# SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

## HALF A CENTURY IN GEOPHYSICS

IN his presidential address to Section A (Mathematics and Physics), Sir Harold Jeffreys points out that the developments in geophysics in the twentieth century serve to illustrate some fundamental points in scientific method. The dispute on the age of the Earth had come to a head with Huxley's address of 1869. Helmholtz's contraction theory and Kelvin's theory of the cooling of the Earth had both led to estimates of the age of the order of 20 million years, but estimates from the rates of accumulation of sediments gave about 300 million years. Huxley emphasized uncertainties in the physical data, and incidentally cast doubts on the validity of the use of mathematics that, if accepted, would reduce science to mere cataloguing, since mathematics is the only method of testing whether a hypothesis explains the data. The discovery of radioactivity led to estimates of the ages of rocks, and it now appears that the age of the Earth is at least 2,000 million years and may be 3,000 million years. Radioactivity produces a delay in cooling that accounts for the discrepancy between these estimates and that of Kelvin. The estimate from the accumulation of sediments was wrong because the present rate of denudation is probably several times the average through geological time. It was suggested by Perrin and Eddington in 1920 that the maintenance of the Sun's radiation could be due to the conversion of hydrogen to helium, but a fully described mechanism had to wait for more knowledge of nuclear physics, and was not given until 1939, by Bethe and Gamow. The reconciliation of the results has been due mainly to increased co-operation between workers in different fields and to the development of the consequences of hypotheses far beyond the range of direct verification.

Poisson in 1829 had predicted that a solid should transmit both longitudinal and transverse elastic waves, and attempts were made to identify these with waves sent out by natural earthquakes. These were not successful until 1900, on account of low magnification and insufficient damping of the instruments used. R. D. Oldham achieved the identification, and it is from his work that modern seismology has developed. He also recognized in 1906, from the evidence of travel times, that the velocity of the longitudinal wave drops considerably about half-way to the centre of the Earth. Later work has shown that this corresponds to a central core, almost certainly liquid. The times of the elastic waves are now known to accuracies of order 1 sec. out of totals up to 25 min., and the velocities are known all the way to the centre with, on the whole, corresponding accuracies.

The study of gravity and certain astronomical observations give the Earth's mass and moment of inertia. The velocities of seismic waves yield a relation between pressure and density, and from this relation and the mass and moment of inertia the distribution of density can be found with some accuracy. The mean density of the core is about 10 gm./cm.$^3$, and would be in agreement with the hypothesis that the core is mainly liquid iron under compression. A sharp discontinuity of material is indicated by the fact that it gives strong reflexions. W. H. Ramsey has proposed an alternative hypothesis, that the core is of the same material as the rocky shell, but in a state of pressure degeneracy. This deserves detailed theoretical examination.

Earthquakes occur at various depths, up to about one-tenth of the Earth's radius. The mechanism of an earthquake is that gradually increasing shear stress leads to fracture when it reaches a certain amount. This is a normal process in an ordinary solid but not in any sort of fluid. Present knowledge of imperfections of elasticity does not suggest that it is ever valid to apply the mathematics of viscous flow, in which the rate of deformation is proportional to the shear stress, to materials with such rigidities as we find throughout the Earth's shell. These and other considerations are evidence against theories that require extensive convection in the shell. Thermal changes due to differences of cooling in an ordinary solid provide more hope of an explanation of rise and fall of the land surface and of mountain formation.

Terrestrial magnetism is coming into closer relation with the rest of geophysics than had been the case until recently. In particular, the electrical properties indicated should provide means of checking inferences about the thermal state, and Bullard and others are examining the hypothesis that slow changes of the magnetic field are due to electric currents in the liquid core.

The methods of geophysics are now being extensively applied for investigation of structure at small depths. The original motive was economic; but the methods are now being used for problems of pure geology and geophysics. The British Association, especially through its Seismological Committee and the Committee on the Thermal Conductivities of Rocks, has played a leading part in the increased co-operation between users of different techniques in this field.

## ORGANIC CHEMISTRY SINCE 1837

PROF. G. R. CLEMO'S presidential address to Section B (Chemistry) commences with the reminder that, when the British Association first met in Liverpool in 1837, Liebig was among those who attended. Being imbued with a missionary zeal for organic chemistry, then developing on the Continent, Liebig made a strong plea for its advancement in Britain, and his advocacy created such an impression that he was invited to write a report on the application of organic chemistry to physiology and agriculture; largely as a result of the interest thus aroused, the Royal College of Chemistry was founded in 1845. Hofmann was appointed professor, and, inspired by Liebig's conception of organic chemistry, he made the institution a great centre of research.

Hofmann's inspiring prophecies so impressed a fifteen-year old disciple in 1853 that the first coal-tar dye, mauve, was discovered in 1856 by W. H. Perkin when attempting to prepare quinine, and in 1869 Perkin synthesized alizarin, thus fulfilling one of Hofmann's predictions. In spite of Perkin's remarkable success in developing the first industry to be based on research, it rapidly declined after his retirement in 1873 but prospered greatly in Germany. Following Hofmann's return to Berlin in 1865, nine years were to elapse before Roscoe established the