thin and regular and the corium is composed of connective tissue only. The alveolar bone is compact. On a diet deficient in vitamins A and D the gingival region is thick, the epithelium is hypertrophied and finger-like processes extend down into the corium, in which varying degrees of cell infiltration are present: the alveolar bone is poorly calcified and consists in part of osteoid tissue. Experiments proved conclusively that, whereas vitamin D controls the calcification of the jawbone, vitamin A is responsible for the perfect development of the soft tissues. The gingival epithelium is thus comparable to epithelia in other regions which are abnormally developed in the absence of vitamin A. The distinction between the effects of the two vitamins was clearly seen when vitamin A was supplied to one animal as mammalian liver oil (which contains no vitamin D) and vitamin D to its litter mate as irradiated ergosterol.

Periodontal disease does not develop when the animals are fed on a diet containing abundant fat soluble vitamins, even though it is soft and pappy throughout life. For prevention it is essential that the puppy be fed on a good diet for the first months after weaning: if the intake of vitamins A and D is low at this period, a certain amount of disease almost invariably develops even although the diet is good for the rest of life. When the tissues are properly developed owing to an adequate vitamin intake, very considerable resistance to disease is shown in later life even though the diet is incomplete for long periods. After the disease has once appeared, further progress can be arrested by administration of large amounts of vitamins A and D, but a complete cure was not observed. It may be concluded that diet acts primarily by controlling the developmental structure of the periodontal tissues and not by any direct or indirect effects concerned with bacterial decomposition in the mouth. Prevention appears to be all-important: once the tissues have developed abnormally, prevention of disease becomes extremely difficult.

Caries has been observed only occasionally in the teeth of dogs, rabbits, rats, and monkeys, and attempts at its experimental production have usually failed. Even when micro-organisms were fed for a long period, they were rarely found in the teeth. In rabbits, however, softening of the exposed dentine on the occlusional surface of the molars was fairly frequent, especially when the animal had been fed on a defective diet, and organisms were found in the dentinal tubules in the majority of such teeth.

When an erupted tooth is attacked by disease or suffers injury, it reacts by the production of secondary dentine. Mrs. Mellanby has shown that the structure of this new dentine, both in dogs and rats, depends on the amount of vitamin D in the diet, in the same way as that of the primary dentine. The reaction only occurs in a living tooth. As secondary dentine was not always found when the teeth were worn down by natural attrition, its production was stimulated artificially by filing the teeth and extracting them after this treatment had been carried out for six weeks. It was found that perfect dentine was laid down when there was abundant vitamin D in the diet, that oatmeal interfered with the action of the vitamin, and that when the diet contained little, little or no secondary dentine, or dentine with many interglobular spaces, was produced.

This experimental study has indicated certain lines of investigation in the problem of the arrest and prevention of caries in human beings; the conclusions reached will be described in Part 3 of this series.

Magnetographs obtained by Amundsen, 1903–1906.*

WHEN Captain Roald Amundsen started his voyage in the *Gjoa* through the North-west Passage in 1903, his first aim was the accomplishment of this great feat of exploration, and his second was the investigation of the magnetic conditions at and near the magnetic pole. After his return from these successful enterprises, he published an account of his voyage, "The North-west Passage", in 1907, but his scientific material for a long time lay stored in the Historical Museum, pending its publication by a board of editors. State grants were made at various intervals between 1908 and 1923 towards the preparation and publication of the results, and the preparation of the terrestrial magnetic data was finished in 1923; at that time further funds for the publication became difficult to obtain, but by restricting the scale of the work the funds were finally obtained for publication by the Geophysical Commission of the Norwegian Academy of Science at Oslo in its regular volumes. Part 1 is to deal with astronomy and meteorology, and Parts 2 and 3 with terrestrial magnetism. The first to appear is Part 3, which consists of a reproduction of all the magnetographs obtained by the expedition, with only sufficient text (17 pages) to explain their nature. It is "assumed that in some way or another funds will be obtained for the publication of Parts 1 and 2"—an assumption which geophysicists will earnestly hope to see confirmed.

Amundsen occupied Gjoahavn on King William's Land (68° 37′ N., 95° 53′ W.) from Sept. 12, 1903, to Aug. 13, 1905, and King Point on the coast of Alaska (69° 6′ N., 138° 8′ W.) from Sept. 3, 1905, to July 11, 1906. At Gjoahavn the variometer house was constructed out of the packing-cases of the expedition (specially prepared free from iron for this purpose) and the instruments were set up by Oct. 31, 1903, and continued working until June 1, 1905; at King Point the dates were Oct. 17, 1905, to Mar. 31, 1906, the variometer house there being constructed of drift timber. The houses at both places were partly dug into the ground, and covered over with sand; even so, the temperature inside them underwent great changes, at Gjoahavn from

* Geofysiske Publikasjoner, vol. 8, pp. 17 + 191 plates. (Oslo, 1930.) 20.00 kr.

5° C. in summer to −26° C. in winter, with a daily range of about 1° C.; at King Point they were still greater, the daily range being 6° or 7° C. Unfortunately, the registering instruments were not well compensated for temperature.

The data have been prepared under the editorship of Nils Russeltvedt and Aage Graarud, and the difficulty of their task must have been very considerable, in inferring temperature coefficients, base line values (frequently altered), and scale values. In stating the latter, they do not indicate in what unit the ordinates are measured, but it appears to be 1 mm. The scale values (per mm.) of the three instruments, which were of Eschenhagen pattern, all registering on one drum, were for declination (in force units) 17γ, in horizontal force 12γ, and for vertical force 5γ until about September 1904, and thereafter 22γ; at King Point the corresponding values were about 20γ, 12γ, and 23γ. In the vertical force record, 1° change of temperature made an apparent change of 140γ in the force. The normal time scale was 20 mm. per hour; in quick runs it was twelve times as great.

The magnetographs show records and base lines for the three magnetic elements and for the temperature. Before reproduction the times were marked on the hour lines automatically registered across the sheets, the date was written on, and the various traces were indicated by letters at one end. It is to be regretted that on sheets which show disturbance, when some of the traces often crossed one another, the letters were not added elsewhere also; in the reproductions it is often not easy to be sure of the identity of each trace on such days, while on the originals the difficulty is likely to have been much less.

The sheets are reduced on reproduction in the ratio 3·46 to 1, so that four can be got on to a quarto page; the reproduction is very good, and the collection should be of great value to those who wish to make intercomparisons between the changes of the earth's field near the auroral zone and elsewhere. The curves indicate the presence from time to time, in the neighbourhood of these stations, of intense overhead currents, usually somewhat to the south, and sometimes flowing eastwards, at others westwards. This would suggest that both stations are within the auroral zones, and it will be of interest to learn later, from Part 1 or 2, whether auroræ usually appeared to the south.

The magnetic results of the Amundsen expedition would have been of still greater value had they coincided in time with Birkeland's magnetic and auroral expeditions of 1902–3, the results of which were published by him in 1908 and 1913. Though this was unfortunately not so, their value will enhance, and be enhanced by, Birkeland's data, and they will form an important link in the chain of evidence which will lead to the elucidation of the very difficult problems presented by magnetic disturbance.

Obituary.

MR. C. T. HEYCOCK, F.R.S.

THE death of Mr. Charles Thomas Heycock, on June 3, removes from among us one who had gained the affection of generations of Cambridge men and who was a pioneer in an important branch of inorganic chemistry. Heycock was the younger son of Frederick Heycock of Braunstone, Oakham, and was born on August 21, 1858; he received his early education at the Grammar Schools of Bedford and Oakham, and entered King's College, Cambridge, as an exhibitioner in 1877, taking the Natural Sciences Tripos in 1880. For many years he taught chemistry, physics, and mineralogy for the Cambridge examinations, and in 1895 he was elected to a fellowship at King's College, becoming a college lecturer and natural sciences tutor in the following year. He was elected a fellow of the Royal Society in 1895, and was awarded the Davy Medal in 1920 for his work on alloys. His original work on the metals attracted the attention of the Goldsmiths' Company, who endowed a readership in metallurgy at Cambridge; he was appointed to this office in 1908 and held it until his retirement in 1928. He was admitted to the Livery of the Goldsmiths' Company in 1909 and to the Court in 1913; he acted as Prime Warden during the year 1922–1923, and took a keen interest in the work of the Company's Assay Office.

Notwithstanding the exacting character of his work as a Cambridge coach, Heycock joined with his lifelong friend, F. H. Neville, in a comprehensive study of the metals and their alloys; this partnership, which was only dissolved by the death of Neville in 1915, led to a remarkable series of papers in which novel directions of investigation were mapped out and developed. The first of these joint papers was published in 1889 and dealt with the depression of the freezing points of metals brought about by others dissolved therein; in this and later papers it was shown that the addition of small amounts of a second metal depresses the freezing point of the first to an extent (1) directly proportionate to the weight of metal added and (2) inversely proportionate to the atomic or molecular weight of the added metal. Raoult's law for ordinary solutions was thus extended to alloys, and a method indicated for calculating the latent heat of fusion of a metal by the application to the freezing point depressions of the now well-known van't Hoff equation. At the outset, mercury thermometers were used in the temperature measurements and only alloys of low melting points could be studied; the introduction by H. L. Callendar of the platinum resistance pyrometer made it possible to extend the scope of the investigation to metals of high melting point. This was done with the assistance of Dr. E. H. Griffiths. During the carrying out of the programme thus extended, the melting points of many of the metals in the pure state were determined; later observers have confirmed the