as old as the oldest of those figured in the respective memoirs of M. Fraipont and Sir Ray Lankester, carries the usual pair of conical bony horn-cores, which appear to have been devoid of terminal antler-like caps. In place of these being covered with hairy skin, the specimen, as mounted by Messrs. Gerrard, shows, however, that they were invested with (so far as I was able to determine) true horny sheaths, resembling candle-extinguishers, and recalling the terminal sheaths surmounting the hair-covered horn-cores of a prongbuck with newly developing horns figured by Dr. Sclater on p. 540 of the Proc. Zool. Soc. for 1880. Messrs. Gerrard were positive that the sheaths came with the skin, and as they appear to correspond in size with the bony cores, I see no reason to doubt the statement, more especially as the sheaths cannot apparently have pertained to any adult antelope.

Were it not for the fact that Dr. Christy is at present somewhere in the Belgian Congo, collecting on behalf of the Museum at Tervueren, I should have deferred making any statement on the subject until I had communicated with him. But as it may be months before I get a reply to a letter just dispatched (even if it ever reaches its destination), I have considered it advisable to put my observations on record, without, however, for the present, making them the basis of any deductions or speculations.

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Thorium Lead—An Unstable Product.

THE work of Boltwood and Holmes some years ago on the occurrence of lead and uranium in minerals rendered it very improbable that the end product of thorium could be lead. From recent generalisations, however, in respect to radio-elements and the periodic law, it is to be expected that the end products of the radio-active elements should all be isotopic with lead. One method of attacking the problem is the determination of the atomic weight of lead extracted from uranium and thorium minerals. On the assumption that radium G and thorium E are stable, a knowledge of the composition of the mineral from which the lead has been extracted enables one to calculate the expected value for the atomic weight of the lead. Comparison of this value with that found experimentally gives a means of testing whether radium G and thorium E are stable or not.

Using this method, Soddy and Hyman (Trans. Chem. Soc., 1914, vol. cv., p. 1402) obtained a result for lead from a thorite rich in thorium and poor in uranium, which indicates that thorium E is stable. On the other hand, Richards and Lembert made a determination on lead extracted from thorianite, which points to the instability of thorium E (see Fajans, *Heidelberger Sitz. Ber. A.*, 1914, *Abh.* 11). Holmes (NATURE, April 2, 1914) came to a similar conclusion by an examination of the ratio Pb/U_e for a series of analyses of radio-active minerals. If thorium E be stable, this ratio should be constant for minerals of the same geological age, but it should increase with the age of the mineral. Neither criterion was satisfied. In order to examine the question more fully, Holmes and the present writer examined the lead, uranium, and thorium contents of a series of radio-active minerals of Devonian age, from the same locality in Norway. The results of this investigation, shortly to be published, indicate very strongly that thorium E is unstable, and that it cannot therefore be regarded as the end product of thorium.

The present letter indicates how the above results have been applied by the writer to determine the half period value of thorium E, and the method has the advantage that it is quite independent of whether thorium lead (thorium E) is stable or not. A more detailed discussion of the question and its consequences will be published in the near future.

Amongst the minerals analysed by Holmes and the writer were several thorites and orangites, rich in thorium, and well adapted for an examination of the question of the stability of thorium E. These minerals being all of the same age, the total lead present may be regarded as the sum of the following three constituents: (1) Original lead (Pb_1), (2) uranium lead, (3) thorium lead. Further, whether uranium lead and thorium lead are stable or unstable, we can express the above statement as an equation thus:—

$$Pb = Pb_1 + \lambda . Th + \kappa . U.$$

Here Pb, U, and Th represent the content of the mineral in lead, uranium, and thorium respectively; λ is the amount of thorium E in equilibrium with 1 gram of thorium, and κ is the amount of uranium lead present in the mineral per gram of uranium. This last factor κ is constant for minerals of the same age, and varies in sympathy with the age of the mineral—this indicating that radium G is a stable product. The amount of original lead was assumed constant, since the minerals used were similar and from the same locality. Using the results of the analyses of three minerals, three equations are obtained by substitution in that above, and from these equations the values of λ, κ, and Pb_1 can be calculated. This calculation was performed with three different mineral combinations, and consistent results were obtained. The value of λ found was 4×10^{-5} gram. The value of κ found was 0·042, a result known to be correct from other considerations. Now it can readily be shown that the lead-producing power (calculated from the helium generation) of thorium is about 0·4 that of uranium. Whence, if thorium E is stable, the value of λ should be $0{\cdot}4 \times 0{\cdot}042 = 0{\cdot}017$. The low value ($4 \times 10^{-5}$) actually obtained seems to prove beyond question that thorium lead is unstable, and that it has a half period equal to 4×10^{-5} times that of thorium, or $4.10^{-5} \times 1{\cdot}5.10^{10} = 6.10^5$ years. It does not seem likely that thorium lead (thorium E) emits α rays, for these should have a range of about 3 cm., and would have been detected. If, on the other hand, it emits β rays, it is to be expected that bismuth would prove to be the end product of thorium. In any case, the systematic examination of radio-active minerals for bismuth seems highly desirable, for if it is the stable end product of thorium, the ratio Bi/Th will be found constant for minerals of the same geological age, and this ratio will vary in sympathy with the age of the mineral. Thus this ratio could be used for the determination of geological time just as that of lead to uranium has hitherto been used by Holmes ("The Age of the Earth," London; 1913) for the same purpose. If the bismuth isotope from thorium is unstable, the method indicated in this letter could be used to find its half period, and thus further information could be gathered as to the direction of the succeeding disintegration, *i.e.*, whether an α ray change brings the end product into Group III.B (Thallium) or a β ray change carries it still further to the Polonium Group (VI.B).

The one doubtful assumption in the present treatment is that in the minerals used for the calculation of λ, the percentage of original lead present is the same. This assumption is not without foundation, and in a forthcoming publication the writer will adduce evidence in support of the assumption in the case of the minerals used.

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