of radio-active fortunes supposedly stored in the bowels of the earth. In one of the last annalen, August Becker,[6] studying the lavas of Vesuvius in the Lenard's laboratory, detects no unusual radioactivity in the magmas from deep sources, while Lord Kelvin has lately girded his gravitational vestments anew, and is thundering in the *Times* for a return to the simple life, free from radio-active refinements.

We may summarize, therefore, that in each case specific evidence for the adequate occurrence or the localizations of volcanic heat is wanting. Apart from this the manufacture of volcanoes is as easy as an after-dinner discussion. Suppose, for instance, we all got to work conjointly; let me supply the broth, as I trust, thick and hot, while Elihu Thomson kneads in the energy and Major Dutton bombards the whole with α particles. Could anything withstand us? True there has been stuff predicted

> "Impenetrable, impaled with circling fire,
> Yet unconsumed,"

but this need not be mentioned (at least not in the summer), as it is gravely questioned whether it will fit into the periodic law, and it does not concern us if we are good.

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THE RIGIDITY OF THE EARTH.

TO THE EDITOR OF SCIENCE: In his discussions of the interior condition of the earth (SCIENCE, September 7, 1906, and elsewhere), Professor T. J. J. See advances the proposition that the interior matter of the earth is at the same time fluid and highly rigid. Taking the words in their accepted meaning this is a contradiction in terms. If the intended meaning is that deep-seated material is kept solid only by pressure, it is of course no new hypothesis. The experimental evidence for rigidity, which has been adduced by Kelvin, Darwin and others, concerns, however, only the actual present rigidity of the earth, and has no bearing upon the question whether this is or is not due to pressure.

[6] *Annalen der Physik*, XX., p. 634, 1906.

Professor See's own supposed deduction of the earth's rigidity (*Astronomische Nachrichten*, 4104) apparently rests upon a complete misunderstanding of the meaning of modulus of rigidity. He quotes from Kelvin a definition of this modulus stated in a somewhat unusual form which seems to have misled Professor See as to its meaning, although this is made quite clear by the context. The definition quoted is from the article on Elasticity, Encyclopedia Britannica, Vol. VII., p. 805, and is as follows:

> The modulus of rigidity of an isotropic substance is the amount of normal traction or pressure per unit area, divided by twice the amount of elongation in the direction of the traction or of contraction in the direction of the pressure when a piece of the substance is subjected to a stress producing uniform distortion.

The context shows that this definition refers to a body subjected to a traction in one direction, an equal pressure in a rectangular direction, and zero stress in the third rectangular direction. The accompanying strain is the 'uniform distortion' referred to in the definition. With this understanding the definition is exactly equivalent to the more common definition which immediately precedes the one quoted, and which reads as follows:

> The 'modulus of rigidity' of an isotropic solid is the amount of tangential stress divided by the deformation it produces.

For a fluid the value of the modulus of rigidity as thus defined is necessarily zero. Professor See, however, apparently infers from the definition quoted by him that the modulus of rigidity of any body, solid or fluid, is equal to the normal pressure to which it happens to be subjected. At all events this is the basis of the method by which he computes the rigidity of the earth and of other planets. Assuming Laplace's law of density and the resulting distribution of interior pressure, he computes the average pressure throughout the earth and calls this the mean value of the modulus of rigidity for the earth. Of course, Kelvin's definition admits of no such interpretation.

L. M. HOSKINS.

PALO ALTO, CAL.,
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