

mated age of the earth must be again extended. The rhythmic acceleration of geological processes lengthens the estimates based on sedimentation, but would affect the biological argument inversely, since at periods of rapid physical change biological change would have been quickened, and thus the occasional abrupt introduction of a new fauna does

not necessitate so long an interval as has been thought.

The best-known geological estimates of the age of the earth require to be multiplied ten- or twenty-fold in order to agree with the physical estimates, but this increase is consistent with the geological evidence.

By DR. HAROLD JEFFREYS.

THE rate of denudation must have varied very considerably during the earth's history, for it depends on both the height of the land and on the meteorological conditions, both of which have certainly changed very much from time to time. The consistency of the various geological methods among themselves does not prove that there has been no change in the rate of denudation, for such a change would affect them all in the same ratio.

Prof. Eddington's argument shows that there must be an unknown source of energy in the Cepheid variables. It is possible, however, to infer from the condition of the earth that its own age must be much greater than the Kelvin theory allows, and therefore the sun itself must have such a source of energy. The rate of increase of temperature downwards in the earth's crust is the sum of three parts, one depending on the original temperature at the surface, one on the original increase of temperature downwards, and one on the radio-active emission of heat. With the best data available, supposing the time elapsed since solidification to be 1.6×10^9 years, all the known facts regarding the earth's thermal condition can be co-ordinated. If the age is supposed to be 1.6×10^7 years, however, the data cannot be reconciled: the part of the increase of temperature downwards depending on the initial temperature at the surface is by itself greater than the present rate.

If we force an approximate agreement by supposing that the original temperature was uniform and that radio-activity does not exist at depths greater than a kilometre, we can calculate the amount of surface compression available for mountain building, the thickness of the layer of the crust which has cooled considerably and therefore become geologically strong, and the depth to which compressive movements in the crust extend. In each case the results are inconsistent with the geological and geodetic evidence, while the greater estimate of the age of the earth agrees well. We have, in fact, the following comparison:—

	Calculated.		Actual.
	Assumed age of earth		
	1.6×10^9 years.	1.6×10^7 years.	
Area compressed (km. ²) ...	49×10^9	5×10^9	$> 19 \times 10^9$
Greatest depth of considerable cooling (km.) ...	300	30	100-400
Depth of compressive movements (km.)	70	1
			> 10

I do not agree with Lord Rayleigh's suggestion that the earth must be becoming hotter. That hypothesis is not acceptable on cosmogonical grounds, and Dr. Holmes has shown that it is impossible to reconcile it with the existence of volcanic temperatures, and that there must be a concentration of radio-active matter in the upper layers of the crust. Dr. Holmes has told me privately that there is reason to believe that in a fluid magma the radio-active materials will be concentrated in the upper layers on account of the volatility of their compounds, but I do not know whether this argument has been published. The numerical estimates here given rest on the supposition of such a concentration.

An alternative estimate of the age may be made from the tidal theory of the origin of the solar system, the only theory which is not unsatisfactory on dynamical grounds. The planets must, on this theory, have moved originally in highly eccentric orbits, and have had their eccentricities gradually reduced by the action of a gaseous resisting medium. If the density of the medium near Mercury was ρ , the time needed to reduce the eccentricity to its present value would be of the order of $4000/\rho$, C.G.S. units being used. On the other hand, the time it would take the medium to be dispersed by viscosity and diffusion would be of the order of $16 \times 10^{20} \rho$. These must be equal; for if the former was the greater the medium would have dispersed before doing the work, and if the latter was the greater the medium would still be a conspicuous object. This shows that the time needed was of the order of 8×10^{16} sec. or 2.5×10^9 years, agreeing with the estimate given by the uranium-lead ratios.

Obituary.

DR. A. S. F. LEYTON.

BY the death of Dr. Albert Sidney Frankau Leyton on September 21, at fifty-two years of age, we lose a worker who, through his researches in pathology, contributed much to medicine. The value of these researches, though appreciated by those who follow closely the advance in scientific medicine, will come to be fully recog-

nised only when the history of the development of that science during the last four decades is written. Dr. Leyton, the son of Joseph Grünbaum, who early in life settled in this country, had a brilliant scholastic career, first in the City of London School and then at Cambridge, where he was elected a scholar of Gonville and Caius College, and proceeding to his