

of deep focus earthquakes are joined by lines which serve to emphasise the distribution of

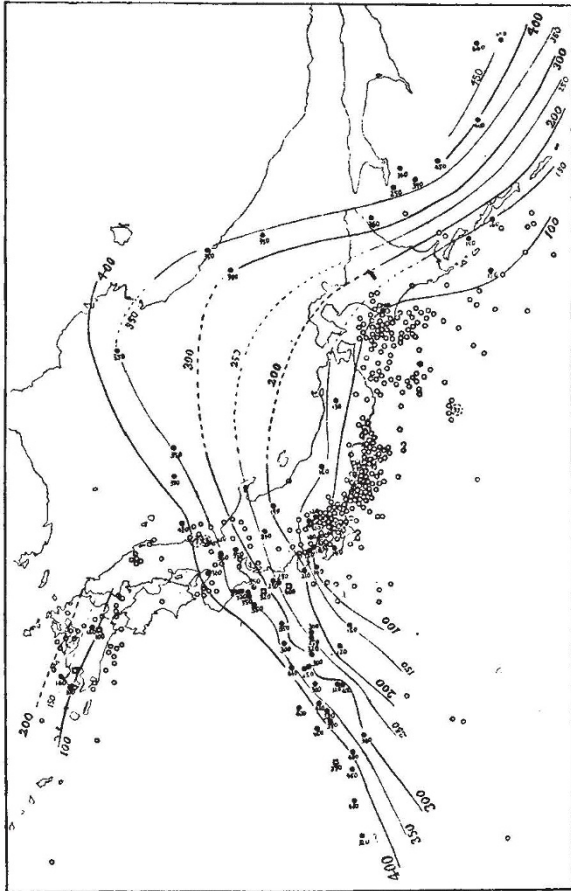


FIG. 2. Lines of equal focal depth for deep-focus earthquakes. ● Deep-focus earthquakes; ○ shallow-focus earthquakes; □, foci not accurately determined. From *Geophysical Magazine* (Tokyo), 8, Nos. 3, 4; 1935.

depth. The innermost of these lines indicates the position of foci with depths of 100 km., the outer-

most of the main series of lines indicates a depth of 400 km. The way in which the foci of ordinary earthquakes cluster on the east of Japan is also illustrated in this diagram.

The directions of the impulsive movements in deep-focus earthquakes with their foci near to the region where the main belt crosses Japan have been studied by Honda. He finds that at places to the north-east of the belt the ground moves downwards and towards the belt. At places to the south-west the movement is upwards and away from the belt. Thus it appears likely that huge faults extending to a depth of about 400 km. or more can exist in the earth's crust and that deep foci are on such faults. Volcanoes, live and extinct, are found above the line where the fault is at a depth of 100 km., whilst ordinary earthquakes with shallow focus occur near where the fault approaches the surface.

It has been suggested that the high frequency of earthquakes round the Pacific is due to the fact that the crust of the earth below an ocean cools more rapidly than the crust over the continents, where the radioactivity of the granite provides a source of heat.

In various studies of the times of transmission of seismic waves it has been found that the thickness of the continental granite is about 15 km. Thus the occurrence of deep-focus earthquakes implies that the strains in the crust lead to fractures at depths of the order twenty times the probable thickness of the granite. Can it be that the influence of a mere skin extends to such a depth? These foci are also far below the level at which isostatic compensation has been supposed hitherto to be operative. It is clear that they must be taken into account in all speculations as to the history of the globe.

## Obituary

Prof. Henry Fairfield Osborn, For.Mem.R.S.

PROF. HENRY FAIRFIELD OSBORN, who died at his home, Castle Rock, Garrison-on-Hudson, N.Y., on November 6, 1935, was one of the foremost palæontologists of the United States, and made great contributions to our knowledge of fossil mammals and reptiles. He was born on August 8, 1857, at Fairfield, Connecticut, and began his scientific education in 1873 at Princeton College (afterwards University), where he was influenced especially by President James McCosh, the psychologist, and Prof. Arnold Guyot, the geologist. After graduating in 1877, he studied human anatomy and histology under Prof. William H. Welch, in New York; and in 1879-80 he followed brief courses in embryology

under F. M. Balfour at Cambridge, and in comparative anatomy under Huxley in London. He then returned to Princeton with a biological fellowship, and in 1881 he was appointed assistant professor of natural science. In 1883 he was promoted to the professorship of comparative anatomy at Princeton, where he remained until 1891.

While Osborn was a student at Princeton, great interest was being aroused by the discoveries of numerous strange extinct mammals and reptiles by Cope and Marsh in the rocks of the western United States. At the end of his course, therefore, in 1877, he and his fellow-students, W. B. Scott and F. Speir, decided to undertake a summer trip to Wyoming in search of similar fossils, and they brought back a

small collection of early Tertiary mammalian remains, on which they published a report. In the following year they went again to Wyoming and Colorado to continue their collecting, and in subsequent years one or other of them paid repeated visits to the west for similar field work. Princeton thus began to take a share in making known the remarkable extinct vertebrates which awaited discovery in the western country then becoming more readily accessible.

These researches attracted the notice of the trustees of the American Museum of Natural History and the professors of Columbia College (afterwards University) in New York. The Museum wished to extend its scope and make a representative collection of fossil vertebrates, while Columbia decided to add biology to the subjects to be taught. In 1891, Osborn was therefore invited to become curator of the Department of Vertebrate Palaeontology in the American Museum, and at the same time the first professor of biology (afterwards zoology) in Columbia University. He accepted both these appointments, and held them with brilliant success until 1910, when he had thoroughly organised them and had trained a staff to continue his work. Having ample private means, he then retired to devote himself entirely to palaeontological research and to the administration of the Museum. Meanwhile, he was nominated research professor of zoology in the University, and he continued to be assistant to the president of the Museum. In 1901 he was elected a trustee and vice-president of the Museum, and eventually from 1908 until 1933 he served as president. At the same time, from 1900 onwards, Osborn was vertebrate palaeontologist to the U.S. Geological Survey, and for four years (1900-4) he also held the same office in the Geological Survey of Canada. In 1906 he was nominated secretary of the Smithsonian Institution, Washington, but he decided to remain at New York.

The earlier collectors of fossils in the west had been handicapped by the frequent presence of hostile Indians, who had made detailed geological surveying impossible. When Osborn began his work at the American Museum, conditions were improving, and he took advantage of this circumstance to arrange that collectors in future should devote as much time as necessary to determining the succession of the rocks in which the various fossils occurred. Year after year he sent out his trained assistants to collect in this way, and he frequently accompanied them with help and encouragement. He and his wealthy friends provided adequate funds for the explorations, and thus was accumulated in the American Museum a unique series of fossil vertebrates of which the relative ages were definitely known. Most of these fossils were mammalian remains from the Tertiary formations, and as soon as the most important of them had been examined and described by himself and his colleagues, Osborn greatly facilitated research by publishing his "Correlation between Tertiary Mammal Horizons of Europe and America" (1900). The American Museum then began to take an active interest in the discovery of fossil vertebrates in other parts of the world. In 1898 it had already shared in

the Princeton University's third expedition to Patagonia. In 1906-7, Osborn himself accompanied a party in the Fayum, Egypt. In 1922 he visited central Asia, where American Museum expeditions under Dr. Roy Chapman Andrews had already made important collections of new fossil vertebrates. In 1923 another expedition under Dr. Barnum Brown collected fossil mammals in India. Osborn had, indeed, wisely decided that our knowledge of extinct faunas could best be advanced by direct comparison of the fossils of one part of the world with those of another, and that American palaeontology must not be isolated.

While occupied with the planning and direction of the collecting expeditions and the preparation of the fossils in the Museum, Osborn and his staff published a long series of valuable papers on various parts of the collection and on the rocks in which they were found. He also contemplated the publication of several exhaustive memoirs on groups which were specially well represented in America, but he was only able to complete one on the Equidae or horses (1918) and one on the Titanotheres (1929). Others on the Elephants and the Sauropodous Dinosaurs were left in a forward state of preparation. The published memoirs are noteworthy for their beautiful illustrations and their wealth of valuable facts; but their composite authorship and their peculiar style of composition make them sometimes unsatisfactory for reference.

Osborn also found time to write several books which have contributed to the advance of vertebrate palaeontology or spread an interest in the subject. His early work "From the Greeks to Darwin" (1894) has often been reprinted, and it was eventually issued in a revised edition. His "Evolution of Mammalian Molar Teeth" (1907) and "The Age of Mammals" (1910) are technical works of reference. His "Men of the Old Stone Age" (1915) and "Man rises to Parnassus" (1927) are popular works which have had a very wide circulation. His "Origin and Evolution of Life" (1916-17) is semi-popular. His volumes on "Impressions of Great Naturalists" (1924) and on "Cope: Master Naturalist" (1931) contain many interesting personal reminiscences.

Osborn's genial personality and calm sound judgement led to his being appealed to for help in many undertakings beyond his chosen sphere. He took a prominent part, for example, in the foundation of the New York Zoological Society and the planning of its Zoological Park, and he was president of the organisation from 1909 until 1923. He was also well known and much esteemed in England, where he received many tokens of appreciation. He was an honorary D.Sc. of Oxford and Sc.D. of Cambridge. He was a foreign member of the Royal Society, and of the Linnean, Geological and Zoological Societies of London; and an honorary member of the Royal Society of Edinburgh and the Royal Irish Academy. He received the Darwin Medal from the Royal Society in 1918, and the Wollaston Medal from the Geological Society of London in 1926. The death of an old friend and colleague is indeed widely mourned.

A. S. W.