

INDIAN SCIENCE CONGRESS ASSOCIATION

MADRAS MEETING

THE DECCAN TRAPS: AN EPISODE OF THE TERTIARY ERA

At the dawn of the Tertiary era, vast outpourings of basaltic lavas covered immense regions in the north-western United States, in the old Thulean province which extended from Greenland to Scotland and Ireland, and in the Deccan. In estimating the exact geological age of these lavas, much depends on the interpretation of the fossils (chiefly plants) from interbedded sedimentary deposits. Recent work on the interbasaltic flora of the Hebrides was summarized by Sir Albert Seward in his presidential address to the British Association at Dundee in 1939, and now Prof. B. Sahni, presiding at the twenty-seventh Indian Science Congress held in Madras during January 2-8, has discussed the Inter-Trappean flora of the Deccan.

Fissure eruptions, Prof. Sahni thinks, may once have spread sheets of lava over some half million square miles, and even after continuous erosion for millions of years the Deccan Traps still cover an area of 200,000 square miles. Thickest along the west coast (six to ten thousand feet), their abrupt ending gives no measure of their extension over a tract of land that foundered into the Arabian Sea.

The flora is known mainly from sediments in the Nagpur and Chhindwara districts of the Central Provinces, occurring between some of the lowest and oldest flows in the whole series; the plant-bearing beds at Rajahmundry on the east coast are also low in the series. No Inter-Trappean beds have yet been discovered in the middle part, and the lava-flows may have issued in such rapid succession that there was no time for extensive colonization or deposition of sediments. (The plant-bearing beds of western Scotland are also found between some of the basal flows.) At Bombay Island the upper members of the Deccan Traps include sedimentary beds yielding a pigmy frog and other organic remains, but no plants have yet been recorded. The highest Traps are in places covered by marine beds of known Eocene age, which fixes an upper limit for the age of the series.

The view that the Traps were poured out during the Cretaceous is not supported by the fossils. One of the most conclusive single pieces of evidence is the occurrence of fruits belonging to the brackish-water stemless palm *Nipa*, a plant characteristic of Eocene beds at many points near the shores of the former Tethys Sea, for example, in the London and Paris basins, in Poland, southern Russia and Egypt. The palms, known from numerous fruits as well as from abundant petrified wood, dominated the Inter-Trappean flora; although this family arose in the Cretaceous period, it did not become prominent until after the Tertiary era had begun. The abundant charophyte fruits support an early Tertiary age, while the water-ferns, unknown from pre-Tertiary rocks, are represented by a beautifully preserved *Azolla*.

Numerous other elements in the flora are of botanical rather than geological importance; they include fungi belonging to the *Perisporiaceæ* and *Sordariaceæ*, many types of spores, and various dicotyledonous fruits.

GALACTIC DYNAMICS

For his presidential address in the Section of Mathematics, Prof. A. C. Banerji chose as his subject "The Development of Galactic Dynamics and Some Allied Problems". Under this heading was considered a wide selection of the mathematical researches that have been made into the effects of rotation on gravitating masses.

The survey began with the classical researches concerning the stability of spheroids and ellipsoids of uniform density, and went on to a discussion of the pear-shaped figure, while the later work of Jeans on the analogous behaviour when the mass is compressible was also touched upon. The possibility of extending the treatment to the case of a fluid under more general physical conditions led to the recent investigations by Milne, Bhatnagar and others on the distortions that a fairly small rotation would cause in polytropic distributions, and in particular Chandrasekhar's results for double stars. The work by Eddington in which any spherical distribution can be discussed by means of a variable polytropic index was considered next and reference was made to the special feature of this method, that many properties are intermediate between the corresponding properties of the two spheres whose polytropic indexes are the extreme values of the variable polytropic index.

Turning to the problem of rotating nebulae of galactic dimensions, the discussion was commenced by describing Hubble's classification of the various observed types. Before proceeding to the problem presented by the spiral arms of nebulae, the difficulties found by Jeans concerning the impossibility of the formation of stars in an equilibrium configuration of a nebula were brought forward. As for the theories of the spiral forms of the arms, Jeans's point-mass model was considered first to demonstrate the difficulty that the existence of stars is incompatible with the necessary gaseous structure of the nebulae. The results obtained by E. W. Brown that spiral arms could persist for long periods only under very artificial systems of forces were quoted next, and in the same category were taken the more speculative suggestions of Vogt and Lambrecht postulating cosmical repulsion in the galaxies. Proceeding to our own galaxy, it was suggested that the differential rotation may be an indication of instability in the outer regions.

Arising out of the question of the formation of spiral arms, Prof. Banerji said that it is first necessary to decide whether in Newton's second law the impressed force is proportional to the mass times the acceleration or to the rate of change of momentum, and various opinions on this point were cited. The existence of interstellar matter and its possible dynamical effects completed the account given of galactic problems.

In conclusion, Prof. Banerji referred to the recent advances in the theory of the origin of the solar system. It was explained how the former difficulties relating to angular momentum had been resolved by Lyttleton, starting with the hypothesis that the planets were formed from a companion star to the sun during an encounter with an intruding star.

The effects of tidal friction in bringing about some of the detailed features of the solar system were briefly discussed, as, for example, the suggestion that the slow rotation of Venus can be explained by supposing that Mercury was formerly a satellite of this planet, and that the retrograde satellite of Neptune arose as a result of an encounter between two direct satellites, of which one escaped as an independent small planet (Pluto), and the other was diverted into a retrograde orbit.

MAGNETIC STUDIES OF AROMATIC MOLECULES

Prof. K. S. Krishnan delivered the presidential address to the Section of Physics, taking as his subject "The Diamagnetism of the Mobile Electrons in Aromatic Molecules".

Prof. Krishnan pointed out that our knowledge of aromatic molecules, particularly benzene, has been extended very considerably during the last few years by the quantum-mechanical treatment of the linkages and valency electrons and by the experimental determination of the symmetry and normal modes of vibration by means of infra-red and Raman spectra. It is now known that in benzene one electron of each carbon atom is mobile and can move from carbon to carbon, conferring on the molecule magnetic properties somewhat similar to those of free electrons in metals.

Outlines were given of the theories of paramagnetism of an electron gas and of diamagnetism of a free-electron gas; and the experimental data on graphite were reviewed with special reference to the temperature variation of magnetic anisotropy. These data verify Landau's view that quantization of the motion of free electrons in the magnetic field leads to a balancing between the diamagnetic and paramagnetic contributions, and that the temperature-independent diamagnetism of the free-electron gas is one third of its paramagnetism.

Mobile electrons in aromatic molecules are free to move anywhere in the ring; this is the same as postulating resonance between canonical structures, five of which are required for benzene, whilst for naphthalene 42 and for anthracene (or phenanthrene) 429 are necessary. Mobile electrons in aromatic molecules give rise to abnormal diamagnetism in the direction perpendicular to the plane of the ring and, consequently, to large diamagnetic anisotropies. For single crystals of such magnetically anisotropic molecules, if the magnetic constants are known, orientations of the molecules in the crystal lattice can be deduced, or, conversely, if molecular orientations are known from X-ray data, the principal magnetic constants of the molecules can be calculated. This calculation supports the theory when applied to sixteen aromatic molecules, and the contribution of mobile electrons is approximately proportional to the number of benzene rings in the molecule. These mobile electrons also give rise to optical effects, fluorescence and absorption, in both of which it is the component parallel to the molecular plane which is active. Not only are mobile electrons associated with benzene rings, but also with other conjugated ring structures, for example, cyanuric trichloride and phthalocyanine.

The address concluded with a brief consideration of theoretical calculations of the magnitude of diamagnetic anisotropies.

ROLE OF CHEMISTRY IN FORESTRY

Dr. S. Krishna, presiding over the Section of Chemistry, covered a wide range of topics in his address upon the role of chemistry in forestry. His topic is very suitable to current conditions, as it directs attention to the many ways in which Indian sources of supply, of drugs, dyes, tanning material and the raw material for many industries might be drawn upon, with increased income for the country and a diminished demand for imports. The work of the chemist was reviewed in connexion with production, conservation and utilization, but perhaps the main emphasis was placed upon the latter.

Very interesting Indian examples were cited of differences in chemical constitution and of economic importance, which had remained unrecognized by the systematist. In the Kurram valley (North-West Frontier Province) two varieties of *Artemisia maritima* grow side by side, one of which yields nearly 2 per cent of santonin but the other has none; only later was it noted that the young plants of the valuable forms had reddish stems, while the others were green at this stage. Four varieties of *Eucalyptus dives* exist, morphologically indistinguishable, but yielding oils with piperitone content ranging from 5 to 50 per cent. In connexion with seasoning, problems of timber impregnation were discussed, and attention was also directed to the recent Russian experiments using ultra-short waves.

Considerable attention was given to the possibility of increasing forest revenue by greater utilization of minor products. Baluchistan forests, run at a deficit for more than thirty years, have recently become solvent on the sale of Ephedra. Although many minor products would not repay harvesting on a large scale, they may have possibilities if organized on the lines of 'cottage industries'. Amongst minor 'forest' products, grasses and bamboos have supplied most revenue, particularly for the production of the better grades of paper. Another minor product available to prevent present imports is turpentine, now obtained from the oleoresin of *Pinus longifolia*. This is not so rich in pinene content as the turpentine from other species of pines such as *P. excelsa*; when such sources are tapped, they would be available for conversion into camphor, at present wholly imported.

Dr. Krishna advocated the formation of an association to stimulate the cultivation and utilization of medicinal plants in India, in order to promote the utilization of India's very valuable drugs, sources of many of which are found in India's forests.

THE UPPER CRETACEOUS AND LOWER EOCENE

Prof. L. Rama Rao, in his presidential address to the Section of Geology, took as his subject "Recent Advances in our Knowledge of the Upper Cretaceous and Lower Eocene Beds of India, with special reference to the Cretaceous-Eocene Boundary".

During the past few years several geologists, working in various parts of India, have made material contributions to our knowledge of the stratigraphy and palaeontology of the uppermost Cretaceous and Lower Eocene rocks of this region. Much new light has thus been thrown upon the position and nature of the Cretaceous-Eocene boundary and upon questions of palaeogeography.

The Ranikot beds, long ago recognized as the basal division of the Eocene in Sind, have been shown to be of pre-Ypresian age. They are now known to be much more widely distributed than was formerly supposed, occurring also in the North-West Frontier Province, the Salt Range, Kashmir, Tibet, Burma, and western Iran. In the Samana Range (North-West Frontier Province) the Hangu Shale, with its rich fauna, seems to constitute the lowest fossiliferous horizon of this formation anywhere known; it is separated from Upper Cretaceous deposits by a conformable series of beds which, however, have yielded no fossils. A similar transition from the Cretaceous to the Eocene seems also to exist in Burma and possibly in Tibet.

In the Peninsular area interesting discoveries of fossils have recently been made in beds intercalated in and underlying the Deccan Trap; their study has led to the conclusion that the Trap belongs to the Lower Eocene rather than to the Cretaceous, as formerly supposed. The well-known Infra-Trappean bed of Rajahmundry would appear to lie almost upon the border-line between the Cretaceous and the Eocene. Prof. Rama Rao's own researches have led to the important new discovery of Lower Eocene beds overlying the Cretaceous in the Pondicherry district. Especial reference was made to the study of the fossil algae of many of the rocks under discussion, as this work is proving of great help in their correlation.

In discussing, next, the geography of early Eocene times, Prof. Rama Rao visualizes, in the west, an arm of the ancestral Indian Ocean stretching northward so as to cover Sind, Baluchistan, parts of the Punjab, the North-West Frontier Province, and Kashmir; and dividing, in the north, into two branches, which extended respectively to Iran and Tibet. A second arm of this sea, situated to the east of India, extended northward into parts of Assam and Burma. Reference was made to the divergent views of various authorities as to whether there was direct communication with the Mediterranean Sea of that period.

In his concluding remarks, Prof. Rama Rao pointed out that the great geographical changes which heralded the incoming of Tertiary times must everywhere have affected the balance of marine life; hence a normally evolving succession of forms may not have persisted even in those parts of the sea where sedimentation was uninterrupted.

GEOGRAPHY IN NATIONAL PLANNING

The Section of Geography and Geodesy was formed on the occasion of the Jubilee meeting at Calcutta in January 1938, when its sessions were attended by a strong delegation from Britain. The president this year of the Section was Dr. S. P. Chatterjee, and in his presidential address he directed attention to the part which should be played by geographical studies in national planning.

A stock-taking of resources on a provincial basis is an essential pre-requisite of any work of national reconstruction, and that there is no country in the world where there is a greater need of a detailed land utilization survey than India. The assertions that in Bengal, which is selected for study as Dr. Chatterjee's native province, the land is deteriorating, soils losing fertility, marshes and lakes increasing in area at the cost of good arable lands, and river-borne sediment failing to build up the land, all require substantiation. The official statistics, skillfully shown in cartographic form, show that only one third of British India (contrasted with nearly half of 'Indian' India) is actually cropped. In Bengal, which in places supports a rural population, albeit in a condition very near the starvation level, of a thousand persons per square mile, no less than one quarter of the whole province is classed as fallow and cultivable waste, whilst less than half is actually cropped.

Dr. Chatterjee has clearly appreciated his training both in the French school and in Britain, and has attacked the problem on a regional basis. He gives the preliminary results of a survey carried out in the past two years and suggests a division of Bengal into ten regions. As frequently happens, the local cultivators know and appreciate small differences in soil and the local names (mainly based on texture) have been used to divide the new alluvium into ten types the distribution of which is shown on an instructive map.

As Chatterjee says, "since national planning means a conscious effort of man to change his environment in the best national interest, it is rational to be equipped with a thorough and accurate knowledge of the type, historic growth and present distribution of the various factors that go to form our cultural landscape, which is the subject matter of geography", and on this basis he appeals for an All-India organization for conducting a geographical survey.

(To be continued)

AIR CIRCULATION OVER INDIA

A MEMOIR of the India Meteorological Department (26, Part 10) by K. R. Ramanathan and K. P. Ramakrishnan, entitled "The General Circulation of the Atmosphere over India and its Neighbourhood", is probably the most complete account that has yet appeared of the average winds and temperatures in the upper atmosphere over India in each month of the year.

The observations of upper wind made with the aid of pilot balloons at observatories, and those of cloud movement, together with the measurements of temperature aloft by sounding balloon made at Agra, Poona and Hyderabad, form the basis of the

discussion. Mean isotherms for various levels up to 6 km. were obtained partly from the changes of wind with height, from which the mean magnitudes and directions of the temperature gradients were calculated, and partly from the mean temperatures at the different heights for the three upper air observatories, supplemented in some cases by temperatures measured at Peshawur or Quetta. Although in theory it is sufficient, having obtained a chart of temperature gradient, to have the vertical distribution of temperature at only a single station in order to be able to draw the absolute values of the isotherms, in practice, the computations being only approximate