

but always retaining very nearly the same inclination to the plane of the earth's orbit. This motion of the pole changes the position of the equinoxes by about fifty seconds annually, and always in the same direction. Thus the pole-star, after a certain time, will entirely lose its claim to that appellation, until in the course of somewhat more than 25,000 years the earth's axis shall again occupy its present angular position, and again point very nearly as now to the pole-star. This motion of the axis is called *precession*. It is caused by the attraction of the sun and moon, and principally the moon, on the protuberant parts at the earth's equator; and if these parts were solid to a great depth, the motion thus produced would differ considerably from that which would exist if they were perfectly fluid, and incrustated over with a thin shell only a few miles thick. In other words, the disturbing action of the moon will not be the same upon a globe all solid and upon one nearly all fluid, or it will not be the same upon a globe in which the solid shell forms one half of the mass, and another in which it forms only one tenth.

Mr. Hopkins has, therefore, calculated the amount of precessional motion which would result if we assume the earth to be constituted as above stated; *i. e.* fluid internally, and enveloped by a solid shell; and he finds that the amount will not agree with the observed motion, unless the crust of the earth be of a certain thickness. In calculating the exact amount some ambiguity arises in consequence of our ignorance of the effect of pressure in promoting the solidification of matter at high temperatures. The hypothesis least favourable for a great thickness is found to be that which assumes the pressure to produce no effect on the process of solidification. Even on this extreme assumption the thickness of the solid crust must be nearly *four hundred miles*, and this would lead to the remarkable result that the proportion of the solid to the fluid part would be as 49 to 51, or to speak in round numbers, there would be nearly as much solid as fluid matter in the globe. The conclusion, however, which Mr. Hopkins announces as that to which his researches have finally conducted him, is thus expressed: "Upon the whole, then, we may venture to assert, that the minimum thickness of the crust of the globe, which can be deemed consistent with the observed amount of precession, cannot be less than one-fourth or one-fifth of the earth's radius." That is from 800 to 1000 miles.*

It will be remarked, that this is a *minimum*, and any still *greater* amount would be quite consistent with the actual phenomena; the calculations not being opposed to the supposition of the general solidity of the entire globe. Nor do they preclude us from imagining that great lakes or seas of melted matter may be distributed through a shell 400 or 800 miles thick, provided they be so inclosed as to move with it, whatever motion of rotation may be communicated by the disturbing forces of the sun and moon.

* Phil. Trans. 1839, and Researches in Physical Geology, 1st, 2nd, and 3rd series, London, 1839—1842.