

### Radium and the Evolution of the Earth's Crust.

It is now well known that if the proportion of radium in the interior of the earth is the same as that in the surface rocks, the earth ought to be growing hotter, and the temperature gradient of the crust ought to be much higher than we find it. A simple calculation shows that a distribution of radium averaging  $2 \times 10^{-14}$  grams in each gram of rock throughout the earth would suffice to preserve thermal equilibrium. The amounts of radium actually found in the surface rocks are approximately as follows:—

Acid	...	...	$3 \times 10^{-12}$ grams per gram
Intermediate	...	2	" "
Basic	...	1	" "
Ultrabasic	...	0.5	" "

In addition to the elements of the uranium family, those of the thorium family must also be considered, for they afford an equally important supply of heat.

Prof. Strutt was the first to indicate the way in which the obvious dilemma might be escaped. In order that the earth should be nearly in thermal equilibrium (i.e. not growing hotter, but cooling at the very slow rate allowed by the radio-active elements as they decrease in quantity in accordance with their progressive disintegration), it is necessary to assume that the earth's store of radium is concentrated near the surface. As the following arguments indicate, this conception is less arbitrary than would appear at first sight. The radio-active elements are found most abundantly in the acid rocks, their more basic associates being less embarrassingly rich. The more acid rocks are characteristic of only the outermost zones of the crust, and there are many reasons for believing that with depth the more basic rocks largely predominate. Seismic and other terrestrial phenomena have now provided us with data from which the condition of the earth's interior may be deduced with some confidence. First, there is the crustal zone, rapidly becoming less silicic with depth, having a mean density of 2.8, and an approximate thickness of thirty miles. Within a fairly sharp surface of discontinuity comes what may be called the stony zone. The density is 3.4, and judging from the close analogy presented by meteorites, the material would be of ultra-basic composition. This zone dies out at a depth variously estimated at from 600 to 900 miles. The internal core of the earth is probably largely composed of iron, its density being about 8.

In a number of meteorites, the radium content has been determined by Prof. Strutt and the present writer, and if it may be assumed that they afford a clue to the problem, the heavy metallic core should be completely destitute of radium, and the stony zone should contain only a small proportion, very much less than that of the ultra-basic rocks of the crust.

On the planetesimal hypothesis, the two internal zones find a ready explanation. It is supposed that the earth began as a nebulous knot, and that it has grown up to its present mass by the capture of associated planetesimals. It is very unlikely that as a whole it was ever in a molten condition. Internal heat probably arose largely from the condensation of the mass during the period of its growth. The temperature would slowly rise until the fusion point of certain of the constituents was reached, and the liquid tongues and pockets thus formed would tend to move away from the centre, the lighter and less viscous stony material being squeezed outwards relatively to a network of the heavier and more rigid metallic materials. Once vulcanism had been initiated in this way, the process would continue until a highly metallic nucleus had collected. Surrounding it there would gradually form a thick zone of silicate rocks,

the differentiation from the original heterogeneous mixture of stony and metallic constituents being due to the selective fusion of the former. There seems to be little doubt that the radio-active elements would be concentrated in the stony zone. With the establishment of ocean and atmosphere, a new factor in surface differentiation arose, and sedimentary rocks were deposited for the first time. In some way which, as yet, we understand but vaguely, both igneous and denudational differentiation then combined in developing the earth's crust. We now find in the latter all those rocks which hold a maximum content both of silica and of the radio-active elements. The relative concentration of these constituents having taken place at the expense of the zone below, the conjectural paucity of the latter in radium finds a suggestive explanation.

Before the advent of radium, geologists had not recognised the difficulties presented by the peculiar chemical constitution of the earth's crust. Radium did not create this difficulty, but has merely directed attention towards it. Any explanation of the high percentage of silica in the surface rocks will explain equally well their richness in radium.

It can scarcely be said now that radium has given us "a blank cheque on the bank of time." Not only did the discovery of radium destroy the validity of the older thermal arguments, but also it led directly to the elaboration of a new and more refined method. Every radio-active mineral may be regarded as a self-contained hourglass, the radio-active end-products, helium and lead, slowly accumulating at the expense of their ultimate parent, uranium. In the few cases which up to the present have been investigated, periods of enormous duration have been revealed, and the geologist who ten years ago was embarrassed by the shortness of the time allowed to him for the evolution of the earth's crust is now still more embarrassed by the superabundance with which he is confronted. The time scale up to date, as determined by the lead ratio, is as follows:—

Carboniferous	...	...	340 million years
Devonian	...	...	370 "
Ordovician	...	...	430 "
Algonkian	...	...	1000 "
Archæan	...	...	{ 1300 "
			{ 1600 "

We must not moan over the apparent difficulties with which the geologist has been faced since the advent of radium. Rather should they be welcomed in that they open the way for further advances. If at present some of our ideas are mutually incompatible, the discrepancies do not demand a wholesale rejection of the facts, but simply a re-interpretation of the fundamental hypotheses on which so many of our doctrines seem to hang.

ARTHUR HOLMES.

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### An Amphipod Invasion.

MANY specimens of a small amphipod crustacean, *Euthemisto compressa*, Goës, have been forwarded to me by Mr. T. H. Nelson, of Redcar. On May 23 and 24 these were washed ashore in incredible numbers on the coast of Yorkshire, where they lay from Saltburn to Teesmouth—a distance of ten miles—in drifts several inches deep. The pools were alive with the crustaceans, and to the east of Redcar a fisherman was seen raking them into heaps, and wheeling away barrow-loads to put on his garden as manure. In the sea hundreds at a time could be scooped up in one's hands.

*Euthemisto compressa* is an uncommon British

species recorded sparingly from a few localities, but off Redcar it occasionally appears in extraordinary shoals in springtime. Such visitations have occurred previously in the second week of February, 1892, April, 1907, and April 2, 1908. In general the creatures come ashore after a N. or N.E. wind, but on the present occasion a gentle westerly wind had prevailed for a few days. I should be glad to receive information from naturalists or fishermen who may have observed these minute "shrimps" about the same date, on other parts of the coast or in the open sea, so that knowledge may be gained of the full extent and of the provenance of the shoal.

JAMES RITCHIE.

Royal Scottish Museum, Edinburgh.

#### New Zealand Vegetation.

IN NATURE for April 10 (p. 147), under the title "New Zealand Vegetation," I notice the following sentence:—"The northern rivers and estuaries display a mangrove vegetation—a unique and unexpected occurrence outside of the tropics."

The writer of the article is evidently not aware that mangrove formations are found at intervals all round the coasts of Australia. The species which forms them is *Avicennia officinalis*, L., which occurs in all the Australian States, but not in Tasmania. It reaches its southerly limit in Western Australia in the neighbourhood of Bunbury ( $33\frac{1}{2}^{\circ}$  S.), where the trees reach a height of about 12 ft. On the east coast it is most familiar on the shores of the Parramatta River in Sydney Harbour, which is a little further south than Bunbury, but it occurs so far south as Corner Inlet, on the east side of Wilson's Promontory ( $39^{\circ}$  S.). This southernmost point of the Australian continent is one degree further south than any point on the north coast of the North Island of New Zealand.

W. B. ALEXANDER.

The Western Australian Museum and Art Gallery,  
Perth, Western Australia, May 10.

I FEAR that in attempting to compress into a few paragraphs a general sketch of the plant communities of New Zealand I inadvertently conveyed the erroneous impression concerning the distribution of the mangrove vegetation in Australasia which Mr. W. B. Alexander has corrected in his interesting note. The sentence which he quotes is perhaps less misleading if read in connection with that immediately preceding it, and containing the statement upon which I wished to lay chief stress in enumerating the main types of New Zealand vegetation—"to find an equal variety a continent extending to the tropics would have to be visited." I was quite aware of the well-known fact that the eastern or Indo-Malayan mangrove flora, well developed on the northern littoral of Australia, extends in an impoverished form along the eastern and western coasts southwards, though it is interesting to note that it actually reaches the most southerly point of the Australian continent. It may be added that Prof. Bews (Annals Natal Museum, ii., 1912, p. 297) has recently described what appears to be the most southerly extension of the mangrove vegetation on the opposite side of the Indian Ocean, in Durban Bay; here, as in the subtropical and warm temperate parts of Australasia, the rich eastern mangrove flora is represented by an interesting though poorly developed outlier consisting of *Avicennia officinalis*, *Bruguiera gymnorhiza*, and *Rhizophora mucronata*.

F. C.

#### Anthelia.

IN connection with the correspondence in NATURE on the bright light on dew round the shadow of one's head, the accompanying photograph, which shows the

phenomenon on dew on seakale, may be of interest. It was taken here on October 7, 1899, at 8.35 a.m. It shows the shadow of the camera, so that in spite of the irregularity of the leaves the radius of the



bright light is easily measured as nearly  $8^{\circ}$ . The scale of the photograph is  $8.5^{\circ}$  to the inch.

T. W. BACKHOUSE.

West Hendon House, Sunderland, June 10.

#### Antennæ for Wireless Telegraphy.

I WAS interested to see Mr. Campbell Swinton's letter on wireless receiving with his bedstead as an aerial. Many of the more powerful stations are, however, much easier to receive than is generally supposed; for instance, I have been able to read the Eiffel Tower nine o'clock news message with only 12 ft. of No. 18 S.W.G. copper wire stretched across my attic (second floor, about 25 ft. from the ground) using good earth to waterpipes, with usual tuning coils and condensers, bornite-zincite detector, and very sensitive 4000 ohm telephone (H. W. Sullivan), without any relay. Even when the aerial was reduced to 6 ft. of wire the signals were just audible, but very faint.

ARNOLD G. HANSARD.

Limpsfield, Surrey, June 10.

SOME months ago, in endeavouring to reduce the antenna to the smallest possible dimensions, such as by placing a series of wires just over the instruments, I found that by using a bedstead (without wire mattress) signals of "strength 8"—i.e. moderately loud—could easily be obtained from Paris *without the aid of a Brown relay*—a costly instrument, reputed to increase the strength of signals five times. The apparatus used was simply the orthodox loose coupling with crystal detector. The bed used is on the second floor of my house, about 20 ft. from the ground, and the gas-pipe below the same floor served as an earth connection.

Under the same conditions Norddeich is usually readable, and sometimes Poldhu and Nauen. That nearer stations are also heard is obvious.

I should be pleased to give a demonstration of