point. I expect to gradually publish this evidence as time permits.

Except for rather obvious evidence of impacting (less than 200) in the rocks, I would not expect the uniformitarian scientists to see much of this evidence, since they do not expect it. After all, they reject the Genesis Flood, and cannot see the abundant evidence for the Flood in the rocks and fossils.

Mr Hunt points to the asteroid belt and wonders why it exists. Nobody really knows. It can't be the result of an asteroid swarm moving into the solar system because of their precise orbits around the sun. Mr Hunt also suggests the asteroid belt may possibly protect the inner solar system from asteroid bombardments. How could this work? I suggested that it is possible that a large asteroid could have hit a small planet to cause the asteroid belt. If it was an asteroid the size of the one that caused the 2,500-km-diameter South Pole-Aitken crater on the moon or the several craters greater than 2,000 km on Mars, such a small planet would likely shatter.

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Energy balance in Earth models

I was very interested to read Don Stenberg's two-part article[1,2] proposing a model of Earth history which addresses some of the fundamental problems raised by the conclusions of the RATE (Radioisotopes And The age of the Earth) project. In particular, Stenberg's model holds promise of demonstrating a plausible global energy balance during the inferred period of accelerated nuclear decay. There was at first glance an obvious problem with Stenberg's radiogenic heating calculation,[3] but these have now been corrected by Reece.[4]

However, I believe that Stenberg's calculation also overlooks a critically important energy sink, which, if handled correctly, can add a good measure of robustness and flexibility to his model. He notes[5] that potential energy would have been released by separation of the mantle as the earth heated up, and estimates that this would have produced about 3.1 × 10^{30} Joules of additional heating. A correct estimate of the energy change due to radial redistribution of material within the earth requires evaluation of the difference in gravitational potential energy between the initial and final configurations. The total gravitational potential energy *U* of a uniform sphere of mass *M* and radius *R* is[6]

$$U = \frac{-3GM^2}{5R}$$

where *G* is the Newtonian constant of gravitation. Hence the increase in potential energy when a uniform sphere expands from radius R_0 to R_1 (i.e. when material is lifted in a gravitational field, which involves doing work against gravity, and therefore represents an energy sink) is

$$U = \frac{-3GM^2}{5}\left(\frac{1}{R_0} - \frac{1}{R_1}\right).$$

Using $G = 6.673 \times 10^{-11}\ \mathrm{m^3kg^{-1}s^{-2}}$ and $M = 5.974 \times 10^{24}$ kg,[7,8] together with Stenberg's radius figures of $R_0 = 6.128 \times 10^3$ km and $R_1 = 6.378 \times 10^3$ km, we deduce = 9.138 × 10^{30} J.

However, since the earth models of interest have a layered or onion-like structure, a more realistic estimate of the energy change involves calculating *U* region-by-region for Stenberg's 'before' and 'after' configurations. We assume spherical symmetry and also that the density remains constant within any given region. The calculation proceeds by considering the incremental contribution to *U* of a thin shell of material of density ρ(r) and thickness *dr* when the mass of material within this radius is *m(r)*. The mass of this shell is

$$dm = 4\pi r^2 p(r)\,dr$$

and hence its contribution to gravitational potential energy is

$$dU = \frac{-Gm(r)\,dm}{r} = 4\pi Gm(r)p(r)rdr$$

If the outer radius is R_E we deduce

$$U = -4\pi G\int_0^{Rg} m(r)p(r)\,rdr.$$

If, counting outwards from the centre, the regions are labelled 1, 2, 3, and so on, then the gravitational potential energy for the innermost region is simply

$$U = \frac{-3GM_1^2}{5R_1}.$$

For the second region the result is

$$U_2 = \frac{-3GM_2}{2\left(R_2^3 - R_1^3\right)}\left[M_1\left(R_2^2 - R_1^2\right) + M_2\frac{2R_2^5 - 5R_2^2R_1^3 + 3R_1^5}{5\left(R_2^3 - R_1^3\right)}\right]$$

and similarly for subsequent regions; for regions 3 and beyond the first term inside the square brackets must include the *total* mass inside the current region, such that becomes, and so on. The total for a model involving *n* such regions is then simply

$$U = \sum_{i=1}^{n} U_i.$$

The result of this calculation (which can be done on a spreadsheet) is that in Stenberg's pre-Flood Earth, $U_i = -2.63 \times 10^{32}$ J and in his present-day Earth, $U_p = -2.5 \times 10^{32}$ J. The energy sink resulting from the expansion is therefore 1.3 × 10^{31} J. Note that this is much larger than Stenberg's estimated potential energy change *and carries the opposite sign* in the global energy balance.

Assuming that we now have at least roughly correct figures for radiogenic heating (1.62 × 10^{31} J according to Reece, 1.54 × 10^{31} J according to my own calculations) and for the heat required for partially melting the earth's core and heating up its mantle (1.1 × 10^{31} J),[5] the energy sink represented by expansion is much larger than required for the energy balance. I therefore suggest that a larger pre-Flood Earth, corresponding to a smaller proposed expansion and a smaller rise in gravitational potential energy, would provide a better model than that proposed by Stenberg. It should not then be difficult to balance global energy changes.

This analysis does not, of course, deal with more detailed issues of, for example, mineral and element distributions and changes in these through the Flood, which requires input from geologists. However one further point needs attention: in Stenberg's model the outer core is given a higher density (15.7 gm/cc) than the inner core (13.0 gm/cc), which is a highly unstable density distribution, since if the core material can flow at all it will be subject to a Rayleigh–Taylor instability.[9–12] This is another reason why, I suggest, changes to Stenberg's model can and should be made. His model certainly seems worthy of further development by creation scientists.

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» Don Stenberg replies:

I appreciate William Worraker's analysis showing how the increasing potential energy of an expanding Earth during the Flood could serve as a significant heat sink for heat from accelerated radioactive decay. He sensibly suggests that perhaps the pre-Flood earth was somewhat warmer and larger than I propose in my model to account for the amount of energy released during accelerated decay. However, I hesitate to embrace that solution for now for two reasons. The first reason is that if the earth expanded less that I proposed in my model, then the mystery of pre-Flood corals which appear to record ~400-day years (or ~22-hour days) would remain unsolved. The second reason is that a warmer pre-Flood Earth could not have had a permanently magnetized core, thus leaving unsolved the mystery of the changing lifespans of the biblical patriarchs. In light of the significant heat sink that an expanding Earth provides, my preference is to consider instead if there are heat sources that I have not yet accounted for. For instance, my calculations have thus far assumed negligible heat from extinct radionuclides, but it is conceivable that they could have provided as much or more heat during accelerated decay as the four major isotopes that I included in my analysis. Clearly more work is needed on these important questions.

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Starlight, time and the new physics

Since John Hartnett published his young universe model in 2007 in *Starlight, Time and the New Physics*,[1] he has met with little challenge, at least publically. Yet, upon investigation, the construction of his model demonstrates striking weaknesses, one of which may be dire. About four difficulties are discussed below. While his math may seem robust, it is only as good as the structure it builds. Surprisingly, it is something so elementary in nature which may undermine his efforts and ultimately bring the model down. Since, in the discussion of his ideas, Hartnett was deliberately silent about the beginning, his response to this challenge should evoke a full disclosure of the mechanics of the model from the very outset of creation. On that explanation will hang the fate of his ideas.

Hartnett may himself be using a fudge factor to help eliminate another 'fudge factor'. A key motivation for his work (*Starlight, Time and the New Physics*, p. 122) is to obviate the need for dark matter, which to him is only another big bang fudge factor (p. 14). However, to attain his goal, he overreaches and upsets physical convention to add a new dimension to the spacetime metric—'spacevelocity'. In truth, his 5D universe adds a second temporal term to our otherwise conventional 4D spacetime. To him, there are two time dimensions. But if you know even the basics of metrics and the physical orientations of their terms, it is not at all surprising that a bonus dimension might well give the appearance of solving the problem of galaxy rotation curves (a feat to which he lays claim in Appendix 3). This may prompt another physicist to insist that what Hartnett has found is a mathematical explanation for the effects of halo dark matter on galaxy rotations, which mimics a fifth dimension in the spacetime metric! And who could argue? After all, neither dark matter nor the spacevelocity dimension currently exist as anything more than theoretical constructs. Neither has yet been demonstrated to be a physical feature of our universe. So which is the real 'fudge factor'? It's all a matter of perspective and bias. Hartnett says