix}$	$\begin{pmatrix} 3.517 \\ -6.917 \\ 8.725 \end{pmatrix}$
NAZ-AME	$\begin{pmatrix} 40.185 \\ -44.075 \\ 644.358 \end{pmatrix}$	$\begin{pmatrix} 8.037 \\ -8.815 \\ 128.872 \end{pmatrix}$	$\begin{pmatrix} 1.607 \\ -1.763 \\ 25.774 \end{pmatrix}$	$\begin{pmatrix} 0.402 \\ -0.440 \\ 6.440 \end{pmatrix}$	$\begin{pmatrix} 55.318 \\ -43.973 \\ 573.323 \end{pmatrix}$	$\begin{pmatrix} 16.932 \\ -13.190 \\ 170.418 \end{pmatrix}$	$\begin{pmatrix} 2.246 \\ -1.758 \\ 22.775 \end{pmatrix}$
EUA-AME	(i) $\begin{pmatrix} -41.090 \\ 30.531 \\ 108.928 \end{pmatrix}$	$\begin{pmatrix} -8.218 \\ 6.106 \\ 21.758 \end{pmatrix}$	$\begin{pmatrix} -1.644 \\ 1.221 \\ 4.357 \end{pmatrix}$	$\begin{pmatrix} -0.411 \\ 0.305 \\ 1.089 \end{pmatrix}$	$\begin{pmatrix} -4.109 \\ 3.053 \\ 10.893 \end{pmatrix}$	$\begin{pmatrix} -0.411 \\ 0.305 \\ 1.089 \end{pmatrix}$	$\begin{pmatrix} -0.083 \\ 0.061 \\ 0.218 \end{pmatrix}$
	(ii) $\begin{pmatrix} -38.841 \\ 27.289 \\ 105.286 \end{pmatrix}$	$\begin{pmatrix} -7.768 \\ 5.457 \\ 21.058 \end{pmatrix}$	$\begin{pmatrix} -1.554 \\ 1.091 \\ 4.211 \end{pmatrix}$	$\begin{pmatrix} -0.388 \\ 0.273 \\ 1.053 \end{pmatrix}$	$\begin{pmatrix} -3.884 \\ 2.729 \\ 10.529 \end{pmatrix}$	$\begin{pmatrix} -0.388 \\ 0.273 \\ 1.053 \end{pmatrix}$	$\begin{pmatrix} -0.078 \\ 0.055 \\ 0.211 \end{pmatrix}$
AFR-AME	(i) $\begin{pmatrix} -16.886 \\ -55.562 \\ 89.432 \end{pmatrix}$	$\begin{pmatrix} -3.377 \\ -11.113 \\ 17.887 \end{pmatrix}$	$\begin{pmatrix} -0.676 \\ -2.223 \\ 3.577 \end{pmatrix}$	$\begin{pmatrix} -0.169 \\ -0.555 \\ 0.999 \end{pmatrix}$	$\begin{pmatrix} -1.689 \\ -5.556 \\ 8.943 \end{pmatrix}$	$\begin{pmatrix} -0.169 \\ -0.555 \\ 0.999 \end{pmatrix}$	$\begin{pmatrix} -0.034 \\ -0.109 \\ 0.179 \end{pmatrix}$
	(ii) $\begin{pmatrix} -14.384 \\ -57.678 \\ 91.023 \end{pmatrix}$	$\begin{pmatrix} -2.876 \\ -11.536 \\ 18.205 \end{pmatrix}$	$\begin{pmatrix} -0.576 \\ -2.308 \\ 3.641 \end{pmatrix}$	$\begin{pmatrix} -0.144 \\ -0.577 \\ 0.910 \end{pmatrix}$	$\begin{pmatrix} -1.439 \\ -5.767 \\ 9.102 \end{pmatrix}$	$\begin{pmatrix} -0.144 \\ -0.577 \\ 0.910 \end{pmatrix}$	$\begin{pmatrix} -0.029 \\ -0.115 \\ 0.182 \end{pmatrix}$

Table 3. Cont'd 1.

Plate-pair	GA1	GA2	GA3	GA4	GB1	GB2	GB3
AME-ANT	$\begin{pmatrix} 15.268 \\ 3.002 \\ -85.161 \end{pmatrix}$	$\begin{pmatrix} 3.053 \\ 0.601 \\ -17.033 \end{pmatrix}$	$\begin{pmatrix} 0.611 \\ 0.121 \\ -3.406 \end{pmatrix}$	$\begin{pmatrix} 0.153 \\ 0.030 \\ -0.851 \end{pmatrix}$	$\begin{pmatrix} 1.527 \\ 0.300 \\ -8.516 \end{pmatrix}$	$\begin{pmatrix} 0.153 \\ 0.030 \\ -0.861 \end{pmatrix}$	$\begin{pmatrix} 0.031 \\ 0.006 \\ -0.170 \end{pmatrix}$
COC-AME	$\begin{pmatrix} -294.163 \\ 1063.592 \\ 106.885 \end{pmatrix}$	$\begin{pmatrix} -58.832 \\ 212.718 \\ 21.377 \end{pmatrix}$	$\begin{pmatrix} -11.767 \\ 42.543 \\ 4.275 \end{pmatrix}$	$\begin{pmatrix} -2.941 \\ 10.636 \\ 1.069 \end{pmatrix}$	$\begin{pmatrix} -279.028 \\ 1063.694 \\ 35.850 \end{pmatrix}$	$\begin{pmatrix} -83.372 \\ 319.111 \\ 9.176 \end{pmatrix}$	$\begin{pmatrix} -11.128 \\ 42.548 \\ 1.276 \end{pmatrix}$
NAZ-PAC	$\begin{pmatrix} 144.067 \\ -216.887 \\ 787.498 \end{pmatrix}$	$\begin{pmatrix} 28.814 \\ -43.377 \\ 157.500 \end{pmatrix}$	$\begin{pmatrix} 5.763 \\ -8.675 \\ 31.500 \end{pmatrix}$	$\begin{pmatrix} 1.441 \\ -2.168 \\ 7.872 \end{pmatrix}$	$\begin{pmatrix} 144.067 \\ -216.887 \\ 789.498 \end{pmatrix}$	$\begin{pmatrix} 43.220 \\ -65.067 \\ 236.249 \end{pmatrix}$	$\begin{pmatrix} 5.763 \\ -8.675 \\ 31.500 \end{pmatrix}$
EUA-PAC	(i) $\begin{pmatrix} 62.790 \\ -142.281 \\ 252.064 \end{pmatrix}$	$\begin{pmatrix} 12.558 \\ -28.456 \\ 50.413 \end{pmatrix}$	$\begin{pmatrix} 2.512 \\ -5.691 \\ 10.083 \end{pmatrix}$	$\begin{pmatrix} 0.628 \\ -1.423 \\ 2.521 \end{pmatrix}$	$\begin{pmatrix} 84.636 \\ -169.867 \\ 225.068 \end{pmatrix}$	$\begin{pmatrix} 25.876 \\ -51.572 \\ 66.920 \end{pmatrix}$	$\begin{pmatrix} 3.434 \\ -6.856 \\ 8.943 \end{pmatrix}$
	(ii) $\begin{pmatrix} 65.039 \\ -145.523 \\ 248.426 \end{pmatrix}$	$\begin{pmatrix} 13.008 \\ -29.105 \\ 49.686 \end{pmatrix}$	$\begin{pmatrix} 2.602 \\ -5.821 \\ 9.937 \end{pmatrix}$	$\begin{pmatrix} 0.651 \\ -1.455 \\ 2.485 \end{pmatrix}$	$\begin{pmatrix} 84.861 \\ -170.185 \\ 224.704 \end{pmatrix}$	$\begin{pmatrix} 25.899 \\ -51.604 \\ 66.884 \end{pmatrix}$	$\begin{pmatrix} 3.439 \\ -6.862 \\ 8.936 \end{pmatrix}$
PAC-IND	$\begin{pmatrix} -265.093 \\ 63.571 \\ -411.843 \end{pmatrix}$	$\begin{pmatrix} -53.019 \\ 12.714 \\ -82.369 \end{pmatrix}$	$\begin{pmatrix} -10.604 \\ 2.543 \\ -16.474 \end{pmatrix}$	$\begin{pmatrix} -2.651 \\ 0.635 \\ -4.119 \end{pmatrix}$	$\begin{pmatrix} -265.093 \\ 63.571 \\ -411.843 \end{pmatrix}$	$\begin{pmatrix} -79.528 \\ 19.072 \\ -123.552 \end{pmatrix}$	$\begin{pmatrix} -10.604 \\ 2.543 \\ -16.474 \end{pmatrix}$

Table 3. Cont'd 2.

Plate-pair	GA1	GA2	GA3	GA4	GB1	GB2	GB3
PAC-ANT	$\begin{pmatrix} -88.612 \\ 175.814 \\ -228.301 \end{pmatrix}$	$\begin{pmatrix} -17.723 \\ 35.163 \\ -45.661 \end{pmatrix}$	$\begin{pmatrix} -3.545 \\ 7.033 \\ -9.132 \end{pmatrix}$	$\begin{pmatrix} -0.856 \\ 1.758 \\ -2.283 \end{pmatrix}$	$\begin{pmatrix} -87.218 \\ 173.214 \\ -222.691 \end{pmatrix}$	$\begin{pmatrix} -26.135 \\ 51.907 \\ -66.682 \end{pmatrix}$	$\begin{pmatrix} -3.486 \\ 6.923 \\ -8.895 \end{pmatrix}$
COC-PAC	$\begin{pmatrix} -190.283 \\ 89.780 \\ 250.025 \end{pmatrix}$	$\begin{pmatrix} -38.056 \\ 178.156 \\ 50.414 \end{pmatrix}$	$\begin{pmatrix} -7.611 \\ 35.631 \\ 10.001 \end{pmatrix}$	$\begin{pmatrix} -1.902 \\ 8.908 \\ 2.501 \end{pmatrix}$	$\begin{pmatrix} -190.283 \\ 890.780 \\ 250.025 \end{pmatrix}$	$\begin{pmatrix} -57.085 \\ 267.234 \\ 75.007 \end{pmatrix}$	$\begin{pmatrix} -7.611 \\ 35.631 \\ 10.001 \end{pmatrix}$
NAZ-ANT	$\begin{pmatrix} 55.455 \\ -41.073 \\ 559.197 \end{pmatrix}$	$\begin{pmatrix} 11.091 \\ -8.214 \\ 111.839 \end{pmatrix}$	$\begin{pmatrix} 2.218 \\ -16.420 \\ 22.368 \end{pmatrix}$	$\begin{pmatrix} 0.555 \\ -0.410 \\ 5.589 \end{pmatrix}$	$\begin{pmatrix} 56.849 \\ -43.673 \\ 564.807 \end{pmatrix}$	$\begin{pmatrix} 17.085 \\ -13.160 \\ 169.567 \end{pmatrix}$	$\begin{pmatrix} 2.277 \\ -1.752 \\ 22.605 \end{pmatrix}$
COC-NAZ	$\begin{pmatrix} -334.350 \\ 1107.667 \\ -537.473 \end{pmatrix}$	$\begin{pmatrix} -66.870 \\ 221.533 \\ -107.495 \end{pmatrix}$	$\begin{pmatrix} -13.374 \\ 44.306 \\ -21.499 \end{pmatrix}$	$\begin{pmatrix} -3.343 \\ 11.076 \\ -5.371 \end{pmatrix}$	$\begin{pmatrix} -334.350 \\ 1107.667 \\ -537.473 \end{pmatrix}$	$\begin{pmatrix} -100.305 \\ 332.301 \\ -161.242 \end{pmatrix}$	$\begin{pmatrix} -13.374 \\ 44.306 \\ -21.499 \end{pmatrix}$
AFR-EUA	(i) $\begin{pmatrix} 24.204 \\ -86.093 \\ -19.492 \end{pmatrix}$	$\begin{pmatrix} 4.841 \\ -17.219 \\ -3.898 \end{pmatrix}$	$\begin{pmatrix} 0.968 \\ -3.444 \\ -0.780 \end{pmatrix}$	$\begin{pmatrix} 0.242 \\ -0.860 \\ -0.195 \end{pmatrix}$	$\begin{pmatrix} 2.420 \\ -8.609 \\ -1.950 \end{pmatrix}$	$\begin{pmatrix} 0.242 \\ -0.860 \\ -0.195 \end{pmatrix}$	$\begin{pmatrix} 0.049 \\ -0.170 \\ -0.039 \end{pmatrix}$
	(ii) $\begin{pmatrix} 24.457 \\ -84.967 \\ -14.263 \end{pmatrix}$	$\begin{pmatrix} 4.892 \\ -16.993 \\ -2.853 \end{pmatrix}$	$\begin{pmatrix} 0.978 \\ -3.339 \\ -0.570 \end{pmatrix}$	$\begin{pmatrix} 0.244 \\ -0.850 \\ -0.143 \end{pmatrix}$	$\begin{pmatrix} 2.445 \\ -8.496 \\ -1.427 \end{pmatrix}$	$\begin{pmatrix} 0.244 \\ -0.850 \\ -0.143 \end{pmatrix}$	$\begin{pmatrix} 0.049 \\ -0.170 \\ -0.029 \end{pmatrix}$

Table 3. Cont'd 3.

Plate-pair	GAL	GA2	GA3	GA4	GB1	GB2	GB3	
IND-EUA	(i)	$\begin{pmatrix} 202.403 \\ 78.710 \\ 159.779 \end{pmatrix}$	$\begin{pmatrix} 40.461 \\ 15.742 \\ 31.956 \end{pmatrix}$	$\begin{pmatrix} 8.092 \\ 3.148 \\ 6.394 \end{pmatrix}$	$\begin{pmatrix} 2.023 \\ 0.788 \\ 1.598 \end{pmatrix}$	$\begin{pmatrix} 180.457 \\ 106.290 \\ 186.775 \end{pmatrix}$	$\begin{pmatrix} 53.652 \\ 32.500 \\ 56.632 \end{pmatrix}$	$\begin{pmatrix} 7.170 \\ 4.313 \\ 7.531 \end{pmatrix}$
		$\begin{pmatrix} 200.054 \\ 81.952 \\ 163.417 \end{pmatrix}$	$\begin{pmatrix} 40.011 \\ 16.391 \\ 32.683 \end{pmatrix}$	$\begin{pmatrix} 8.002 \\ 3.278 \\ 6.537 \end{pmatrix}$	$\begin{pmatrix} 2.000 \\ 0.820 \\ 1.634 \end{pmatrix}$	$\begin{pmatrix} 180.232 \\ 106.614 \\ 187.139 \end{pmatrix}$	$\begin{pmatrix} 53.629 \\ 32.532 \\ 56.668 \end{pmatrix}$	$\begin{pmatrix} 7.165 \\ 4.319 \\ 7.538 \end{pmatrix}$
	(ii)	$\begin{pmatrix} 178.099 \\ 164.803 \\ 179.271 \end{pmatrix}$	$\begin{pmatrix} 35.620 \\ 32.961 \\ 35.854 \end{pmatrix}$	$\begin{pmatrix} 7.124 \\ 6.592 \\ 7.171 \end{pmatrix}$	$\begin{pmatrix} 1.781 \\ 1.648 \\ 1.793 \end{pmatrix}$	$\begin{pmatrix} 178.037 \\ 114.889 \\ 188.725 \end{pmatrix}$	$\begin{pmatrix} 53.410 \\ 33.360 \\ 56.827 \end{pmatrix}$	$\begin{pmatrix} 7.121 \\ 4.483 \\ 7.570 \end{pmatrix}$
		$\begin{pmatrix} 175.597 \\ 166.919 \\ 177.680 \end{pmatrix}$	$\begin{pmatrix} 35.119 \\ 33.384 \\ 35.536 \end{pmatrix}$	$\begin{pmatrix} 7.024 \\ 6.677 \\ 7.107 \end{pmatrix}$	$\begin{pmatrix} 1.756 \\ 1.670 \\ 1.777 \end{pmatrix}$	$\begin{pmatrix} 177.787 \\ 115.110 \\ 188.566 \end{pmatrix}$	$\begin{pmatrix} 53.385 \\ 33.382 \\ 56.811 \end{pmatrix}$	$\begin{pmatrix} 7.116 \\ 4.489 \\ 7.567 \end{pmatrix}$
IND-AFR	(i)	$\begin{pmatrix} -1.618 \\ -52.560 \\ 4.271 \end{pmatrix}$	$\begin{pmatrix} -0.324 \\ -10.512 \\ 0.854 \end{pmatrix}$	$\begin{pmatrix} -0.065 \\ -2.102 \\ 0.171 \end{pmatrix}$	$\begin{pmatrix} -0.016 \\ -0.525 \\ 0.043 \end{pmatrix}$	$\begin{pmatrix} -0.162 \\ -5.256 \\ 0.427 \end{pmatrix}$	$\begin{pmatrix} -0.016 \\ -0.525 \\ 0.043 \end{pmatrix}$	$\begin{pmatrix} -0.003 \\ -0.103 \\ 0.009 \end{pmatrix}$
		$\begin{pmatrix} 0.840 \\ -54.676 \\ 5.862 \end{pmatrix}$	$\begin{pmatrix} 0.177 \\ -10.935 \\ 1.172 \end{pmatrix}$	$\begin{pmatrix} 0.035 \\ -2.187 \\ 0.235 \end{pmatrix}$	$\begin{pmatrix} 0.009 \\ -0.547 \\ 0.059 \end{pmatrix}$	$\begin{pmatrix} 0.088 \\ -5.467 \\ 0.586 \end{pmatrix}$	$\begin{pmatrix} 0.009 \\ -0.547 \\ 0.059 \end{pmatrix}$	$\begin{pmatrix} 0.002 \\ -0.109 \\ 0.012 \end{pmatrix}$
	(ii)							
AFR-ANT	(i)							
	(ii)							

Table 3. Cont'd 4.

Plate-pair	GA1	GA2	GA3	GA4	GB1	GB2	GB3
IND-ANT	$\left(\begin{array}{l} 176.481 \\ 112.243 \\ 183.542 \end{array} \right)$	$\left(\begin{array}{l} 35.296 \\ 22.449 \\ 36.708 \end{array} \right)$	$\left(\begin{array}{l} 7.059 \\ 4.490 \\ 7.342 \end{array} \right)$	$\left(\begin{array}{l} 1.765 \\ 1.123 \\ 1.836 \end{array} \right)$	$\left(\begin{array}{l} 177.875 \\ 109.643 \\ 189.152 \end{array} \right)$	$\left(\begin{array}{l} 53.394 \\ 32.835 \\ 56.870 \end{array} \right)$	$\left(\begin{array}{l} 7.118 \\ 4.380 \\ 7.579 \end{array} \right)$

Table 4. Comparison between the computed relative angular velocity of each plate-pair for models GA and GB with that observed by Chase, 1972.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. ($\diamond$) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AME-PAC					
Observed	7.86		52	-73	18
Harper, 1975	6.36	0.81	37	-57	19.40
GA1	247.27	31.46	35.37	-58.99	19.40
GA2	49.45	6.29	35.37	-58.99	19.39
GA3	9.89	1.25	35.37	-58.98	19.39
GA4	2.47	0.31	35.38	-58.98	19.39
GB1	289.22	36.79	47.78	-62.83	7.79
GB2	87.84	11.17	48.54	-63.13	7.19
GB3	11.68	1.48	48.35	-63.05	7.34
NAZ-AME					
Observed	7.35		60	-129	
Harper, 1975	647.11	88.04	84.71	-47.64	29.63
GA1	129.42	17.61	84.71	-47.64	29.63
GA2	25.98	3.52	84.71	-47.65	29.63
GA3	6.47	0.88	84.71	-47.58	29.63
GA4	577.66	79.59	82.97	-38.48	30.74
GB1	171.76	23.36	82.82	-37.92	30.97
GB2	22.95	3.12	82.86	-38.05	30.88
GB3					

Table 4. Cont'd 1.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
(1) EUA-AME					
Observed	2.36		48	155	
Harper, 1975	3.26	1.38	68	153	20
GA1	120.35	50.99	64.83	143.39	17.95
GA2	24.07	10.19	64.83	143.39	17.95
GA3	4.81	2.03	64.83	143.40	17.94
GA4	1.20	0.50	64.83	143.42	17.94
GB1	12.03	5.09	64.83	143.39	17.95
GB2	1.20	0.50	64.83	143.42	17.94
GB3	0.24	0.10	64.71	143.69	17.78
(11) EUA-AME					
Observed	2.36		48	155	
Harper, 1975	3.26	1.38	68	153	20
GA1	115.49	48.93	65.73	144.91	18.52
GA2	23.10	9.78	65.73	144.91	18.52
GA3	4.62	1.95	65.73	144.93	18.51
GA4	1.15	0.49	65.75	144.87	18.54
GB1	11.55	4.89	65.73	144.91	18.52
GB2	1.15	0.49	65.75	144.87	18.54
GB3	0.23	0.09	65.66	144.81	18.47

Table 4. Cont'd 2.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
(i) AFR-AME					
Observed	3.44				
Harper, 1975	3.06	0.89	66	-29	33
GA1	106.63	30.99	57	-101	22.29
GA2	21.33	6.19	57.00	-73.10	22.29
GA3	4.27	1.23	57.00	-73.10	22.29
GA4	1.16	0.33	56.99	-73.10	20.49
GB1	10.66	3.09	59.85	-73.06	22.29
GB2	1.16	0.33	57.00	-73.09	20.49
GB3	0.21	0.06	59.85	-73.06	21.81
			57.47	-72.68	
(ii) AFR-AME					
Observed	3.44				
Harper, 1975	3.06	0.89	66	-29	33
GA1	108.71	31.60	57	-101	23.57
GA2	21.74	6.32	56.85	-76.00	23.57
GA3	4.35	1.26	56.85	-76.00	23.57
GA4	1.09	0.31	56.84	-76.00	23.58
GB1	10.87	3.16	56.83	-76.00	23.57
GB2	1.09	0.31	56.85	-76.00	23.58
GB3	0.22	0.06	56.83	-76.00	23.47
			56.91	-75.84	

Table 4. Cont'd 3.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AME-ANT					
Observed	3.30			-73	
Harper, 1975					
GA1	86.57	26.23	-79.65	11.12	26.81
GA2	17.31	5.25	-79.65	11.14	26.84
GA3	3.46	1.04	-79.64	11.20	26.86
GA4	0.87	0.26	-79.62	11.09	26.85
GB1	8.66	2.62	-79.64	11.12	26.84
GB2	0.87	0.26	-79.62	11.09	26.85
GB3	0.17	0.05	-79.48	10.95	26.86
COC-AME					
Observed	17.3			-119	
Harper, 1975					
GA1	108.69	64.08	5.53	105.46	126.10
GA2	221.74	12.81	5.53	105.46	126.10
GA3	44.35	2.56	5.53	105.46	126.10
GA4	11.09	0.64	5.53	105.46	126.10
GB1	1100.27	63.59	1.87	104.64	128.98
GB2	329.85	19.07	1.59	104.64	129.19
GB3	44.00	2.54	1.66	104.66	129.14

Table 4. Cont'd 4.

Plate-pair	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
NAZ-PAC					
Observed	14.6		59	-97	
Harper, 1975	19.7	1.35	53	-73	15
GA1	829.43	56.81	71.70	-56.41	47.99
GA2	165.89	11.36	71.70	-56.41	47.99
GA3	33.18	2.27	71.70	-56.40	47.99
GA4	8.29	0.57	71.70	-56.39	47.99
GB1	829.43	56.81	71.70	-56.41	47.99
GB2	248.83	17.04	71.70	-56.41	47.99
GB3	33.18	2.27	71.70	-56.40	47.99
PAC-IND					
Observed	12.9		-58	174	
Harper, 1975	493.89	38.29	-56.50	166.52	4.32
GA1	98.78	7.66	-56.50	166.52	4.32
GA2	19.76	1.53	-56.50	166.52	4.32
GA3	4.94	0.38	-56.50	166.53	4.31
GA4	493.89	38.29	-56.50	166.52	4.32
GB1	148.17	11.49	-56.50	166.51	4.32
GB2	19.76	1.53	-56.50	166.52	4.32
GB3					

Table 4. Cont'd 5.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
(i) EUA-PAC					
Observed	8.85		63	-90	
Harper, 1975					
GA1	296.18	33.46	58.33	-66.19	12.48
GA2	59.24	6.69	58.33	-66.19	12.48
GA3	11.85	1.33	58.33	-66.19	12.48
GA4	2.96	0.33	58.33	-66.19	12.48
GB1	294.40	33.32	49.86	-63.52	19.42
GB2	88.36	9.98	49.23	-63.36	19.99
GB3	11.78	1.33	49.39	-63.40	19.84
(ii) EUA-PAC					
Observed	8.85		63	-90	
Harper, 1975					
GA1	295.17	33.35	57.31	-65.92	13.16
GA2	59.63	6.67	57.31	-65.92	13.16
GA3	11.81	1.33	57.31	-65.92	13.16
GA4	2.95	0.33	57.32	-65.90	13.17
GB1	294.37	33.32	49.76	-63.50	19.51
GB2	88.36	9.98	49.20	-63.35	20.01
GB3	11.78	1.33	49.34	-63.38	19.89

Table 4. Cont'd 6.

Plate-pairs	Rate. 10^{-7} deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
PAC-ANT					
Observed	9.76	0.83	-70	107	20
Harper, 1975	8.09	30.88	-51	117	21.29
GA1	301.47	6.17	-49.23	116.75	21.29
GA2	60.29	1.23	-49.23	116.75	21.29
GA3	12.06	0.03	-49.42	115.96	21.02
GA4	3.01	30.32	-49.42	116.73	21.56
GB1	295.30	9.06	-48.95	116.73	21.58
GB2	88.45	1.20	-48.93	116.73	20.88
GB3	11.80		-48.93		
COC-PAC					
Observed	23.70	39.85	36	-108	121.31
Harper, 1975	944.57	7.97	15.35	102.06	120.99
GA1	189.02	1.59	15.47	102.52	121.31
GA2	37.78	0.39	15.35	102.06	121.31
GA3	9.45	39.85	15.35	102.05	121.31
GA4	944.57	11.95	15.35	102.06	121.31
GB1	283.37	1.59	15.35	102.06	121.31
GB2	37.78		15.35	102.06	121.31
GB3			15.35	102.06	121.31

Table 4. Cont'd 7.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factod	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
NAZ-ANT					
Observed	5.76		36	-114	
Harper, 1975					
GA1	563.44	97.81	82.96	-36.48	52.79
GA2	112.69	19.56	82.97	-36.52	52.78
GA3	22.54	3.91	82.97	-36.51	52.78
GA4	5.63	0.97	82.96	-36.46	52.79
GB1	569.34	98.84	82.77	-37.53	52.63
GB2	170.93	29.67	82.75	-37.61	52.62
GB3	22.79	3.95	82.76	-37.58	52.62
COC-NAZ					
Observed	11.9		8	-116	
Harper, 1975			-5	107	138
GA1	105	8.80	-24.92	106.80	135.86
GA2	1275.77	107.21	-24.92	106.80	135.86
GA3	255.15	21.44	-24.92	106.80	135.86
GA4	51.03	4.28	-24.92	106.80	135.86
GA4	12.76	1.07	-24.90	106.80	135.86
GB1	1275.77	107.21	-24.92	106.80	135.86
GB2	382.73	32.16	-24.92	106.80	135.86
GB3	51.03	4.28	-24.92	106.80	135.86

Table 4. Cont'd 8.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
(1) AFR-EUA					
Observed	3.28		25	-27	
Harper, 1975					
GA1	91.53	27.91	-12.30	-74.30	59.30
GA2	18.31	5.58	-19.29	-74.30	59.30
GA3	3.66	1.11	-12.30	-74.30	59.30
GA4	0.91	0.28	-12.31	-74.28	59.30
GB1	9.15	2.79	-12.30	-74.30	59.30
GB2	0.91	0.28	-12.31	-74.28	59.30
GB3	0.18	0.05	-12.43	-73.92	59.10
(11) AFR-EUA					
Observed	3.28		25	-27	
Harper, 1975					
GA1	89.56	27.30	-9.16	-73.94	57.07
GA2	17.91	5.46	-9.17	-73.94	57.07
GA3	3.58	1.09	-9.15	-73.95	57.07
GA4	0.90	0.27	-9.18	-73.98	57.12
GB1	8.96	2.73	-9.17	-73.95	57.08
GB2	0.90	0.27	-9.18	-73.98	57.12
GB3	0.18	0.05	-9.31	-73.02	57.15

Table 4. Cont'd 9.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
(i) IND-EUA Observed Harper, 1975	8.04		22	25	
GA1	269.61	33.53	36.34	21.25	14.71
GA2	53.91	6.70	36.36	21.26	14.72
GA3	10.78	1.34	36.37	21.26	14.73
GA4	2.70	0.33	36.35	21.28	14.72
GB1	280.62	34.90	41.73	30.50	20.26
GB2	84.51	10.51	42.08	31.21	20.74
GB3	11.26	1.40	41.99	31.03	20.62
(ii) IND-EUA Observed Harper, 1975	8.04		22	25	
GA1	271.10	33.70	37.09	22.28	15.27
GA2	54.20	6.74	37.09	22.28	15.27
GA3	10.84	1.34	37.09	22.28	15.27
GA4	2.71	0.34	37.09	22.29	15.27
GB1	280.84	34.93	41.79	30.61	20.34
GB2	84.53	10.51	42.10	31.24	20.77
GB3	11.26	1.40	42.02	31.08	20.66

Table 4. Cont'd 10.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ)°	Long. (λ)°	Pole misfit (Z)°
(1) IND-AFR					
Observed	6.33		15	48	
Harper, 1975	6.89	1.09	30	48	15
GA1	301.69	47.66	36.46	42.78	21.96
GA2	60.34	9.53	36.46	42.78	21.96
GA3	12.07	1.90	36.46	42.78	21.96
GA4	3.02	0.47	36.46	42.78	21.96
GB1	283.75	44.82	41.69	32.84	29.73
GB2	84.82	13.40	42.06	31.99	30.38
GB3	11.32	1.78	41.98	32.19	30.23
(ii) IND-AFR					
Observed	6.33		15	48	
Harper, 1975	6.89	1.09	30	48	15
GA1	300.44	47.46	36.26	43.55	21.63
GA2	60.09	9.49	36.26	43.55	21.63
GA3	12.02	1.89	36.25	43.55	21.63
GA4	3.01	0.47	36.25	43.56	21.62
GB1	283.58	44.79	41.68	32.92	29.69
GB2	84.80	13.39	42.06	32.02	30.37
GB3	11.32	1.78	41.97	32.25	30.20

Table 4. Cont'd 11.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
(i) AFR-ANT					
Observed	2.62		4	-51	
Harper, 1975					
GA1	52.76	20.13	4.64	-88.24	37.13
GA2	10.55	4.02	4.64	-88.23	37.13
GA3	2.11	0.81	4.68	-88.25	37.15
GA4	0.51	0.20	4.68	-88.25	37.15
GB1	5.28	2.01	4.64	-88.23	37.12
GB2	0.53	0.20	4.68	-88.25	37.15
GB3	0.10	0.04	4.99	-88.33	37.22
(ii) AFR-ANT					
Observed	2.62		4	-51	
Harper, 1975					
GA1	54.99	20.99	6.12	-89.12	38.02
GA2	10.99	4.19	6.12	-89.07	37.98
GA3	2.20	0.84	6.13	-89.08	37.99
GA4	0.55	0.21	6.16	-89.06	37.96
GB1	5.50	2.09	6.12	-89.08	37.98
GB2	0.55	0.21	6.16	-89.06	37.96
GB3	0.11	0.04	6.28	-89.95	37.86

Table 4. Cont'd 12.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ)°	Long. (λ)°	Pole misfit (ϵ)°
IND-ANT					
Observed	6.50		16	24	
Harper, 1975	6.25	0.96	35	37	22
GA1	278.27	42.81	41.27	32.46	26.30
GA2	55.65	8.56	41.27	32.46	26.30
GA3	11.13	1.17	41.27	32.46	26.30
GA4	2.78	0.42	41.27	32.47	26.31
GB1	281.85	43.36	42.15	31.65	26.97
GB2	84.64	13.02	42.22	31.59	27.01
GB3	11.28	1.74	42.20	31.61	27.00

Table 5. Comparison between the computed relative angular velocity of each plate-pair for model GB2M and GB3M with that observed by Chase, 1972. Note: model GB2M and GB3M are computed by inverting the values of δ_c and δ_o of model GB2 and GB3 respectively.

Plate-pair	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^\circ$	Long. (λ) $^\circ$	Pole misfit (Z) $^\circ$
AME-PAC					
Observed	7.86		52	-73	
GB2M	27.88	3.55	45.36	-61.95	9.84
GB3M	5.67	0.72	46.59	-62.39	8.78
NAZ-AME					
Observed	7.35		60	-129	
GB2M	59.30	8.07	83.41	-40.25	30.51
GB3M	11.68	1.59	83.19	-39.36	30.65
EUA AME					
Observed	2.36		48	155	
GB2M	3.46	1.47	65.74	144.89	18.53
GB3M	0.46	0.19	65.73	144.91	18.52
AFR AME					
Observed	3.44		66	-29	
GB2M	3.26	0.95	56.85	-75.99	23.57
GB3M	0.43	0.13	56.85	-76.00	23.57

Table 5. Cont'd 2.

Plate-pair	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
PAC-ANT					
Observed	9.76		-70	107	
GB2M	29.67	3.04	-49.01	116.73	21.50
GB3M	5.91	0.61	-48.98	116.73	21.53
COC-PAC					
Observed	23.7		36	108	
GB2M	94.45	3.99	15.35	102.06	121.31
GB3M	18.84	0.79	15.35	102.06	121.31
NAZ-ANT					
Observed	5.76		36	-114	
GB2M	57.23	9.94	79.98	-25.66	54.34
GB3M	11.35	1.97	82.78	-37.42	52.65
COC-NAZ					
Observed	11.9		8	-116	
GB2M	127.58	10.72	-24.92	106.79	135.86
GB3M	25.45	2.14	-24.92	106.79	135.86
AFR-EUA					
Observed	3.28		25	-27	
GB2M	2.69	0.82	-9.16	-73.94	57.07
GB3M	0.36	0.17	-9.16	-73.96	57.07

Table 5. Cont'd 3.

P1-te-pair	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
IND-EUA					
Observed	8.04		22	25	
GB2M	27.82	3.46	40.82	28.71	19.08
GB3M	5.58	0.69	41.31	29.65	19.70
IND-AFR					
Observed	6.33		15	48	
GB2M	28.66	4.57	40.51	35.53	27.72
GB3M	5.69	0.89	41.10	34.25	28.70
AFR-ANT					
Observed	2.62		4	-51	
GB2M	1.65	0.63	6.12	-88.63	37.54
GB3M	0.22	0.08	6.34	-89.11	38.00
IND-ANT					
Observed	6.50		16	24	25.57
gb2M	28.10	4.32	41.96	31.83	26.82
GB3M	5.62	0.86	42.05	31.74	26.89

Table 6. Computed absolute angular velocity components of each plate for model GCl.
 $(\omega \cdot 10^{-7} \text{ deg/yr})$

ANT	AME
$\begin{pmatrix} 0.062 \\ -0.116 \\ 0.249 \end{pmatrix}$	$\begin{pmatrix} 0.673 \\ 0.005 \\ -3.157 \end{pmatrix}$
PAC	EUA
$\begin{pmatrix} -3.483 \\ 6.917 \\ -8.883 \end{pmatrix}$	$\begin{pmatrix} -0.881 \\ 1.096 \\ 1.054 \end{pmatrix}$
IND	NAZ
$\begin{pmatrix} 3.561 \\ 2.187 \\ 3.795 \end{pmatrix}$	$\begin{pmatrix} 0.570 \\ -0.439 \\ 5.651 \end{pmatrix}$
AFR	COC
$\begin{pmatrix} 0.097 \\ -2.303 \\ 0.484 \end{pmatrix}$	$\begin{pmatrix} -2.773 \\ 10.637 \\ 0.280 \end{pmatrix}$

Model GCl is as follows: $(\eta = 10^{21} \text{ poise}, \delta = 400 \text{ Km})$ - for ANT, PAC, AFR, AME and EUA plates.
 $(\eta = 10^{21} \text{ poise}, \delta = 100 \text{ Km})$ - for COC and NAZ plates.
 $(\eta = 10^{21} \text{ poise}, \delta = 200 \text{ Km})$ - for IND plate.

Table 7. Computed relative angular velocity components of each plate-pair for model GC1

AME-PAC $\begin{pmatrix} 4.156 \\ -6.912 \\ 5.726 \end{pmatrix}$	NAZ-PAC $\begin{pmatrix} 4.053 \\ -7.356 \\ 14.534 \end{pmatrix}$	COC-NAZ $\begin{pmatrix} -3.343 \\ 11.076 \\ -5.371 \end{pmatrix}$
NAZ-AME $\begin{pmatrix} -0.103 \\ -0.444 \\ 8.808 \end{pmatrix}$	EUA-PAC $\begin{pmatrix} 2.602 \\ -5.821 \\ 9.937 \end{pmatrix}$	AFR-EUA $\begin{pmatrix} 0.978 \\ -3.399 \\ -0.570 \end{pmatrix}$
EUA-AME $\begin{pmatrix} -1.554 \\ 1.091 \\ 4.211 \end{pmatrix}$	PAC-IND $\begin{pmatrix} -7.044 \\ 4.730 \\ -12.678 \end{pmatrix}$	IND-EUA $\begin{pmatrix} 4.442 \\ 1.091 \\ 2.741 \end{pmatrix}$
AFR-AME $\begin{pmatrix} -0.576 \\ -2.308 \\ 3.641 \end{pmatrix}$	PAC-ANT $\begin{pmatrix} -3.545 \\ 7.033 \\ -9.132 \end{pmatrix}$	IND-AFR $\begin{pmatrix} 3.464 \\ 4.490 \\ 3.110 \end{pmatrix}$
AME-ANT $\begin{pmatrix} 0.611 \\ 0.121 \\ -3.406 \end{pmatrix}$	COC-PAC $\begin{pmatrix} 0.710 \\ 3.720 \\ 9.163 \end{pmatrix}$	AFR-ANT $\begin{pmatrix} 0.035 \\ -2.187 \\ 0.235 \end{pmatrix}$
COC-AME $\begin{pmatrix} -3.446 \\ 10.632 \\ 3.437 \end{pmatrix}$	NAZ-ANT $\begin{pmatrix} 0.508 \\ -0.323 \\ 5.402 \end{pmatrix}$	IND-ANT $\begin{pmatrix} 3.499 \\ 2.303 \\ 3.546 \end{pmatrix}$

Table 8. Comparison between the computed relative angular velocity of each plate-pair for model GCl with that observed by Chase, 1972. Also listed are the results of model GA3.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AME-PAC					
Observed	7.86		52	-73	19.39
Computed	9.89	1.25	35.37	-58.98	19.39
GA3	9.89	1.25	35.37	-58.98	19.39
NAZ-AME					
Observed	7.35		60	-129	28.27
Computed	8.82	1.19	87.04	-76.94	29.63
GA3	25.88	3.52	84.71	-47.65	
EUA-AME					
Observed	2.36		48	155	18.51
Computed	4.62	1.95	65.73	144.93	18.51
GA3	4.62	1.85	65.73	144.23	
AFR-AME					
Observed	3.44		66	-29	23.57
Computed	4.35	1.26	56.84	-75.99	23.57
GA3	4.35	1.26	56.84	-75.29	

Table 8. Cont'd 1.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole mist (Z) $^{\circ}$
AME-ANT					
Observed	3.30		-64	-73	
Computed	3.46	1.04	-79.64	11.20	26.86
GA3	3.46	1.04	-79.64	11.20	26.86
COC-AME					
Observed	17.3		27	-119	
Computed	11.69	0.68	17.09	107.96	116.60
GA3	44.68	2.56	5.53	105.46	126.10
NAZ-PAC					
Observed	14.6		59	-97	
Computed	16.78	1.14	59.98	-61.15	18.00
GA3	33.18	2.27	71.70	-56.40	47.99
EUA-PAC					
Observed	8.85		63	-90	
Computed	11.81	1.33	57.31	-65.92	13.16
GA3	11.81	1.33	57.31	-65.92	13.16

Table 8. Cont'd 2.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
PAC-IND					
Observed	12.9		-58	174	15.14
Computed	15.25	1.18	-56.21	146.12	4.32
GA3	19.76	1.53	-56.50	166.51	
PAC-ANT					
Observed	9.76		-70	107	21.29
Computed	12.06	1.23	-49.42	116.75	21.29
GA3	12.06	1.23	-49.42	116.75	
COC-PAC					
Observed	23.7		36	108	35.51
Computed	9.91	0.42	67.54	79.19	121.31
GA3	37.78	1.59	15.35	102.06	
NAZ-ANT					
Observed	5.76		36	-114	53.32
Computed	5.44	0.94	83.64	-32.45	52.78
GA3	22.54	3.91	82.96	-36.51	

Table 8. Cont'd 3.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
COC-NAZ					
Observed	11.9		8	-116	
Computed	12.75	1.07	-24.90	106.79	135.86
GA3	51.03	4.28	-24.92	106.79	135.96
AFR-EUA					
Observed	3.28		25	-27	
Computed	3.58	1.09	-9.15	-73.95	57.07
GA3	3.58	1.09	-9.15	-73.95	57.07
IND-EUA					
Observed	8.04		22	25	
Computed	5.33	0.66	30.92	13.79	13.41
GA3	10.84	1.34	37.08	22.27	15.27
IND-AFR					
Observed	6.33		15	48	
Computed	8.22	1.29	22.23	36.17	13.33
GA3	11.13	1.71	41.27	32.46	26.31

Table 8. Cont'd 4.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AFR-ANT					
Observed	2.62		4	-51	37.99
Computed	2.20	0.84	6.13	-89.08	37.99
GA3	2.20	0.84	6.13	-89.08	
IND-ANT					
Observed	6.50		16	24	25.57
Computed	5.49	0.84	40.25	33.35	26.31
GA3	11.13	1.71	41.27	32.46	

Table 9. Computed absolute angular velocity components of each plate for model GC2.
 ($\omega \cdot 10^{-7} \text{deg/yr}$)

ANT	AME
$\begin{pmatrix} 0.155 \\ -0.289 \\ 0.623 \end{pmatrix}$	$\begin{pmatrix} 0.505 \\ 0.003 \\ -2.368 \end{pmatrix}$
PAC	EUA
$\begin{pmatrix} -2.612 \\ 5.188 \\ -6.662 \end{pmatrix}$	$\begin{pmatrix} -0.220 \\ 0.274 \\ 0.264 \end{pmatrix}$
IND	NAZ
$\begin{pmatrix} 3.561 \\ 2.187 \\ 3.795 \end{pmatrix}$	$\begin{pmatrix} 0.570 \\ -0.439 \\ 5.651 \end{pmatrix}$
AFR	COC
$\begin{pmatrix} 0.097 \\ -2.303 \\ 0.484 \end{pmatrix}$	$\begin{pmatrix} -4.160 \\ 15.956 \\ 0.419 \end{pmatrix}$

Model GC2 is as follows: Φ

($\eta = 10^{20}$ poise, $\delta = 100$ Km)	- for ANT plate.
($\eta = 10^{21}$ poise, $\delta = 100$ Km)	- for EUA and NAZ plates.
($\eta =$ " , $\delta = 150$ Km)	- for COC plate.
($\eta =$ " , $\delta = 200$ Km)	- for IND plate.
($\eta =$ " , $\delta = 300$ Km)	- for PAC and AME plates.
($\eta =$ " , $\delta = 400$ Km)	- for AFR plate.

Table 10. Computed relative angular velocity components of each plate-pair for model GC2.
($\omega \cdot 10^{-7} \text{deg/yr}$)

AME-PAC $\begin{pmatrix} 3.117 \\ -5.185 \\ 4.294 \end{pmatrix}$	NAZ-PAC $\begin{pmatrix} 3.182 \\ -5.627 \\ 12.313 \end{pmatrix}$	COC-NAZ $\begin{pmatrix} -4.730 \\ 16.392 \\ -5.232 \end{pmatrix}$
NAZ-AME $\begin{pmatrix} 0.065 \\ -0.442 \\ 8.019 \end{pmatrix}$	EUA-PAC $\begin{pmatrix} 2.392 \\ -4.914 \\ 6.928 \end{pmatrix}$	AFR-EUA $\begin{pmatrix} 0.317 \\ -2.577 \\ 0.220 \end{pmatrix}$
EUA-AME $\begin{pmatrix} -0.725 \\ 0.271 \\ 2.632 \end{pmatrix}$	PAC-IND $\begin{pmatrix} -6.173 \\ 3.001 \\ 10.457 \end{pmatrix}$	IND-EUA $\begin{pmatrix} 3.781 \\ 1.913 \\ 3.531 \end{pmatrix}$
AFR-AME $\begin{pmatrix} -0.408 \\ -2.306 \\ 2.852 \end{pmatrix}$	PAC-ANT $\begin{pmatrix} -2.767 \\ 5.477 \\ -7.285 \end{pmatrix}$	IND-AFR $\begin{pmatrix} 3.464 \\ 4.490 \\ 3.311 \end{pmatrix}$
AME-ANT $\begin{pmatrix} 0.350 \\ 0.292 \\ -2.991 \end{pmatrix}$	COC-PAC $\begin{pmatrix} -1.548 \\ 10.768 \\ 7.081 \end{pmatrix}$	AFR-ANT $\begin{pmatrix} -0.058 \\ -2.014 \\ -0.139 \end{pmatrix}$
COC-AME $\begin{pmatrix} -4.665 \\ 15.953 \\ 2.787 \end{pmatrix}$	NAZ-ANT $\begin{pmatrix} 0.415 \\ -0.150 \\ 5.028 \end{pmatrix}$	IND-ANT $\begin{pmatrix} 3.406 \\ 2.476 \\ 3.172 \end{pmatrix}$

Table 11. Comparison between the computed relative angular velocity of plate-pairs for model GC2 with that observed by Chase, 1972.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ)°	Long. (λ)°	Pole misfit (Z)°
AME-PAC					
Observed	7.86		52°	-73	
Computed	7.42	0.94	35.36	-58.99	19.40
NAZ-AME					
Observed	7.35		60	-129	
Computed	8.03	1.09	86.81	-81.63	27.93
EUA-AME					
Observed	2.36		48	155	
Computed	2.74	1.16	73.61	159.50	25.69
AFR-AME					
Observed	3.44		66	-29	
Computed	3.69	1.07	50.61	-79.97	29.71
AME-ANT					
Observed	3.30		-64	-73	
Computed	3.02	0.92	-81.33	39.84	10.35
COC-AME					
Observed	17.3		27	-119	
Computed	16.85	0.97	9.52	106.30	122.89

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Table 11. Cont'd 1.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
NAZ-PAC					
Observed	14.6		59	-97	
Computed	13.91	0.95	62.30	-60.51	17.93
EUA-PAC					
Observed	8.85		63	-90	
Computed	8.82	0.997	51.73	-64.04	17.75
PAC-IND					
Observed	12.9		-58	174	
Computed	12.51	0.97	-56.72	154.07	10.79
PAC-ANT					
Observed	9.76		-70	107	
Computed	9.52	0.98	-49.89	116.80	20.64
COC-PAC					
Observed	23.7		36	108	
Computed	12.98	0.55	33.06	98.18	8.60
NAZ-ANT					
Observed	5.76		36	-114	
Computed	5.04	0.88	84.98	-19.87	54.52

Table 11. Cont'd 2.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
COC-NAZ					
Observed	11.9		8	-116	
Computed	17.84	1.50	-17.05	106.09	138.61
AFR-EUA					
Observed	3.28		25	-27	
Computed	2.61	0.79	4.84	-82.98	57.25
IND-EUA					
Observed	8.04		22	25	
Computed	5.52	0.69	39.80	26.84	17.97
IND-AFR					
Observed	6.33		15	48	
Computed	6.56	1.04	30.28	52.35	15.79
AFR-ANT					
Observed	-2.62		4	-51	
Computed	2.02	0.77	-3.95	-88	38.15
IND-ANT					
Observed	6.50		16	24	
Computed	5.27	0.81	36.99	36.01	23.54

Table 12. Recalculated moment of forces on the various plate for model GD1 to GD8. Also included are the moments from table 1.

Plate	M	GD1	GD2	GD3	GD4	GD5	GD6	GD7	GD8
ANT	$\begin{pmatrix} 0.42 \\ -0.46 \\ 0.33 \end{pmatrix}$	$\begin{pmatrix} 0.56 \\ -0.26 \\ 0.36 \end{pmatrix}$	$\begin{pmatrix} 0.53 \\ -0.32 \\ 0.36 \end{pmatrix}$	$\begin{pmatrix} 0.50 \\ -0.38 \\ 0.35 \end{pmatrix}$	$\begin{pmatrix} 0.45 \\ -0.42 \\ 0.34 \end{pmatrix}$	$\begin{pmatrix} 0.38 \\ -0.51 \\ 0.32 \end{pmatrix}$	$\begin{pmatrix} 0.33 \\ -0.56 \\ 0.31 \end{pmatrix}$	$\begin{pmatrix} 0.28 \\ -0.59 \\ 0.29 \end{pmatrix}$	$\begin{pmatrix} 0.23 \\ -0.62 \\ 0.27 \end{pmatrix}$
PAC	$\begin{pmatrix} -30.12 \\ 63.19 \\ -78.43 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
IND	$\begin{pmatrix} 26.33 \\ 21.56 \\ 26.79 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
AFR	$\begin{pmatrix} 2.64 \\ -13.29 \\ 2.04 \end{pmatrix}$	$\begin{pmatrix} -0.49 \\ -12.55 \\ 5.66 \end{pmatrix}$	$\begin{pmatrix} 0.31 \\ -12.90 \\ 4.81 \end{pmatrix}$	$\begin{pmatrix} 1.10 \\ -13.16 \\ 3.91 \end{pmatrix}$	$\begin{pmatrix} 1.88 \\ -13.30 \\ 3.00 \end{pmatrix}$	$\begin{pmatrix} 3.39 \\ -13.30 \\ 1.08 \end{pmatrix}$	$\begin{pmatrix} 4.11 \\ -13.16 \\ 0.12 \end{pmatrix}$	$\begin{pmatrix} 4.79 \\ -12.90 \\ -0.85 \end{pmatrix}$	$\begin{pmatrix} 5.45 \\ -12.55 \\ -1.88 \end{pmatrix}$
AME	$\begin{pmatrix} 2.74 \\ -1.60 \\ -17.38 \end{pmatrix}$	$\begin{pmatrix} -1.09 \\ -8.88 \\ -18.84 \end{pmatrix}$	$\begin{pmatrix} -0.20 \\ -7.16 \\ -18.57 \end{pmatrix}$	$\begin{pmatrix} 0.73 \\ -5.34 \\ -18.27 \end{pmatrix}$	$\begin{pmatrix} 1.61 \\ -3.49 \\ -17.77 \end{pmatrix}$	$\begin{pmatrix} 3.39 \\ 0.25 \\ -16.70 \end{pmatrix}$	$\begin{pmatrix} 4.23 \\ 2.16 \\ -16.09 \end{pmatrix}$	$\begin{pmatrix} 5.06 \\ 4.04 \\ -15.38 \end{pmatrix}$	$\begin{pmatrix} 5.79 \\ 5.86 \\ -14.67 \end{pmatrix}$
EUA	$\begin{pmatrix} -5.58 \\ 3.08 \\ 2.70 \end{pmatrix}$	$\begin{pmatrix} -4.12 \\ 5.09 \\ 2.45 \end{pmatrix}$	$\begin{pmatrix} -4.56 \\ 4.62 \\ 2.55 \end{pmatrix}$	$\begin{pmatrix} -4.94 \\ 4.16 \\ 2.63 \end{pmatrix}$	$\begin{pmatrix} -5.31 \\ 3.64 \\ 2.69 \end{pmatrix}$	$\begin{pmatrix} -5.90 \\ 2.53 \\ 2.73 \end{pmatrix}$	$\begin{pmatrix} -6.13 \\ 1.94 \\ 2.72 \end{pmatrix}$	$\begin{pmatrix} -6.31 \\ 1.34 \\ 2.70 \end{pmatrix}$	$\begin{pmatrix} -6.47 \\ 0.72 \\ 2.65 \end{pmatrix}$
NAZ	$\begin{pmatrix} 2.97 \\ -9.71 \\ 27.90 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
COC	$\begin{pmatrix} -4.38 \\ 0.81 \\ 2.17 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$

Table 13. Computed absolute angular velocity components of each plate for model GD1 to GD8. Also included are the computed angular velocity components of model GD2. ($\omega \cdot 10^{-7}$ deg/yr).

Plate	GC2	GD1	GD2	GD3	GD4	GD5	GD6	GD7	GD8
ANT	$\begin{pmatrix} 0.155 \\ -0.289 \\ 0.623 \end{pmatrix}$	$\begin{pmatrix} 0.239 \\ -0.176 \\ 0.642 \end{pmatrix}$	$\begin{pmatrix} 0.232 \\ -0.211 \\ 0.652 \end{pmatrix}$	$\begin{pmatrix} 0.208 \\ -0.244 \\ 0.644 \end{pmatrix}$	$\begin{pmatrix} 0.183 \\ -0.267 \\ 0.634 \end{pmatrix}$	$\begin{pmatrix} 0.148 \\ -0.317 \\ 0.614 \end{pmatrix}$	$\begin{pmatrix} 0.123 \\ -0.345 \\ 0.606 \end{pmatrix}$	$\begin{pmatrix} 0.099 \\ -0.361 \\ 0.578 \end{pmatrix}$	$\begin{pmatrix} 0.075 \\ -0.377 \\ 0.549 \end{pmatrix}$
PAC	$\begin{pmatrix} -2.612 \\ 5.188 \\ -6.662 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
IND	$\begin{pmatrix} 3.561 \\ 2.187 \\ 3.795 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
AFR	$\begin{pmatrix} 0.097 \\ -2.303 \\ 0.484 \end{pmatrix}$	$\begin{pmatrix} -1.452 \\ -2.451 \\ 1.118 \end{pmatrix}$	$\begin{pmatrix} -0.909 \\ -2.444 \\ 0.970 \end{pmatrix}$	$\begin{pmatrix} -0.578 \\ -2.420 \\ 0.814 \end{pmatrix}$	$\begin{pmatrix} -0.242 \\ -2.375 \\ 0.654 \end{pmatrix}$	$\begin{pmatrix} 0.410 \\ -2.235 \\ 0.314 \end{pmatrix}$	$\begin{pmatrix} 0.763 \\ -2.141 \\ 0.143 \end{pmatrix}$	$\begin{pmatrix} 1.087 \\ -2.028 \\ -0.031 \end{pmatrix}$	$\begin{pmatrix} 1.411 \\ -1.899 \\ -0.215 \end{pmatrix}$
AME	$\begin{pmatrix} 0.505 \\ 0.003 \\ -2.368 \end{pmatrix}$	$\begin{pmatrix} 0.314 \\ -0.871 \\ -2.404 \end{pmatrix}$	$\begin{pmatrix} 0.358 \\ -0.662 \\ -2.405 \end{pmatrix}$	$\begin{pmatrix} 0.403 \\ -0.442 \\ -2.405 \end{pmatrix}$	$\begin{pmatrix} 0.440 \\ -0.219 \\ -2.377 \end{pmatrix}$	$\begin{pmatrix} 0.515 \\ 0.230 \\ -2.314 \end{pmatrix}$	$\begin{pmatrix} 0.545 \\ 0.460 \\ -2.272 \end{pmatrix}$	$\begin{pmatrix} 0.573 \\ 0.684 \\ -2.216 \end{pmatrix}$	$\begin{pmatrix} 0.593 \\ 0.903 \\ -2.157 \end{pmatrix}$
EUA	$\begin{pmatrix} -0.220 \\ 0.274 \\ 0.264 \end{pmatrix}$	$\begin{pmatrix} -0.157 \\ 0.397 \\ 0.314 \end{pmatrix}$	$\begin{pmatrix} -0.176 \\ 0.369 \\ 0.305 \end{pmatrix}$	$\begin{pmatrix} -0.192 \\ 0.342 \\ 0.295 \end{pmatrix}$	$\begin{pmatrix} -0.208 \\ 0.310 \\ 0.281 \end{pmatrix}$	$\begin{pmatrix} -0.234 \\ 0.239 \\ 0.247 \end{pmatrix}$	$\begin{pmatrix} -0.245 \\ 0.201 \\ 0.227 \end{pmatrix}$	$\begin{pmatrix} -0.253 \\ 0.161 \\ 0.207 \end{pmatrix}$	$\begin{pmatrix} -0.261 \\ 0.120 \\ 0.183 \end{pmatrix}$
NAZ	$\begin{pmatrix} 0.570 \\ -0.439 \\ 5.651 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
COC	$\begin{pmatrix} -4.160 \\ 15.956 \\ 0.419 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$

Table 14. Computed relative angular velocity components of the plate-pairs for model GD1 to GD8. Also included are the components of model GC2. ($\omega \cdot 10^{-7}$ deg/yr).

Plate-pair	GC2	GD1	GD2	GD3	GD4	GD5	GD6	GD7	GD8
AME-PAC	$\begin{pmatrix} 3.117 \\ -5.185 \\ 4.294 \end{pmatrix}$	$\begin{pmatrix} 2.926 \\ -6.059 \\ 4.258 \end{pmatrix}$	$\begin{pmatrix} 2.970 \\ -5.850 \\ 5.257 \end{pmatrix}$	$\begin{pmatrix} 3.015 \\ -5.630 \\ 4.257 \end{pmatrix}$	$\begin{pmatrix} 3.052 \\ -5.407 \\ 4.285 \end{pmatrix}$	$\begin{pmatrix} 3.127 \\ -4.958 \\ 4.348 \end{pmatrix}$	$\begin{pmatrix} 3.157 \\ -4.728 \\ 4.390 \end{pmatrix}$	$\begin{pmatrix} 3.158 \\ -4.504 \\ 4.446 \end{pmatrix}$	$\begin{pmatrix} 3.205 \\ -4.285 \\ 4.505 \end{pmatrix}$
NAZ-AME	$\begin{pmatrix} 0.065 \\ -0.442 \\ 8.019 \end{pmatrix}$	$\begin{pmatrix} 0.256 \\ 0.432 \\ 8.055 \end{pmatrix}$	$\begin{pmatrix} 0.212 \\ 0.223 \\ 8.056 \end{pmatrix}$	$\begin{pmatrix} 0.167 \\ 0.003 \\ 8.056 \end{pmatrix}$	$\begin{pmatrix} 0.130 \\ -0.220 \\ 8.028 \end{pmatrix}$	$\begin{pmatrix} 0.055 \\ -0.669 \\ 7.965 \end{pmatrix}$	$\begin{pmatrix} 0.025 \\ -0.899 \\ 7.923 \end{pmatrix}$	$\begin{pmatrix} -0.003 \\ -1.123 \\ 7.867 \end{pmatrix}$	$\begin{pmatrix} -0.023 \\ -1.342 \\ 7.808 \end{pmatrix}$
EUA-AME	$\begin{pmatrix} -0.725 \\ 0.271 \\ 2.632 \end{pmatrix}$	$\begin{pmatrix} -0.471 \\ 1.268 \\ 2.718 \end{pmatrix}$	$\begin{pmatrix} -0.534 \\ 1.031 \\ 2.710 \end{pmatrix}$	$\begin{pmatrix} -0.595 \\ 0.784 \\ 2.700 \end{pmatrix}$	$\begin{pmatrix} -0.648 \\ 0.529 \\ 2.658 \end{pmatrix}$	$\begin{pmatrix} -0.749 \\ 0.009 \\ 2.561 \end{pmatrix}$	$\begin{pmatrix} -0.790 \\ -0.259 \\ 2.499 \end{pmatrix}$	$\begin{pmatrix} -0.826 \\ -0.523 \\ 2.423 \end{pmatrix}$	$\begin{pmatrix} -0.854 \\ -0.783 \\ 2.340 \end{pmatrix}$
AFR-AME	$\begin{pmatrix} -0.468 \\ -2.306 \\ 2.852 \end{pmatrix}$	$\begin{pmatrix} -1.766 \\ -1.580 \\ 3.522 \end{pmatrix}$	$\begin{pmatrix} -1.267 \\ -1.782 \\ 3.375 \end{pmatrix}$	$\begin{pmatrix} -0.981 \\ -1.978 \\ 3.219 \end{pmatrix}$	$\begin{pmatrix} -0.682 \\ -2.156 \\ 3.031 \end{pmatrix}$	$\begin{pmatrix} -0.105 \\ -2.465 \\ 2.628 \end{pmatrix}$	$\begin{pmatrix} 0.218 \\ -2.601 \\ 2.415 \end{pmatrix}$	$\begin{pmatrix} 0.514 \\ -2.712 \\ 2.185 \end{pmatrix}$	$\begin{pmatrix} 0.818 \\ -2.802 \\ 1.942 \end{pmatrix}$
AME-ANT	$\begin{pmatrix} 0.350 \\ 0.292 \\ -2.991 \end{pmatrix}$	$\begin{pmatrix} 0.075 \\ -0.695 \\ -3.046 \end{pmatrix}$	$\begin{pmatrix} 0.126 \\ -0.451 \\ -3.057 \end{pmatrix}$	$\begin{pmatrix} 0.195 \\ -0.198 \\ -3.049 \end{pmatrix}$	$\begin{pmatrix} 0.257 \\ 0.048 \\ -3.011 \end{pmatrix}$	$\begin{pmatrix} 0.367 \\ 0.547 \\ -2.928 \end{pmatrix}$	$\begin{pmatrix} 0.422 \\ 0.809 \\ -2.878 \end{pmatrix}$	$\begin{pmatrix} 0.474 \\ 1.045 \\ -2.794 \end{pmatrix}$	$\begin{pmatrix} 0.518 \\ 1.280 \\ -2.706 \end{pmatrix}$
COC-AME	$\begin{pmatrix} -4.665 \\ 15.953 \\ 2.787 \end{pmatrix}$	$\begin{pmatrix} -4.474 \\ 16.827 \\ 2.823 \end{pmatrix}$	$\begin{pmatrix} -4.518 \\ 16.618 \\ 2.824 \end{pmatrix}$	$\begin{pmatrix} -4.563 \\ 16.398 \\ 2.824 \end{pmatrix}$	$\begin{pmatrix} -4.600 \\ 16.175 \\ 2.796 \end{pmatrix}$	$\begin{pmatrix} -4.675 \\ 15.726 \\ 2.733 \end{pmatrix}$	$\begin{pmatrix} -4.705 \\ 15.496 \\ 2.691 \end{pmatrix}$	$\begin{pmatrix} -4.733 \\ 15.272 \\ 2.635 \end{pmatrix}$	$\begin{pmatrix} -4.753 \\ 15.053 \\ 2.576 \end{pmatrix}$
NAZ-PAC	$\begin{pmatrix} 3.182 \\ -5.627 \\ 12.413 \end{pmatrix}$	"	"	"	"	"	"	"	"
EUA-PAC	$\begin{pmatrix} 2.392 \\ -4.914 \\ 6.928 \end{pmatrix}$	$\begin{pmatrix} 2.455 \\ -4.791 \\ 6.976 \end{pmatrix}$	$\begin{pmatrix} 2.436 \\ -4.819 \\ 6.967 \end{pmatrix}$	$\begin{pmatrix} 2.420 \\ -4.846 \\ 6.957 \end{pmatrix}$	$\begin{pmatrix} 2.404 \\ -4.878 \\ 6.943 \end{pmatrix}$	$\begin{pmatrix} 2.378 \\ -4.949 \\ 6.909 \end{pmatrix}$	$\begin{pmatrix} 2.367 \\ -4.987 \\ 6.889 \end{pmatrix}$	$\begin{pmatrix} 2.359 \\ -5.027 \\ 6.869 \end{pmatrix}$	$\begin{pmatrix} 2.351 \\ -5.068 \\ 6.845 \end{pmatrix}$

Table 14. Cont'd 1.

Plate-pair	GC2	GD1	GD2	GD3	GD4	GD5	GD6	GD7	GD8
PAC-IND	$\begin{pmatrix} -6.173 \\ 3.001 \\ -10.457 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
PAC-ANT	$\begin{pmatrix} -2.767 \\ 5.477 \\ -7.285 \end{pmatrix}$	$\begin{pmatrix} -2.851 \\ 5.364 \\ -7.304 \end{pmatrix}$	$\begin{pmatrix} -2.844 \\ 5.399 \\ -7.314 \end{pmatrix}$	$\begin{pmatrix} -2.820 \\ 5.432 \\ -7.306 \end{pmatrix}$	$\begin{pmatrix} -2.795 \\ 5.455 \\ -7.296 \end{pmatrix}$	$\begin{pmatrix} -2.760 \\ 5.505 \\ -7.276 \end{pmatrix}$	$\begin{pmatrix} -2.735 \\ 5.533 \\ -7.268 \end{pmatrix}$	$\begin{pmatrix} -2.711 \\ 5.549 \\ -7.240 \end{pmatrix}$	$\begin{pmatrix} -2.687 \\ 5.565 \\ -7.211 \end{pmatrix}$
COC-PAC	$\begin{pmatrix} -1.548 \\ 10.768 \\ 7.081 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
NAZ-ANT	$\begin{pmatrix} 0.415 \\ -0.150 \\ 5.028 \end{pmatrix}$	$\begin{pmatrix} 0.331 \\ -0.263 \\ 5.009 \end{pmatrix}$	$\begin{pmatrix} 0.338 \\ -0.228 \\ 4.999 \end{pmatrix}$	$\begin{pmatrix} 0.362 \\ -0.195 \\ 5.007 \end{pmatrix}$	$\begin{pmatrix} 0.387 \\ -0.172 \\ 5.017 \end{pmatrix}$	$\begin{pmatrix} 0.422 \\ -0.122 \\ 5.037 \end{pmatrix}$	$\begin{pmatrix} 0.447 \\ -0.094 \\ 5.045 \end{pmatrix}$	$\begin{pmatrix} 0.471 \\ -0.078 \\ 5.073 \end{pmatrix}$	$\begin{pmatrix} 0.495 \\ -0.062 \\ 5.102 \end{pmatrix}$
COC-NAZ	$\begin{pmatrix} -4.740 \\ 16.392 \\ 5.232 \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$	$\begin{pmatrix} " \\ " \\ " \end{pmatrix}$
AFR-EUA	$\begin{pmatrix} 0.317 \\ -2.577 \\ 0.220 \end{pmatrix}$	$\begin{pmatrix} -1.295 \\ -2.848 \\ 0.804 \end{pmatrix}$	$\begin{pmatrix} -0.733 \\ -2.813 \\ 0.665 \end{pmatrix}$	$\begin{pmatrix} -0.386 \\ -2.762 \\ 0.519 \end{pmatrix}$	$\begin{pmatrix} -0.034 \\ -2.685 \\ 0.373 \end{pmatrix}$	$\begin{pmatrix} 0.644 \\ -2.474 \\ 0.067 \end{pmatrix}$	$\begin{pmatrix} 1.008 \\ -2.342 \\ -0.084 \end{pmatrix}$	$\begin{pmatrix} 1.340 \\ -2.189 \\ -0.238 \end{pmatrix}$	$\begin{pmatrix} 1.672 \\ -2.019 \\ -0.398 \end{pmatrix}$
IND-EUA	$\begin{pmatrix} 3.781 \\ 1.913 \\ 3.531 \end{pmatrix}$	$\begin{pmatrix} 3.718 \\ 1.790 \\ 3.481 \end{pmatrix}$	$\begin{pmatrix} 3.737 \\ 1.818 \\ 3.490 \end{pmatrix}$	$\begin{pmatrix} 3.753 \\ 1.845 \\ 3.500 \end{pmatrix}$	$\begin{pmatrix} 3.769 \\ 1.877 \\ 3.514 \end{pmatrix}$	$\begin{pmatrix} 3.795 \\ 1.948 \\ 3.548 \end{pmatrix}$	$\begin{pmatrix} 3.806 \\ 1.986 \\ 3.568 \end{pmatrix}$	$\begin{pmatrix} 3.814 \\ 2.026 \\ 3.588 \end{pmatrix}$	$\begin{pmatrix} 3.822 \\ 2.067 \\ 3.612 \end{pmatrix}$
IND-AFR	$\begin{pmatrix} 3.464 \\ 4.490 \\ 3.311 \end{pmatrix}$	$\begin{pmatrix} 5.013 \\ 4.638 \\ 2.677 \end{pmatrix}$	$\begin{pmatrix} 4.470 \\ 4.631 \\ 2.825 \end{pmatrix}$	$\begin{pmatrix} 4.139 \\ 4.607 \\ 2.981 \end{pmatrix}$	$\begin{pmatrix} 3.803 \\ 4.562 \\ 3.141 \end{pmatrix}$	$\begin{pmatrix} 3.151 \\ 4.422 \\ 3.481 \end{pmatrix}$	$\begin{pmatrix} 2.798 \\ 4.328 \\ 3.652 \end{pmatrix}$	$\begin{pmatrix} 2.474 \\ 4.215 \\ 3.826 \end{pmatrix}$	$\begin{pmatrix} 2.150 \\ 4.086 \\ 4.01 \end{pmatrix}$

Table 14. Cont'd 2.

Plate-pair	GC2	GD1	GD2	GD3	GD4	GD5	GD6	GD7	GD8
AFR-ANT	$\begin{pmatrix} -0.052 \\ -2.014 \\ -0.139 \end{pmatrix}$	$\begin{pmatrix} -1.691 \\ -2.275 \\ 0.476 \end{pmatrix}$	$\begin{pmatrix} -1.141 \\ -2.233 \\ 0.318 \end{pmatrix}$	$\begin{pmatrix} -0.786 \\ -2.176 \\ 0.170 \end{pmatrix}$	$\begin{pmatrix} -0.425 \\ -2.108 \\ 0.020 \end{pmatrix}$	$\begin{pmatrix} 0.262 \\ -1.918 \\ -0.300 \end{pmatrix}$	$\begin{pmatrix} 0.640 \\ -1.796 \\ -0.463 \end{pmatrix}$	$\begin{pmatrix} 0.988 \\ -1.667 \\ -0.609 \end{pmatrix}$	$\begin{pmatrix} 1.336 \\ -1.522 \\ -0.764 \end{pmatrix}$
IND-ANT	$\begin{pmatrix} 3.406 \\ 2.476 \\ 3.172 \end{pmatrix}$	$\begin{pmatrix} 3.322 \\ 2.363 \\ 3.153 \end{pmatrix}$	$\begin{pmatrix} 3.329 \\ 2.398 \\ 3.143 \end{pmatrix}$	$\begin{pmatrix} 3.353 \\ 2.431 \\ 3.151 \end{pmatrix}$	$\begin{pmatrix} 3.378 \\ 2.454 \\ 3.161 \end{pmatrix}$	$\begin{pmatrix} 3.413 \\ 2.504 \\ 3.181 \end{pmatrix}$	$\begin{pmatrix} 3.438 \\ 2.532 \\ 3.189 \end{pmatrix}$	$\begin{pmatrix} 3.462 \\ 2.548 \\ 3.217 \end{pmatrix}$	$\begin{pmatrix} 3.486 \\ 2.564 \\ 3.246 \end{pmatrix}$

Table 15. Comparison between the computed relative angular velocity of each plate-pair for model GD1 to GD8 with that observed by Chase, 1972. Also listed are the results of model GC2.

Plate-pairs	Rate. 10^{-7} deg/yr	Speed factor	Lat. (ϕ)°	Long. (λ)°	Pole misfit (Z)°
AME-PAC					
Observed	7.86		52	-73	
GD1	7.96	1.02	32.33	-64.22	20.69
GD2	7.82	0.99	32.98	-63.31	20.34
GD3	7.68	0.98	32.69	-61.83	20.95
GD4	7.53	0.96	34.44	-60.56	19.70
GC2	7.42	0.94	35.37	-58.99	19.40
GD5	7.30	0.93	36.57	-57.76	15.43
GD6	7.18	0.91	37.68	-56.27	18.51
GD7	7.08	0.90	38.87	-54.73	18.25
GD8	6.99	0.89	40.09	-53.21	18.07
NAZ-AME					
Observed	7.35		60	-129	
GD1	8.07	1.10	86.43	59.35	30.58
GD2	8.06	1.09	87.81	46.45	32.18
GD3	8.06	1.09	88.81	1.03	30.78
GD4	8.03	1.09	88.18	-59.42	29.41
GC2	8.03	1.09	86.81	-81.63	27.93
GD5	7.99	1.08	85.18	-85.30	26.71
GD6	7.97	1.08	83.52	-88.40	25.40
GD7	7.95	1.08	81.88	-89.87	24.20
GD8	7.92	1.07	80.25	-89.02	23.30

Table 15. Cont'd 1.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
EUA-AME					
Observed	2.36		48	155	
GD1	3.04	1.28	63.54	110.38	28.66
GD2	2.95	1.24	66.81	117.38	26.90
GD3	2.87	1.22	69.97	127.20	25.72
GD4	2.79	1.18	72.53	140.77	25.37
GD5	2.74	1.16	73.61	159.50	25.69
GD6	2.67	1.13	73.70	179.31	27.82
GD7	2.63	1.11	71.59	161.85	23.80
GD8	2.61	1.10	68.03	147.66	20.37
	2.61	1.10	63.66	137.48	18.36
AFR-AME					
Observed	3.44		66	-29	
GD1	4.24	1.23	56.07	-41.82	29.71
GD2	4.02	1.17	57.06	-54.59	14.95
GD3	3.90	1.13	55.55	-63.62	19.49
GD4	3.78	1.09	53.28	-72.45	24.66
GD5	3.69	1.07	50.61	-79.97	29.71
GD6	3.70	1.04	46.81	-87.56	35.78
GD7	3.56	1.03	42.78	-85.21	38.14
GD8	3.52	1.02	38.36	-79.27	39.57
	3.51	1.01	33.64	-73.73	38.57

Table 15. Cont'd 2.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AME-ANT					
Observed	3.30				
GD1	3.13	0.95	-64	-73	13.51
GD2	3.09	0.94	-77.07	-83.84	18.72
GD3	3.06	0.93	-81.29	-74.39	21.51
GD4	3.02	0.92	-84.79	-45.44	25.89
GD5	3.03	0.92	-85.04	10.58	30.36
GD6	3.00	0.91	-81.34	39.84	35.30
GD7	3.02	0.91	-77.32	56.14	40.26
GD8	3.04	0.92	-72.47	62.34	45.00
		0.92	-67.72	65.60	49.77
			-62.97	67.97	
COC-AME					
Observed	17.3		27	-119	124.14
GD1	17.64	1.02	9.21	104.89	123.83
GD2	17.51	1.01	9.31	105.21	123.51
GD3	17.25	0.997	9.42	105.55	123.25
GD4	17.05	0.98	9.44	105.88	122.89
GD5	16.85	0.97	9.52	106.30	122.74
GD6	16.63	0.96	9.46	106.56	122.50
GD7	16.42	0.95	9.43	106.85	122.31
GD8	16.20	0.94	9.36	107.22	122.14
	15.99	0.92	9.27	107.52	

Table 15. Cont'd 3.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (z) $^{\circ}$
NAZ-PAC					
Observed	14.6		59	-97	
GD1					
GD2					
GD3		as		GC2	
GD4					
GC2	13.91	0.95	62.30	-60.51	17.93
GD5					
GD6		as		GC2	
GD7					
GD8					
EUA-PAC					
Observed	8.85		63	-90	17.78
GD1	8.81	0.99	52.34	-62.87	17.74
GD2	8.81	0.99	52.22	-63.18	17.72
GD3	8.82	0.99	52.10	-63.46	17.72
GD4	8.82	0.99	51.93	-63.76	17.76
GC2	8.82	0.99	51.73	-64.04	17.80
GD5	8.83	0.99	51.53	-64.34	17.87
GD6	8.83	0.99	51.29	-64.61	17.95
GD7	8.83	0.99	51.05	-64.86	18.07
GD8	8.84	0.99	50.78	-65.11	

Yable 15. Cont'd 4.

Plate-pairs	Rate. 10^{-7} deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
PAC-IND					
Observed	12.9		-58	174	
GD1					
GD2					
GD3		as		GC2	
GD4					
GC2	12.51	0.97	-56.72	154.07	10.79
GD5					
GD6					
GD7		as		GC2	
GD8					
PAC-ANT					
Observed	9.76		-70	107	
GD1	9.50	0.97	-50.25	117.99	20.42
GD2	9.53	0.98	-50.16	117.78	20.48
GD3	9.53	0.98	-50.05	117.44	20.56
GD4	9.53	0.98	-49.97	117.13	20.60
GC2	9.52	0.98	-49.89	116.80	20.64
GD5	9.53	0.98	-49.77	116.63	20.75
GD6	9.55	0.97	-49.66	116.3	20.81
GD7	9.52	0.98	-49.54	116.04	20.91
GD8	9.50	0.97	-49.40	115.77	21.02

Table 15. Cont'd 5.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
COC-PAC					
Observed	23.7		36	108	
GD1					
GD2					
GD3		as		GC2	
GD4					
GC2	12.98	0.55	33.06	98.18	8.60
GD5					
GD6		as		GC2	
GD7					
GD8					
NAZ-ANT					
Observed	5.76		36	-114	52.65
GD1	5.03	0.87	85.18	-38.47	53.13
GD2	5.02	0.87	85.34	-34.00	53.79
GD3	5.02	0.87	85.31	-28.31	54.18
GD4	5.03	0.87	85.17	-23.96	54.52
GC2	5.05	0.88	84.98	-19.87	54.84
GD5	5.06	0.88	85.02	-16.12	55.25
GD6	5.07	0.88	84.83	-11.88	55.52
GD7	5.10	0.88	84.62	-9.40	55.79
GD8	5.13	0.89	84.42	-7.14	

Table 15. Cont'd 6.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
COC-NAZ					
Observed	11.9		8	-116	
GD1					
GD2					
GD3		as		GC2	
GD4					
GC2	17.85	1.50	-17.05	106.10	138.61
GD5					
GD6		Same		GC2	
GD7					
GD8					
AFR-EUA					
Observed	3.28		25	-27	37.66
GD1	3.23	0.98	14.41	-65.55	47.09
GD2	2.98	0.91	12.89	-75.39	54.00
GD3	2.84	0.86	10.54	-82.04	61.59
GD4	2.71	0.83	7.91	-89.27	57.26
GC2	2.61	0.79	4.84	-82.99	52.23
GD5	2.56	0.78	1.50	-75.41	46.93
GD6	2.55	0.77	-1.89	-66.71	43.10
GD7	2.57	0.78	-5.30	-58.53	41.55
GD8	2.65	0.81	-8.63	-52.04	

Table 15. Cont'd 7.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
IND-EUA					
Observed	8.04		22	25	
GD1	5.40	0.67	40.15	25.71	18.16
GD2	5.43	0.67	40.02	25.94	18.04
GD3	5.45	0.68	39.93	26.18	17.96
GD4	5.48	0.68	39.85	26.47	17.89
GD2	5.52	0.69	39.80	26.83	17.87
GD5	5.55	0.69	39.75	27.17	17.84
GD6	5.58	0.69	39.73	27.56	17.87
GD7	5.61	0.70	39.72	27.98	17.90
GD8	5.65	0.70	39.74	28.41	17.97
IND-AFR					
Observed	6.33		15	48	
GD1	7.34	1.15	21.40	42.77	8.10
GD2	7.03	1.11	23.70	46.01	8.90
GD3	6.87	1.08	25.70	48.06	10.70
GD4	6.72	1.06	27.87	50.18	13.03
GD2	6.57	1.04	30.28	52.35	15.79
GD5	6.45	1.02	32.66	54.53	18.63
GD6	6.32	0.997	35.32	57.12	21.91
GD7	6.21	0.98	38.05	59.59	25.23
GD8	6.12	0.97	40.97	62.25	28.77

Table 15. Cont'd 8.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AFR-ANT					
Observed	2.62				
GD1	2.87	1.09	4	-51	6.02
GD2	2.53	0.96	9.53	-53.38	12.31
GD3	2.32	0.89	7.23	-63.93	19.09
GD4	2.15	0.82	4.20	-70.14	27.79
GD2	2.02	0.77	0.53	-78.60	38.16
GD5	1.96	0.74	-3.95	-88.35	33.66
GD6	1.96	0.75	-8.81	-82.22	26.11
GD7	2.03	0.77	-13.65	-70.39	22.97
GD8	2.16	0.83	-17.45	-59.35	24.77
			-20.67	-48.72	
IND-ANT					
Observed	6.50				
GD1	5.15	0.79	16	24	23.94
GD2	5.17	0.80	37.72	35.42	23.84
GD3	5.20	0.80	37.45	35.77	23.74
GD4	5.24	0.81	37.26	35.94	23.65
GD2	5.27	0.81	37.13	36.00	23.54
GD5	5.30	0.81	36.99	36.02	22.36
GD6	5.33	0.82	36.92	36.27	23.48
GD7	5.37	0.83	36.76	36.37	23.52
GD8	5.41	0.83	36.81	36.35	23.10
			36.87	36.33	

Table 16. Moments and computed absolute angular velocity components of each plate for model GE1.

Plate	$M(5.3 \cdot 10^{31} \text{ dyn cm})$	$\omega \cdot 10^{-7} \text{ deg/yr}$
ANT	$\begin{pmatrix} 0.56 \\ -0.26 \\ 0.36 \end{pmatrix}$	$\begin{pmatrix} 0.239 \\ -0.176 \\ 0.642 \end{pmatrix}$
PAC	$\begin{pmatrix} -30.12 \\ 63.19 \\ -78.43 \end{pmatrix}$	$\begin{pmatrix} -2.612 \\ 5.188 \\ -6.662 \end{pmatrix}$
IND	$\begin{pmatrix} 26.33 \\ 21.56 \\ 26.79 \end{pmatrix}$	$\begin{pmatrix} 3.561 \\ 2.187 \\ 3.795 \end{pmatrix}$
AFR	$\begin{pmatrix} -0.49 \\ -12.55 \\ 5.66 \end{pmatrix}$	$\begin{pmatrix} -1.452 \\ -2.451 \\ 1.118 \end{pmatrix}$
AME	$\begin{pmatrix} 2.74 \\ -1.60 \\ -17.38 \end{pmatrix}$	$\begin{pmatrix} 0.505 \\ 0.003 \\ -2.368 \end{pmatrix}$
EUA	$\begin{pmatrix} -4.12 \\ 5.09 \\ 2.45 \end{pmatrix}$	$\begin{pmatrix} -0.157 \\ 0.397 \\ 0.314 \end{pmatrix}$
NAZ	$\begin{pmatrix} 2.97 \\ -9.71 \\ 27.90 \end{pmatrix}$	$\begin{pmatrix} 0.570 \\ -0.439 \\ 5.651 \end{pmatrix}$
COC	$\begin{pmatrix} -4.38 \\ 0.81 \\ 2.17 \end{pmatrix}$	$\begin{pmatrix} -4.160 \\ 15.956 \\ 0.419 \end{pmatrix}$

Table 17. Computed relative angular velocity components of each plate-pair for model GE1.
($\omega \cdot 10^{-7}$ deg/yr)

AME-PAC $\begin{pmatrix} 3.117 \\ -5.185 \\ 4.294 \end{pmatrix}$	NAZ-PAC $\begin{pmatrix} 3.182 \\ -5.627 \\ 12.313 \end{pmatrix}$	COC-NAZ $\begin{pmatrix} -4.730 \\ 16.392 \\ 5.232 \end{pmatrix}$
NAZ-AME $\begin{pmatrix} 0.065 \\ -0.442 \\ 8.019 \end{pmatrix}$	EUA-PAC $\begin{pmatrix} 2.455 \\ -4.791 \\ 6.976 \end{pmatrix}$	AFR-EUA $\begin{pmatrix} -1.295 \\ -2.848 \\ 0.804 \end{pmatrix}$
EUA-AME $\begin{pmatrix} -0.662 \\ 0.394 \\ 2.682 \end{pmatrix}$	PAC-IND $\begin{pmatrix} -6.173 \\ 3.001 \\ -10.457 \end{pmatrix}$	IND-EUA $\begin{pmatrix} 3.718 \\ 1.790 \\ 3.481 \end{pmatrix}$
AFR-AME $\begin{pmatrix} -1.957 \\ -2.454 \\ 3.486 \end{pmatrix}$	PAC-ANT $\begin{pmatrix} -2.851 \\ 5.364 \\ -7.304 \end{pmatrix}$	IND-APR $\begin{pmatrix} 5.013 \\ 4.638 \\ 2.677 \end{pmatrix}$
AME-ANT $\begin{pmatrix} 0.266 \\ 0.179 \\ -3.010 \end{pmatrix}$	COC-PAC $\begin{pmatrix} -1.548 \\ 10.768 \\ 7.081 \end{pmatrix}$	AFR-ANT $\begin{pmatrix} -1.691 \\ -2.275 \\ 0.476 \end{pmatrix}$
COC-AME $\begin{pmatrix} -4.665 \\ 15.953 \\ 2.787 \end{pmatrix}$	NAZ-ANT $\begin{pmatrix} 0.331 \\ -0.263 \\ 5.009 \end{pmatrix}$	IND-ANT $\begin{pmatrix} 3.322 \\ 2.363 \\ 3.153 \end{pmatrix}$

Table 18. Comparison between the computed relative angular velocity of each plate-pair for model GE1 with that observed by Chase, 1972. Also listed are the results of model GC2.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AME-PAC					
Observed	7.86		52	-73	
GC2	7.42	0.94	35.36	-58.99	19.40
GE1	7.42	0.94	35.36	-58.99	19.40
NAZ-AME					
Observed	7.35		60	-129	
GC2	8.03	1.09	86.81	-81.63	27.93
GE1	8.03	1.09	86.81	-81.63	27.93
EUA-AME					
Observed	2.36		48	155	
GC2	2.74	1.16	73.61	159.50	25.69
GE1	2.79	1.18	73.97	149.24	26.09
AFR-AME					
Observed	3.44		66	-29	
GC2	3.69	1.07	50.61	-79.97	29.71
GE1	4.69	1.36	48.00	-51.42	21.49

Table 18. Cont'd 1.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ) $^{\circ}$	Long. (λ) $^{\circ}$	Pole misfit (Z) $^{\circ}$
AME-ANT					
Observed	3.30		-64	-73	
GC2	3.02	0.92	-81.33	39.84	30.35
GEL	3.02	0.92	-83.92	33.93	24.87
COC-AME					
Observed	17.3		27	-119	
GC2	16.85	0.97	9.52	106.30	122.89
GEL	16.85	0.97	9.52	106.30	122.89
NAZ-PAC					
Observed	14.6		59	-97	
GC2	13.91	0.95	62.30	-60.51	17.93
GEL	13.91	0.95	62.30	-60.51	17.93
EUA-PAC					
Observed	8.85		63	-90	
GC2	8.82	0.997	51.73	-64.04	17.75
GEL	8.81	0.995	52.34	-62.86	17.78

Table 18. Cont'd 2.

Plate-pairs	Rate. 10^{-7} deg/yr	Speed factor	Lat. (ϕ)°	Long. (λ)°	Polemisfit (Z)°
PAC-IND					
Observed	12.9		-58	174	
GC2	12.51	0.97	-56.72	154.07	10.79
GEL	12.51	0.97	-56.72	154.07	10.79
PAC-ANT					
Observed	9.76		-70	107	
GC2	9.52	0.98	-49.89	116.80	20.64
GEL	9.50	0.97	-50.25	117.99	20.42
COC-PAC					
Observed	23.7		36	108	
GC2	12.98	0.55	33.06	98.18	8.60
GEL	12.98	0.55	33.06	98.18	8.60
NAZ-ANT					
Observed	5.76		36	-114	
GC2	5.04	0.88	84.98	-19.87	54.52
GEL	5.03	0.87	85.17	-38.47	52.64

Table 18. Cont'd 3.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ)°	Long. (λ)°	Pole misfit (Z)°
COC-WAZ					
Observed	11.9		8	-116	
GC2	17.84	1.50	-17.05	106.09	138.61
GEL	17.84	1.50	-17.05	106.09	138.61
AFR-EUA					
Observed	3.28		25	-27	
GC2	2.61	0.79	4.84	-82.98	57.25
GEL	2.32	0.98	14.41	-65.54	37.65
IND-EUA					
Observed	8.04		22	25	
GC2	5.52	0.69	39.80	26.84	17.87
GEL	5.39	0.67	40.15	25.70	18.16
IND-AFR					
Observed	6.33		15	48	
GC2	6.56	1.04	30.28	52.32	15.79
GEL	7.33	1.15	21.40	42.77	8.10

Table 18. Cont'd 4.

Plate-pairs	Rate $\cdot 10^{-7}$ deg/yr	Speed factor	Lat. (ϕ)°	Long. (λ)°	Pole misfit (Z)°
AFR-ANT					
Observed	2.62		4	-51	
GC2	2.02	0.77	-3.95	-88	38.15
GE1	2.87	1.09	9.53	-53.37	6.01
IND-ANT					
Observed	6.50		16	24	
GC2	5.27	0.81	36.99	36.01	23.54
GE1	5.15	0.79	37.72	35.42	23.94

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Appendix A

Calculation of the inertia tensor and inverse tensor

A plate is considered to consisting of a number of normalized $10^\circ \times 10^\circ$ unit elements with its centre at the Earth's equator. Such elements may be entirely within the boundaries of the plate under consideration, or they may straddle one of those boundaries and belong, in part, to one or two other plates. The area of an unit element with boundaries at latitude ϕ and $\phi + 10^\circ$ is defined by $[\sin(\phi + 10^\circ) - \sin\phi]$.

The mass centre of the radius vector is first located by dividing the element into a great number of narrow zones or strips with boundaries parallel to the equatorial planes. It is then possible to derive the inertia tensor of each strip. The inertia tensor of a plate is obtained by matrix addition of the inertia tensors of all its elements (or parts of elements). The inverse of the inertia tensor is calculated from the equation,

$$I_{ij}^{-1} = \frac{\text{adj}I_{ij}}{|I_{ij}|} = \frac{[\text{cof}I_{ij}]^T}{|I_{ij}|}$$

where $|I_{ij}|$ is the determinant of I_{ij} , $\text{adj}I_{ij}$ the adjoint of the matrix of I_{ij} , and $[\text{cof}I_{ij}]^T$ the transpose of cofactor matrix of I_{ij} .

END

29 | 1 | 2 | 8 | 1

FIN