

hotter than now the only contradiction to a "heating-up" earth.

Assuming, as before, the antiquity of the earth to be at least 300 million years (t), then in that period a supply of heat of 3×10^{-13} cal. per gm. per sec. (h) would have raised the interior of the earth to a temperature given by

$$\begin{aligned} S\theta &= ht \\ \theta &= 3 \times 10^{-13} \times 3 \times 10^9 \times 3.2 \times 10^7 / 0.02 = 14,000^\circ \text{ C.,} \end{aligned}$$

where S is the specific heat of the internal material. Though loss by conduction to the surface and latent heat effects are here neglected, the calculation is sufficient to show that a uniform distribution of the radio-active elements would give rise to internal temperatures too high to be reconciled with the observed temperature gradients.¹¹ We may safely conclude that there is very much less uranium, radium, and thorium in the inner portion of the earth than there is in the crust, and a maximum limit may be assigned to the content of radio-active elements. It would appear a minimum limit may also be set.

According to Lord Kelvin, as we have seen above, a period of cooling of more than forty million years could not have elapsed between the solidification of the terrestrial crust and the establishment of the present temperature gradient. If, however, the antiquity of the earth is more than 300 million years, then the temperature gradient has been maintained by some other source of heat, and the radio-activity of the rocks is amply sufficient for the purpose if it extends to quite moderate depths. The present temperature gradient would be maintained for an indefinite time if the stream of heat from the interior came from the radio-activity of the rocks.

There would need to be $6 \times 10^{12} / 0.06 = 10^{14}$ gm. of terrestrial radium to supply the heat lost by conduction, for a layer of the earth's crust 14 km. deep, if of density 3, has a mass of 2.1×10^{25} , and it would give out $2.1 \times 10^{25} \times 3 \times 10^{-13} = 6 \times 10^{12}$ cal./sec., assuming the content in this surface layer of radium and thorium, and therefore the heat emission was that of the surface rocks. There is very probably at least this amount of the radio-active elements; otherwise it is not apparent why the temperature gradient of the crust has its present value, though the antiquity of the earth probably exceeds 300 million years. If the age greatly exceeds that period, then the present temperature gradient can depend but little on the secular cooling of the earth from a molten state.

Prof. Strutt¹² has determined the minimum age of thorianite by evaluating the ratio

$$\frac{\text{The quantity of helium in the mineral at present}}{\text{The rate at which the helium is produced}}$$

The refinement of the experiment will be appreciated when it is recalled that the rate of production of the helium is only 4×10^{-8} c.c. per gm. of thorianite per year. He found, as already mentioned, 280 million years for the age of one specimen and 250 millions for another.

To deduce a minimum age for a mineral in this manner it must be assumed that—

- (1) There was no original store of helium in the mineral when it was formed.
- (2) The mineral has not gained helium at any time except as it does now.
- (3) That the present rate of accumulation of helium is the same as in the remote past, when possibly high pressures and temperatures obtained.

The observational basis for these assumptions are:—

For (1) and (2). If the helium was originally present in the mineral when it was formed, or added later, then we would expect to find helium in other minerals in which helium is not now accumulating, but no such minerals are known. Helium is only found in appreciable quantities when associated with thorium and uranium. The mechanism¹³ of how it is continuously and unchangingly produced from these elements is known in great detail.

For (3). That radio-active changes are independent of temperature and pressure has been repeatedly tested and confirmed.

¹¹ This will be seen at once to follow from a calculation given by Strutt, Proc. Roy. Soc., p. 482, 1906.

¹² Proc. Roy. Soc., lxxxiv., 379, 1910.

¹³ See for example Rutherford, Nobel lecture, 1908.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Marquise Arconati Visconti has made a donation of 500,000 francs to the University of Paris, to be employed for the benefit of the faculties of science and arts.

IN connection with the Institute of Chemistry, Mr. C. F. Cross will deliver the first of two lectures on "Cellulose" at University College, London, on Friday, January 26. Sir William Ramsay, K.C.B., F.R.S., will preside.

THE post-graduate scholarship, of the value of 200*l.* per annum, in naval architecture has been awarded by the Royal Commissioners for the Exhibition of 1851 to Mr. Arthur Cannon, of Glasgow University, and formerly of the Royal Naval College, Greenwich.

WE learn from the issue of *Science* for December 15, 1911, that nearly a hundred students from the college of engineering of the University of Wisconsin were then on their yearly tour of inspection of great engineering plants of the eastern States. Engineering plants in Chicago, Milwaukee, Niagara Falls, Pittsburg, Schenectady, N.Y., and New York City were visited. These tours are required of students of engineering during their junior and senior years, and are arranged to cover industries that illustrate the work of the course pursued by the student. Four professors accompanied the students on their tour of inspection.

THE annual meeting of the Geographical Association will be held on January 13 at University College, Gower Street, London, W.C. In the morning, at 11 a.m., a discussion on the organisation of home-work in school geography will be opened by Prof. L. W. Lyde, and a paper on the population of the world will be read by Prof. A. J. Herbertson. In the afternoon, at 3 p.m., Dr. G. R. Parkin will deliver his presidential address, and afterwards Prof. Herbertson will exhibit lantern views of typical land-forms selected by a committee of the International Geographical Congress, and Miss S. Nicholls maps and views of typical land-forms in the Near East.

IT is announced in *Science* that by the will of Mrs. Jan K. Sacher the University of California is to receive 100,000*l.* The will stipulates that 40,000*l.* is to be spent on a granite campanile tower, 300 feet in height, to be erected in the centre of the University grounds. An endowment of 100,000*l.* has been secured, we learn from the same source, by Huron College, in Huron, S.D. St. Lawrence University, too, has obtained a 40,000*l.* endowment fund, of which the General Education Board has contributed 10,000*l.* Our contemporary also states that by the will of Miss J. M. Smith the sum of 1000*l.* is given to the American Association for the Advancement of Science. Similar bequests are made to the National Geographic Society of Washington and to the American Forestry Association of Washington. Other items of interest to men of science are 2000*l.* to the University of Pittsburg, 2000*l.* to the Allegheny Observatory, and 1000*l.* to the School of Liberal Arts and Sciences.

THE Senate of the University of St. Andrews has decided to confer the honorary LL.D. degree, *in absentia*, upon the following distinguished men, who were chosen for the degree on the occasion of the celebration of the 500th anniversary of the foundation of the University last September, but were unable to be present on that occasion:—Prof. Pietro Blaserna, professor of experimental physics in the University of Rome, president R. Accademia dei Lincei; Prof. M. J. M. Hill, F.R.S., Astor professor of pure mathematics, University College, London, and lately Vice-Chancellor of the University of London; Prof. Hugo Kronecker, professor of physiology, University of Berne; Prof. G. M. Mittag-Leffler, professor of pure mathematics in the University of Stockholm and Rector of that University, founder and editor of *Acta Mathematica*; M. Paul Meyer, directeur de l'Ecole Nationale des Chartes, Paris, professeur honoraire au Collège de France; Prof. Karl Pearson, F.R.S., Galton professor of eugenics and director of the Laboratory of National Eugenics, University of London; Mr. Charles D. Walcott, secretary of the Smithsonian Institution, Washington, U.S.A.; and Prof. P. Zorn, professor of international law in the University of Bonn.

THE annual meeting of the Association of Public School Science Masters will be held on Wednesday and Thursday, January 10 and 11, at the London Day Training College, Southampton Row. The president this year is Sir J. J. Thomson, and the meeting promises to be of unusual interest. The exhibition of scientific apparatus, books, and new experiments will probably be the largest the association has yet brought together, and several subjects in the programme should promote lively discussion. During Wednesday afternoon Messrs. M. D. Hill and E. J. Lewis will read short papers on "Chemistry and Physics as a necessary Introduction to Biology" and "Plant Biology" respectively. Dr. Ludlam will also discuss the educational value of "Qualitative analysis." Sir J. J. Thomson will deliver his address on Thursday at eleven, and will be followed by Mr. C. E. Ashford, on "The Place of Electrostatics in a Science Course." On Thursday afternoon there will be a discussion, commenced by Mr. G. F. Daniell, on "Practical Examinations in Science." Mr. A. Vassall will also read a short paper on "Educational Psychology." On Wednesday evening there will be a dinner at the Trocadero in conjunction with the Mathematical Association. The secretary asks us to state that the discussions and exhibition are open to anyone interested in science teaching.

THE following courses of advanced lectures, which are free to students, in scientific subjects have been announced for delivery in connection with the University of London during the first term of 1912. Eight lectures on "The Self-government of the Pueblo Indians under Spanish and American Administration" will be given by Miss Barbara Freire-Marreco at the London School of Economics and Political Science on Thursdays at 3 p.m., beginning on January 25. Five lectures and one demonstration on "Genetics" will be given by Prof. F. Keeble at the Imperial College (Royal College of Science) on Thursdays at 5 p.m., beginning on January 18. Dr. W. N. Shaw, F.R.S., will lecture on "The Meteorology of the Globe" at the Meteorological Office, South Kensington, on Fridays at 5 p.m., beginning on January 19. Four lectures on "Recent Work in Physiology relating to the Circulation and to the Nervous System, with Special Reference to the Human Subject," will be given by Dr. A. D. Waller, F.R.S., in the Physiological Laboratory, South Kensington, beginning on Tuesday, January 23, at 5 p.m. Fourteen lectures on "The Hæmoflagellates" will be given at the Lister Institute of Preventive Medicine, Chelsea, by Prof. E. A. Minchin, F.R.S., on Tuesdays and Fridays at 5 p.m., commencing on Tuesday, January 16. Four Chadwick lectures on "Water and Water Supply" will be given by Sir Alexander R. Binnie at the Institution of Civil Engineers on Thursdays, beginning on February 1, at 5.30 p.m. Five lectures entitled "A Study of Jöhne's Bacillus of Cattle and the Lepra Bacilli of Man and Rats" will be given, under the will of the late Mr. Thomas Brown, by Mr. F. W. Twort, superintendent of the Brown Animal Sanatory Institution, in the Theatre of the Royal College of Surgeons, Lincoln's Inn Fields, W.C., on Monday, January 8, and the four following days, at 4 p.m.

SOCIETIES AND ACADEMIES.

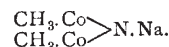
DUBLIN.

Royal Dublin Society, December 19, 1911.—Mr. R. Lloyd Praeger in the chair.—Prof. James Wilson: The inheritance of the dun coat-colour in horses. In a previous paper—the inheritance of coat-colour in horses—published in 1910 (Sc. Proc. Roy. Dublin Soc.), it was shown that the ordinary colours fit into each other like a nest of Chinese boxes, chestnut being innermost, and then, coming in succession, black, bay, brown, dun, and grey and roan. The data concerning dun were few, and its position was merely suggested in a footnote. More data—500 to 600 cases—have since been collated, and these confirm the former placing. From this it follows that dun cannot be a "reversion," since it can result only from dun matings and occasionally from grey and roan. The author discussed the history of the idea that dun is a reversion. It probably originated in Lord Morton's quagga-crossing

"experiments," and in Dr. Macdonald's criticism of these (both published by the Royal Society). Hamilton Smith's theory that horses are descended from five original stripes did not require a reversion theory; but Darwin's theory, expressed tentatively, that horses are descended from a single dun-coloured and striped species, required one, and to him mainly are we indebted for the opinion that dun is a reversion. Darwin relied upon Lord Morton's description of the foals his chestnut mare bore after her quagga hybrid, and on three other cases. Lord Morton said that one of the chestnut mare's foals had a faint dun tint in two places, and Darwin called two of them "partially dun"—later writers have called them dun altogether. These foals, however, were ordinary bays, and the other three cases were undoubted misdescriptions. Data are collected in the present paper from various stud-books, and these are confirmed by the progeny of two homozygous dun sires which were stationed recently on Clare Island, on the coast of Mayo.—E. A. Newell **Arber**: Contributions to our knowledge of the floras of the Irish Carboniferous rocks. Part i.—The Lower Carboniferous (Carboniferous Limestone) flora of the Ballycastle Coalfield, Antrim. Of the seven species recorded from this coalfield, *Adiantites antiquus* (Ett.), *Sphenopteris flabellata*, Baily, *Lepidodendron Veltheimi*, Sternb., and *L. Volkmannianum*, Sternb., are the more important. The evidence of the flora points to the conclusion that the coalfield is of Lower Carboniferous age, and that the rocks belong to the higher, or Carboniferous Limestone, horizon of the Lower Carboniferous.

CALCUTTA.

Asiatic Society of Bengal, December 6, 1911.—G. R. **Kayo**: A brief bibliography of Hindu mathematics. This is a list of works dealing with the history of Hindu mathematics. It is professedly incomplete, and it is difficult to decide what ought and what ought not to be included. This list requires amplification, particularly in the matter of Sanskrit texts and manuscripts. The original Hindu works do not go beyond the time of Bhāskarā (twelfth century A.D.), as, after this period, Hindu mathematical works cease to have any historical interest.—Rev. H. **Hosten**: Father A. Monserrate's "Mongolicæ Legationis Commentarius." This precious manuscript, after passing successively through Fort William College, the Calcutta Public Library, and the Imperial Library, was transferred in 1903 to St. Paul's Cathedral Library, where the Rev. W. K. Firminger discovered it. It must have belonged formerly to one of the Jesuit houses of Goa. How it came to Calcutta it is impossible to say. The earliest account of northern India by a European since the days of Vasco de Gama, the manuscript contains a detailed history of the first Jesuit mission to Akbar, and more than 100 pages are consecrated to Akbar's campaign against Kābul in 1581-2. There is in it an excellent map, drawn to scale, showing all the places passed through by Monserrate between Goa, Sūrāt, Agrā, Lahor, and Kābul (1580-2). It appears from the preface that Monserrate was the author of four distinct works:—(1) "Mongolicæ Legationis Commentarius"; (2) a work on the geography and natural history of India; (3) a history of his journey to Ethiopia; (4) a work on the geography and natural history of Arabia.—Prafulla Chandra **Ray** and Rasik Lal **Datta**: Contributions from the Chemical Laboratory, Presidency College. Allylammonium nitrite. A short paper dealing with the preparation and properties of allylammonium nitrite. The substance was made by double decomposition of allylamine hydrochloride and silver nitrite. Allylamine nitrite is a thick brownish liquid with the characteristic smell of all alkylamine nitrites.—Jitendra Nath **Rakshit**: Contributions from the Chemical Laboratory, Presidency College. Preliminary note on sodiumdiacetamide. This note deals very shortly with the method of preparing



Acetamide (purified by recrystallisation from benzene), anhydrous thiophene, free benzene, and freshly cut metallic sodium were boiled together under a reflex condenser for twenty or thirty minutes, when a copious crop of white crystals separated.—B. L. **Chaudhuri**: Fresh-water