CREATIONISM AND CONTINENTAL DRIFT

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Calculations of the energy needed for continental drift as well as the energy dissipated by it show that classical continental drift will not fit into a creationist framework. If it is believed that the continents were at one time joined, then either God separated them in a manner in which the laws of nature were not involved or the earth expanded in such a way that the viscous forces were not involved.

Over the past few years, in response to the overwhelming geologic evidence, many creationists have embraced a modified form of the continental drift model. The main difference between secular and creationist drift models is the amount of time believed necessary for continental separation to occur. Stuart Nevins believes that,

> "The cause for the ancient breaking up of continents can be explained easily by the enormous catastrophic forces of Noah's Flood which broke the lithosphere into moving plates which for a short time overcame the viscous drag of the earth's mantle."[1]

Mark W. Tippetts in a recent article concerning continental separation stated,

> "Since neither rates of geological processes nor the amount of time between events is known, it is mostly a matter of speculation as to the amount of time necessary to form the geological record as seen in the rocks of the earth's crust. Therefore, this author is free to use as little time as seems necessary to agree with the time indicated from a literal interpretation of Scripture."[2]

Scientifically, are we free to use any length of time we feel is necessary to separate the continents ? This article is intended to demonstrate certain constraints on any continental separation and the place to start is to investigate what the effects would be of moving the continents around in a short time span as Nevins believes.

Philosophically, there are only four ways that the continents could be separated. First, God, himself, could have separated them outside of the natural laws of physics. If this is believed, the reader need not go further, for the matter is outside the realm of science. Secondly, an expansion of the earth would separate the continents effectively. Thirdly, forces acting at the surface of the earth could push the continents apart. Finally, motion in the mantle could drag the continents apart. These last two possibilities will be examined further.

Unfortunately, most creationists when discussing continental separation not only fail to specify which of these latter two forces are responsible for the separation but also fail to describe their nature precisely. Therefore, this article will examine the effects of separating the continents in a 5000 year time frame for convectional forces and surface forces.

Subsurface Forces

About the only conceivable mechanism for separating the continents by subsurface forces is the convection cell.† It can be shown that the maximum velocity in the vertical direction for a steady-state convection cell is (see appendix) $V_0 = T_0\,(g\varrho\nu\alpha/3\mu\psi)^{1/2}$ where T_0 is the temperature *difference* between the upward flowing mantle stream and the surrounding mantle, g is the acceleration of gravity, ϱ is the density, ν is the coefficient of expansion, α is the thermal diffusivity, μ is the viscosity of the mantle and ψ is the temperature gradient in the vertical.[3]

Before evaluating this expression we need to determine T_0 and $\mu \bullet \mu$, the viscosity has been determined from the isostatic rebound of Fennoscandia to be of the order of 10^{22} poise.‡. However, since the calculations involve certain uniformitarian assumptions which would not be acceptable to creationists as a whole, it seems reasonable to re-evaluate the viscosity and see if it might be smaller.

The equation from which the viscosity is determined will not be derived here, but it is [4] given by $\mu = \zeta\Delta t\varrho' g)/(2n\Delta\zeta)$ where ζ is the original displacement in the vertical, $\Delta\zeta$ is the uplift which has occurred in Δt *time*, ϱ' is the density of the displaced asthenosphere approximately equal to 3.3, and n is a constant which depends upon the horizontal extent of the load. $n^2 = l^2 + m^2$ where $l = \pi/A$, $M = \pi/b$ and A and B are the orthogonal dimensions of the load.

Uniformitarian methods estimate that the central area of Fennoscandia has risen 130 m from 5000 B. C. to 1950 A. D. Gravity anomalies indicate that the area should rise 150 m more before equilibrium is established. The orthogonal dimensions of the ice cap is estimated to have been 1200 km. by 1800 km. Using these values the viscosity is estimated to be $\mu = 2.4 \times 10^{22}$ poise. Although this value is probably fairly close to the actual value, it is instructive to calculate the viscosity based upon the assumption that the time is off by a factor of 2. This would mean a change of 130 m in elevation since 1525 B. C. Thus $\mu = 1.2 \times 10^{22}$ poise. Therefore, it would appear that an estimate of 10^{22} poise for the viscosity of the mantle would be of the correct order of magnitude. For comparison, thick honey has a viscosity of around 100 poise while for water it is 0.01 poise.

The temperature inside of the convection cell is the

†A convection cell, is analogous to a vat of liquid, heated at one end. The warmed liquid, being lighter, rises and moves to the other end, where it cools and sinks. Thus convection currents are set up; and anything floating on the surface would be carried along with the current.

‡Viscosity is a measure of how difficult it is to get a liquid to flow. Thus the viscosity of molasses is greater than that of water. A unit of viscosity is the poise; the more poises the thicker, in the sense of not flowing readily, is the liquid.

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only other parameter which needs to be determined the temperature *in excess* of the thermostatic condition can be determined by the amount of uplife at an oceanic ridge.[5] If the upwelling plume is T_0 hotter than the surrounding mantle, then the density in the plume is $\Delta\varrho = \varrho_m \nu T_0$ less than the surrounding mantle. ϱ_m is the mean density of the mantle. If D is the depth of the plume, the net bouyancy force upwards per unit area is $F = \varrho_m \nu T_0 D g$. This force is balanced by the extra weight of the ridge.

If h is the height of the ridge, ϱ_w is the density of water and ϱ_r is the density of the ridge material, the excess weight per unit area is $F = (\varrho_r - \varrho_w) gh$. Equating the two forces yields $T_0 = h(\varrho_r - \varrho_w)/)\varrho_m \nu D)$. Letting $\varrho_r = 3.3$, $\varrho_w = 1$, $\varrho_m = 4.0$, h=1 km, and D=200 km, and $\nu = 2 \times 10^{-5}/°C$, gives $T_0 = 143$ °C.

Substituting the expression for T_0 into that for V_0 gives $V_0 = h[(\varrho_r - \varrho_w)/\varrho_m \nu D]\ [g\varrho\nu\alpha/3\mu\psi]^{1/2}$.

When the relation found for T_0 is used $\varrho = \varrho_m(1-\nu T_0)$, $\varrho = 3.98$ if $\varrho_m = 4.0$. Using all previously defined values and $\alpha = 0.01$ and $\psi = 1$ °C/km, we have, $V_0 = 7.3 \times 10^{-9}$ cm/sec = .23 cm/year.

As a point of comparison, the velocity needed for continental drift to have occurred in the past few thousand years is enormous next to the theoretical velocity. If a shelfedge is 1500 km from a ridge and the drift occurred over a period of 5000 years, the average velocity must be 300 meters per year. If this rate were continuing today it would be measurable. Since no movement of this magnitude is measurable, the next question which must be asked is could the velocity have varied exponentially; say $V = V_0\ exp(-\omega t)$? This would mean that some parameter determining V_0 would have to vary exponentially. It is difficult to see any of these except T_0 varying in time. If T_0 were the cause of the variation, T_0 would be equal to 18 million degrees centigrade hotter than the surrounding mantle in order for V_0 to be equal to 300 m/yr. Obviously this is too hot. The only other possibility is that the mantle's viscosity has been seriously overestimated. However, this seems unlikely.

Thus it is concluded, that convection cells cannot account for the separation of the continents in a creationist framework.

Surface Forces

As mentioned above most creationists when discussing continental separation fail to specify the precise nature of the forces involved. The examination of surface forces presented below will not specify what forces could be responsible either. This means that the result of pushing or pulling the continents apart by means of forces acting on the surface of the earth will be applicable regardless of the forces involved.*

If the continents are moving at a constant velocity U in the x-direction, hydrodynamics tells us that there will be some depth h such that the velocity of the mantle material will be zero.[6] If F_0 is the tangential component of this force per unit area, then the total force will be $F_0 bl$ where b is the width and l the length of the region under consideration. The frictional force can be shown to be $(\mu bl)\ (\partial u/\partial z)$, where u is the velocity of the fluid. Since the motion is steady these two forces must balance. Therefore,

$$\frac{du}{dz} = \frac{-F_0}{\mu}$$

Integrating

$$u = C - \frac{F_0}{\mu} z$$

where C is the constant of integration.

Since at $z=0$, $u=0$ and at $z=h$, $u=U$ we have $F = -uU/h$ and $C=0$. Therefore, $u = Uz/h$. Motion like that described is called plane couette flow. The velocity varies linearly from 0 at z=0 to U at z=h.

The rate of temperature rise during such motion due to the frictional dissipation of heat is

$$\varrho C_v \frac{\partial T}{\partial t} = \mu \left[\frac{\partial u}{\partial z}\right]^2$$

where ϱ is the density of the mantle, C_v is the specific heat of the mantle, T is the temperature and t is the time.[7]

This, with the relation for u, gives:

$$T = \frac{\mu U^2 t}{\varrho C_v h^2} \Bigg|_{t_0}^{t_1}$$

If $U = 300$ m/yr, $\mu = 10^{22}$ poise, $\varrho = 4$, $C_v = 0.2$ (the value for basalt), $t_0 = 0$, and $t_1 = 5000$ years $= 1.57 \times 10^{11}$ sec, and giving h the ridiculous value of the radius of the earth, we find that the temperature of the earth after such movement would be $T = 4.3 \times 10^9$ °C Thus it must be concluded that the temperature rise due to the movement of the continents through the mantle, regardless of the forces involved would vaporize the earth if it occurred within the time frame allotted to creationists.

These results show that neither convection cells nor any other forces could have separated the continents within a few thousand years, *if the viscous forces were involved in that movement.* This leaves only two possibilities to explain the fit of the continents. Either God separated the continents outside of natural agencies or that the earth expanded in such a way that the viscous forces were not involved. The expansion of the earth caused by an expansion of each individual atom due to a change in the permittivity of free space (the electric force) is a possibility which could avoid the viscosity problem.

Appendix A

Figure 1 shows the model of a convection cell with the origin taken as the base of the cell. We will assume a linear thermostatic temperature gradient (ψ) which on average is 1 °C/km. The temperature which will be used in this derivation will be the temperature in *excess* of the thermostatic gradient. Similarly, the pressure (P) will be defined as that in *excess* of the hydrostatic pressure which is ϱgz.

*A situation of the sort might be set up in a deep pan of taffy, if one were to push horizontally on the top of the taffy, the bottom layer, in contact with the bottom of the pan, remaining stationary.

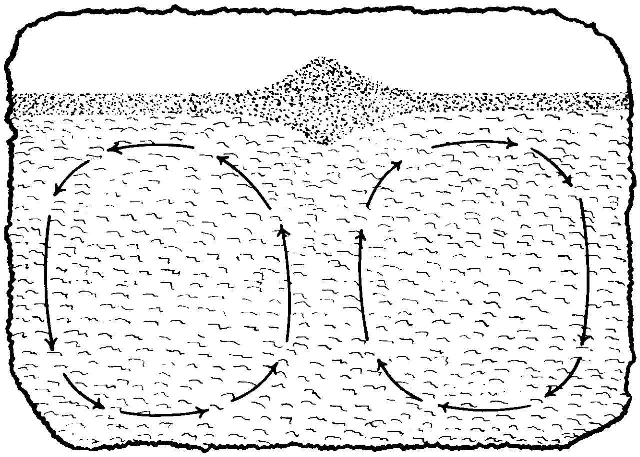

Figure 1. This shows a model of a convection cell. In the analogue of a heated vat of liquid, here the heat would have been applied under the middle of the vat.

The density of the mantle will be assumed to vary only with the temperature, according to $\varrho = \varrho_m(1-\nu T)$ where ϱ_m is the hydrostatic, thermostatic density, ν is the volumetric coefficient of expansion and T is the temperature in excess of the thermostatic condition.

The first three equations governing the motion of a steady-state convection cell are simply the equations of motion of a viscous fluid. These are:

$$-\frac{\partial P}{\partial x} + \mu\nabla^2 V_x = 0 \qquad (1)$$

$$-\frac{\partial P}{\partial y} + \mu\nabla^2 V_y = 0 \qquad (2)$$

$$-\frac{\partial P}{\partial z} + \mu\nabla^2 V_z - g\varrho\nu T = 0 \qquad (3)$$

where μ is the coefficient of viscosity and V_x, V_y, V_z are the components of velocity.

The fourth equation is the equation of continuity

$$\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} = 0 \qquad (4)$$

The final equation is the heat flow equation

$$\alpha\nabla^2 T = \frac{\partial T}{\partial t} = \psi V_z \qquad (5)$$

where α is the thermal diffusivity and t is the time.

We will assume that the velocities and excess temperature and pressure in the x-y plane can be represented by harmonics. Letting

$V_x = V_x(z)e^{ilx}e^{imy}$
$V_y = V_y(z)e^{ilx}e^{imy}$
$V_z = V_z(z)e^{ilx}e^{imy}$
$P = P(z)e^{ilx}e^{imy}$
$T = T(z)e^{ilx}e^{imy}$

and substituting these into Equations (1) through (5) we have

$$-ilP + \mu(-l^2V_x - m^2V_x + \frac{d^2V_x}{dz^2}) = 0 \qquad (6)$$

$$-imP + \mu(-l^2V_y - m^2V_y + \frac{d^2V_y}{dz^2}) = 0 \qquad (7)$$

$$-\frac{dP}{dz} + \mu(-l^2V_z - m^2V_z + \frac{d^2V_z}{dz^2}) - g\varrho\nu T = 0 \qquad (8)$$

$$ilV_x + imV_y + \frac{dV_z}{dz} = 0 \qquad (9)$$

$$\alpha(-l^2T - m^2T + \frac{d^2T}{dz^2}) = \psi V_z \qquad (10)$$

Taking the derivative with respect to z of Equations (6), (7), and (9) we have

$$-il\frac{dP}{dz} + \mu(-l^2\frac{d}{dz} - m^2\frac{d}{dz} + \frac{d^3}{dz^3})V_x = 0 \qquad (11)$$

$$-im\frac{dP}{dz} + \mu(-l^2\frac{d}{dz} - m^2\frac{d}{dz} + \frac{d^3}{dz^3})V_y = 0 \qquad (12)$$

$$il\frac{dV_x}{dz} + im\frac{dV_y}{dz} + \frac{d^2V_z}{dz^2} = 0 \qquad (13)$$

Multiplying Equation (11) by il and Equation (12) by im, adding and substituting from Equation (13) we have

$$\frac{dp}{dz} = \frac{-\mu}{l^2+m^2}(-l^2-m^2+\frac{d^2}{dz^2})(-\frac{d^2V_z}{dz^2}) \qquad (14)$$

Substituting this into equation 8 we have,

$$-\frac{-\mu}{l^2+m^2}(-l^2-m^2+\frac{d^2}{dz^2})(\frac{d^2V_z}{dz^2}) + (-l^2-m^2+\frac{d^2}{dz^2})V_z - g\varrho\nu T = 0 \qquad (15)$$

We have now reduced our problem to two unknowns and two equations: (10) and (15). At the top and bottom of the cell all motion is horizontal so $V_z = 0$. Equally at the top and bottom of the cell the temperature is not in excess of the thermostatic condition. Therefore $T = 0$. If we assume that $V_z = V_0 \sin(kz)$ and $T = T_0 \sin(kz)$ where the depth of the convection cell is $D = \pi/k$ substituting that into Equations (10) and (15) gives

$$(l^2+m^2+k^2)^2V_0 + g\varrho\nu(l^2+m^2)T_0 = 0 \qquad (16)$$

and

$$\psi V_0 + \alpha(l^2+m^2+k^2)T_0 = 0 \qquad (17)$$

The determinant of the coefficients has to be equal to zero if these equations are to have a solution. This means

$$(l^2 + m^2 + k^2)^3 - \frac{g\varrho\psi\nu}{\mu\alpha}(l^2 + m^2) = 0 \qquad (18)$$

Rearranging

$$k^2 = \left[\frac{g\varrho\psi\nu}{\mu\alpha}(l^2 + m^2)\right]^{1/3} - (l^2 + m^2) \qquad (19)$$

Letting $k^2 = y$, $l + m^2 = x$, and $(g\varrho\psi\nu/\mu\alpha)^{1/3} = a$, puts Equation (19) into the form $y = ax^{1/3} - x$, or:

$$\frac{dy}{dx} = (1/3)ax^{-2/3} - 1 = C \qquad (20)$$

where C is the value which this equation has, given x. Using equation 20, solving for a and substituting into the equation for y gives $y = [3(C+1)-1]\,x$. Therefore:

$$(l^2 + m^2) = \frac{k^2}{3(C-1) - 1} \qquad (21)$$

Solving for V_0 in both Equations (16) and (17) and multiplying the results we have:

$$V_0 = T_0\left[\frac{g\varrho\nu\alpha(l^2+m^2)}{\mu\psi(l^2+m^2+k^2)}\right]^{1/2} \qquad (22)$$

Substituting Equation (21) into Equation (22) gives:

$$V_0 = T_0\left[\frac{g\varrho\nu\alpha}{3\mu\psi(C+1)}\right]^{1/2} \qquad (23)$$

Obviously V_0 is a maximum when $C = 0$. In this case Equation (23) reduces to:

$$V_0 = T_0\left[\frac{g\varrho\nu\alpha}{3\mu\psi}\right]^{1/2} \qquad (24)$$

References

[1] Nevins, Stuart, 1978. Continental drift, plate tectonics, and the Bible. (In) Up with creation, edited by D. T. Gish and D. H. Rohrer. Creation-Life Publishers, San Diego, P. 178.

[2] Tippetts, Mark W., 1979. Pangaea shattered. *Creation Research Society Quarterly* 16 (1): 7-15, and 83.

[3] Officer, Charles B., 1974. Introduction to Theoretical Geophysics. Springer-Verlag. Most of the derivations of this equation can be found on pp. 373-377 of this book.

[4] *Ibid.*, p. 370.

[5] Phillips, O. M., 1968. The heart of the earth. Freeman, Cooper, and Co., San Francisco. The derivation of the temperature equation can be found on pp. 221 and 222.

[6] Rogers, Ruth H., 1978. Fluid mechanics. Routledge and Kegan Paul, Pp. 94 and 97.

[7] Bird, R. B., W. E. Stewart, and E. N. Lightfoot, 1960. Transport phenomena. John Wiley and Sons, New York. Pp. 315 and 316.

More Thoughts on the Doppler Effect

(Continued from page 79)

plainly be when it was at its farthest from the Earth, behind the dim star. The eclipse, which is an interruption of the light, surely travels at the same speed as the light; so the Doppler effect must do likewise.

The question being discussed could be stated well in terms of ethers. I know that "ether" is not a popular word in physics nowadays. But if one is to have a wave theory, there has to be something; there can not be waves in, on, of, etc., nothing at all. And "ether" has a fairly definite meaning; whereas "space", "vacuum" etc., mean also many other things.[5,6] I am not saying, of course, that one must accept one of the mechanical models of the ether, which were so popular in the last century.

Now there might be any of three situations: (i) a communal ether; (ii) each source has its own private ether, attached somehow to it and moving with it; or, (iii) likewise each receiver. (Let us say "receiver" rather than "observer", a terribly overused and mis-used word nowadays.) (i) is the situation as Maxwell, e.g., envisaged it. (ii) is a modification of Ritz's view, suggested for consideration by Dingle.[7] (iii) is oddly like a view, mentioned by Aristotle as common (but which he did not share) that vision is something going out from the eye and reaching the thing seen.[8]

If (ii) were true, the Doppler effect, due to motion of the source, would be propagated instantaneously. So it seems to be ruled out. If (iii) were true, the Doppler effects, due to the Earth's motion, for stars at different distances, would take different times to reach the Earth; hence would be seen at different times. But stars in the same direction all show the same Doppler effect at the same time; so (iii) is ruled out. So (i) must be true; we are back to the situation much as Maxwell envisaged it.

References

[1] Slusher, Harold S., 1980. Cosmology and Einstein's postulate of relativity. *Creation Research Society Quarterly* 17 (3):146-147.

[2] Ritz, Walther, 1908. *Recherches critiques sur l'electrodynamique générale. Annals de Chimie et de Physique*, 8 série, t. XIII, pp. 145 et seq..

[3] de Sitter, W., 1913. *Ein astronomischer Beweis fur die Konstanz der Lichtgeschwindigkeit. Physikalische Zeitschrift* XIV (10): 429.

[4] Payne-Gaposchkin, Cecilia, and Katherine Haramundanis, 1970. Introduction to astronomy. Second ed. Prentice-Hall. Pp. 351-358.

[5] Jánossy, L., 1971. Theory of relativity based on physical reality. Akademiai Kiadó, Budapest. See especially pp. 48 and 49, where it is pointed out that even Einstein was of two minds about the ether.

[6] Clube, S.V.M., 1980. The material vacuum. *Monthly Notices of the Royal Astronomical Society* 193 (2): 385-397. Arguments are given for what is in effect an ether much like that envisaged by Lorentz and others.

[7] Dingle, Herbert, 1960. The Doppler effect and the foundations of physics. *British Journal for the Philosophy of Science* XI, (41): 11-31; and (42): 113-129. See especially page 18.

[8] See, e.g., his On sense and sensibles, Chapter 2; and Topics, Book 1, Chapter 14.