# EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS

## MEETING IN LONDON

THE European Association of Exploration Geophysicists has grown rapidly since its foundation in 1951 and now has a membership of more than a thousand, which is still increasing by about two hundred a year. For its ninth meeting the Association met in London at Church House, Westminster, during December 7–9, the distribution by countries of those attending the meeting being as follows: Great Britain, 123; France, 37; Germany, 22; United States, 13; Netherlands, 8; Italy and Yugoslavia, 4 each; Denmark, 3; Belgium, South Africa and Sweden, 2 each; Algeria, Austria, Canada, Eire, Japan, Norway, Spain and Switzerland, 1 each; total, 228. As these figures indicate, the Association takes a very elastic view of its territorial limitations, but the various members are united in their interest in applying the discoveries of physics to the exploration of the Earth's crust and its mineral resources.

The technical meeting was opened by Sir Edward Bullard, then director of the National Physical Laboratory, Teddington, who reviewed recent progress from the point of view of a geophysicist who has just renewed his interest in geophysics after several years in the field of 'un-prefixed' physics. He confessed to having been rather disappointed at the lack of any spectacular progress in geophysical methods during these years. At the same time, he directed attention to the many directions in which progress has been made, and where important developments may be imminent. This theme was taken up again later with more detailed treatment by Dr. R. G. Van Nostrand, who read a paper prepared in collaboration with Milton B. Dobrin on "Current U.S. Developments in Exploration Geophysics". Dr. Van Nostrand disagreed with Sir Edward, and expressed the view that important advances have already been made and are being vigorously applied in the field. He selected as most noteworthy the techniques of magnetic recording and velocity logging, both of which are rapidly entering everyday use in oil prospecting in the United States.

As pointed out by Sir Edward Bullard, the application of magnetic recording techniques to seismic exploration work has been facilitated by the developments demanded by guided-weapon research. The latter is now benefiting in turn by a wider market for high-quality recording apparatus. The advantages of making seismic records magnetically rather than photographically derive from the flexibility introduced by being able to reproduce the information again as electrical impulses. Then varying filters may be applied, or more novel methods under development, to improve the signal-to-noise ratio; time delays may be introduced by automatic correction techniques in order to facilitate interpretation; and lastly, and perhaps most important, the information can be conveniently stored against the day when better interpretation methods allow one to make the fullest use of the recordings, without having to re-shoot in areas which are often exceedingly difficult of access.

The continuous velocity logging of boreholes, continued Dr. Van Nostrand, offers not only greater convenience and speed than the conventional well-shooting, but also, by measuring the seismic velocity through much thinner layers, it gives the variations in velocity in much finer detail. The study of these continuous velocity logs in conjunction with seismic reflexion records shot from the surface is leading to a better understanding of the origin of reflexions. This in turn can lead to better resolution in complex geological situations, and may even afford a solution in some cases for the most challenging problem of present-day oil-finding, namely, the detection of stratigraphic trap reservoirs.

Although recent research in petroleum geophysics has been mainly concentrated on seismic techniques, Dr. Van Nostrand dealt also with several important developments in the application of other geophysical methods to mining exploration and to civil engineering problems. New borehole logging techniques have been applied to the search for uranium, an induced electrical polarization method has been successful in finding ground water, airborne electromagnetic methods have been widely used in the search for base metals in Canada, and a new airborne magnetometer has appeared, which is especially adaptable for use in light aircraft. Also, high-frequency seismic reflexion equipment has now been developed which offers hope for the successful application of reflexion seismology to mining geophysics and other problems involving structure at shallow depths.

The principles of the new airborne magnetometer were dealt with at greater length by G. Phillips and G. S. Waters, of the Signals Research and Development Establishment, Ministry of Supply. They have independently developed an apparatus, similar to that now in use in the United States, for measuring the magnitude of the total geomagnetic field from the frequency of precession of the protons in water around the field. (For a brief account of this work, see *Nature*, October 8, p. 691.) The advantages of this equipment for airborne magnetometer-surveying derive from light weight and simplicity, occasioned mainly by the fact that, unlike the flux-gate type of magnetometer, precise orientation in relation to the direction of the total field is not essential, so that sensitive servo-systems for this purpose are not required. Another advantage lies in freedom from instrumental drift.

The high-frequency seismic reflexion system was also given more detailed treatment at the meeting, its application and future possibilities being the subject of a paper by Curtis H. Johnson. Whereas reflexion equipment in common use at present employs frequencies in the range 30–60 c./s., the new equipment makes use of frequencies of the order 70–200 c./s. By this means the power of resolution is increased, at the expense, of course, of some increase in attenuation within the Earth. By using a faster recording speed and rapid automatic gain control, reflexion as early as 0·025 sec. after the shot can be satisfactorily timed, so that reflecting horizons as shallow as 100 ft. can be mapped. Besides its usefulness for the shallower problems of geophysics outside the petroleum industry, there are circumstances where high-resolution equipment can help the petroleum geophysicist. In areas where deep weathering or drift presents difficult low-velocity-layer correction problems, the reflexion times down to a known shallow marker-bed will give the necessary corrections for the deeper horizons. Other areas seem to be particularly favourable for high-frequency reflexions, so that more reflexions, and greater

resolution between adjacent reflexions, can be obtained even at depths down to 5,000–6,000 ft.

A paper on instrumental distortion and the seismic record, by N. A. Anstey, attracted considerable interest. Taking a standard seismic input pulse—the Ricker velocity wavelet—Anstey has determined the various distortions of this pulse which arise due to filtering, automatic gain control, and high-amplitude effects in reflexion amplifiers. These distortions may affect the relative amplitudes, the shapes of the pulses, and the arrival times. Clearly, in the attempts which are now being made to use the reflexion method to the utmost limits of its resolving power, these instrumental effects must be fully understood, and in this respect Anstey's work is a most valuable contribution.

Out of the remaining twenty-three papers presented at the meeting, almost half dealt with the detailed mathematical and geometrical problems involved in the interpretation of geophysical results. Of these, the papers by F. Veyretout, M. Rimbaut, and by J. Schoeffler and L. N. Nardon were concerned with seismic reflexion problems; those by L. H. Tarrant and by S. Wyrobek dealt with refraction interpretation; those by A. H. Kleijn and by K. Helbig investigated the effects of seismic anisotropy; while A. Lundbak, C. Monnet, A. Hahn and T. Knight gave papers on gravity and/or magnetic interpretation.

Considerable interest was attracted by three papers presenting the results of gravity determinations: the first, by F. A. Vening Meinesz and A. P. Collette, reported a regional gravity survey of the North Sea carried out by means of an underwater gravity-meter, with the co-operation of the Royal Netherlands Navy; another, by G. P. Woollard, W. E. Bonini and J. C. Rose, gave the latest results in their programme for the establishment of a world-wide network of gravity bases; and the third, by Rose and Woollard, described the measurements carried out from end to end of the North American continent with quartz gravity pendulums, with the object of establishing a gravity calibration baseline. Three papers dealt with seismic field-research: two of these, by T. Gaskell and by M. Pieuchet and H. Richard, were concerned with the efficiency of the customary source, that is, explosives either in a shot-hole or on the surface; and in the other, R. G. Mason described investigations of surface waves near the less commonly used alternative source, namely, a dropped weight. Actual field-surveys for mineral resources were the subject of two papers, one by M. Guerrier and A. Rogier on the Lorraine coal-basin, and one by R. Cassinis on exploration for sulphur limestone in Sicily.

The remaining four papers serve to illustrate the diversity of topics at the meeting. W. Domzalski dealt with problems of very shallow refraction work for civil and mining engineering purposes. F. Sumi treated some of the refinements of the electrical earth-resistivity method. Some novel ideas on the possible turning to advantage of seismic noise in prospecting were expounded by M. Matschinski. Lastly, very precise hydrostatic levelling for foundation problems was described by O. Meisser.

The meeting ended with a showing of the British Petroleum Company's film, "The New Explorers". Despite the many counter-attractions of London, attendance at the technical meetings was consistently high, showing that the meeting was most successful in furthering the interchange of geophysical knowledge and ideas.

L. H. TARRANT

# STRUCTURE OF SEMI- AND NON-CRYSTALLINE MATERIALS

THE autumn conference of the X-ray Analysis Group of the Institute of Physics was held in London at the Institution of Civil Engineers during November 18–19, the topic for discussion being "Semi- and Non-Crystalline Materials". In her opening paper, on the mechanism of crystallite growth in carbons, Dr. R. E. Franklin reviewed her work on the structure of graphitic and non-graphitic carbons. The latter can be further classified into graphitizing and non-graphitizing carbons according to whether crystallite growth can be induced by heat-treatment or not. From this fact, and from the nature of order produced during growth, certain conclusions about the mechanism of crystallite growth can be drawn, in particular when the graphitic sheets grow by the addition of edge groups and when growth is normal to the plane of the sheets. In discussing this paper, Dr. G. E. Bacon described his own work on radiation damage in crystalline graphite, where the order destroyed by irradiation can be completely restored by heat-treatment.

Dr. R. Diamond gave an account of a new theoretical method which he has developed for the interpretation of amorphous scattering curves, and which he has applied to the composition of various coals. Exact theoretical curves for the X-ray scattering from perfect condensed aromatic ring systems of various sizes were first calculated on the EDSAC digital computer. A linear combination of such curves was then fitted to each of the observed experimental intensity curves by the method of least squares, and from the coefficients in the combination histograms were obtained showing the proportions of the various ring systems present. This matrix method is to some extent analogous to the process of Fourier inversion; in cases such as this one, where all the possibly existing components are known, it avoids the difficulties due to cut-off and to the inaccuracies in the experimental curves at high values of $(\sin\theta)/\lambda$. The method has been applied by Dr. Diamond to a study of vacuum carbonization of coal, where the effects of polymerization and evaporation have been clearly shown. Dr. L. Cartz has used the same method on the vitrain series of coals and on ethylene diamine extracts of coals, and has derived histograms of molecular sizes, matching being carried out in the region of the (11) band. Discrepancies occurring between theoretical and experimental curves in the region of the (10) band can be explained as due to the $(00l)$, that is, to intermolecular effects. Replying to questions by Dr. Stadler, Drs. Diamond and Cartz stated that they have also examined quinone extracts in which experimental and calculated curves do not agree; a chemical change during extraction is thought to have taken place.

Prof. R. W. Douglas reviewed some of the experimental work on the structure and physical properties of glass. The principal X-ray work in the subject, that of Warren and his associates on silica, and on soda-silica and boric oxide glasses has led to a concept of network-forming atoms and network-modifying atoms. The rather anomalous physical properties of boric oxide and sodium borate glasses have to some extent been explained by recent infra-red absorption measurements on these materials which have given important information on the bonds present. The