PROSPECTING BY GEOPHYSICAL METHODS

THE European Association of Exploration Geophysicists held its second meeting at Manson House, London, during May 22 and 23. About ninety members and visitors attended, half of whom came from abroad. The Society of Exploration Geophysicists of the U.S.A., with which the Association has close ties, was represented by its official delegate, Dr. Alexander Wolf, of Houston, Texas, and the chair was taken, in turn, by the president, Mr. van Weelden (Netherlands), and Mr. G. Westby, president of the Seismograph Service Corporation of the U.S.A. Nine technical papers from France, Germany and Great Britain were presented. Four of these related to seismic prospecting, three mainly to gravity and two to the telluric current method.

In a paper presented by Mr. H. Linsser (Germany) the author attempted to explain, in a simple manner illustrated by diagrams, the mechanisms of a seismic explosion, and to decide which phases of the explosion contribute to the seismic energy propagated. His investigations were supported by experiments, and he has come to the rather surprising conclusion that no perceptible ground motion is set up by a rarefaction wave following the initial compressional impulse. The latter creates a zone of deformation within which the rock medium is stressed beyond the elastic limit and compressed: and apparently this zone assumes a permanent set which withstands the rarefaction rebound.

The significance of diffraction in the detection and mapping of faults was the subject of a paper by Mr. T. Krey (Germany). By theoretical treatment and field observations, Mr. Krey has demonstrated that the overlapping on a seismic record of reflexions from a faulted bed is not necessarily due to thrust faulting or, in the case of a normal fault, a difference in dip of the bed on either side of the fault: it can be due to the effect of diffraction at the edges of the faulted bed. The attenuation of the energy of the diffracted waves with distance from the fault is gradual, and makes precise location of the fault a difficult problem. When employing the customary interpretation technique, the error involved could be of the order of hundreds of feet, and depends on the depth of the reflecting bed and the signal-to-noise ratio of the seismic recording. Errors may also result in the determination of dip.

In stressing the importance of this paper, Dr. A. Wolf suggested that the practical implications of diffracted waves in seismic prospecting were not fully appreciated. He had been able to register them by using geophones connected in opposition and placed 200–300 ft. apart. With such an arrangement the normal reflexions would not be recorded; but waves diffracted at a fault would arrive at the two geophones out of phase and would be registered. In this way he had successfully located faults in the United States.

Mr. J. Goguel (France) described a special slide-rule which he has developed for the rapid determination of the depths of a series of refracting beds, with small dip, from the observed time-curve. The design of the slide-rule is based on the 'intercept time' method of depth calculation and, when adjusted for the velocity values determined from the time curve, it furnishes directly the cosine factors which are required in the depth formulæ.

Laboratory investigations on the variation of the elastic constants of rocks with frequency were described by Prof. J. M. Bruckshaw and Mr. P. C. Mahanta (Great Britain). It is an established fact that there is an appreciable difference (up to 20 per cent) between the statically determined elastic modulus and the effective value at high frequencies, and the experiments described were designed chiefly to secure further information on this change. American investigators have demonstrated that no appreciable change occurs over the frequency-range 140–4,500 c./s., and the authors' investigations were therefore confined to a lower region, between 40 and 120 c./s.

Measurements made on six different rock specimens exhibited a gradual increase of Young's modulus with frequency, but the total increase over the frequency-range employed was only 2·1–2·6 per cent. The trend of the curves suggested that considerably greater changes could be anticipated below 40 c./s. The authors made use of the results to demonstrate the magnitude of the internal dissipation of energy over the frequency-range considered and were able, also, to show that the influence of dispersion in seismic prospecting is unlikely to cause appreciable error in the interpretation of field seismograms.

Much attention has been paid in recent years to the problem of securing the maximum information from gravimeter observations by devising improved methods of removing the effect of the 'regional anomaly'. Papers relating to this problem were presented by Dr. O. Rosenbach (Germany) and Dr. V. Baranov (France).

The former described a development of the 'second derivative' method of interpretation originally published by T. A. Elkins[1]. Dr. Rosenbach explained that Elkins's formula, while applying quite satisfactorily to deep-seated structures which give rise to low fluctuations of the second derivative at surface, cannot handle adequately the more extreme variations of the second derivative which result from density anomalies at shallower depths. The new approach which he described is to expand the gravity values at suitably spaced points on concentric circles as series in G_P (the gravity at the centre) and its derivatives. By combining sets of these series he has derived practical formulæ which furnish a very close approximation to the theoretical curve for the second derivative.

Dr. V. Baranov presented an interesting analytical method of determining the regional anomaly. The problem in practice is to divide the Bouguer anomaly, B, into two component parts, $B = R + A$, R being the regional anomaly and A the sum of the residual anomalies. The isogals which define the regional gravity anomaly should exhibit only slight curvature and should be fairly regularly spaced. Dr. Baranov therefore assumes that the anomaly can be expressed as an analytical function which may be expanded in a power series, and he neglects terms beyond those of the second or third degree. In order to determine the coefficients of this function, he utilizes the con-

dition that the residual anomalies, A, have only a very limited influence, which implies that the integral

$$\psi = \iint (B - R)^2 \, dx \, dy,$$

over the area within which the regional anomaly is required, is a minimum. A complete description of the method was presented, and illustrated by practical examples.

The discussion which followed these two papers on gravity was very lively, and some speakers, led by Prof. Vening Meinez, expressed their doubts of the real practical value of the various methods which attempt to eliminate the 'regional effect' from the Bouguer picture. Dr. Rosenbach, in his reply, emphasized the importance of an appreciation of the scale of the problem in gravity prospecting. It must be realized that a very close network of stations is adopted, and that the modern gravimeter can be read with an accuracy of at least 0·1 milligal.

Prof. K. Jung (Germany) described two elegant geometrical constructions for determining the approximate positions of buried bodies of simple form from their gravity or magnetic anomalies. He explained that these constructions were developed for use by geologists and others with a restricted mathematical background who require to assess roughly the results of a geophysical survey. He described also a simple mathematical development of Nettleton's method of determining near-surface densities from a series of gravity observations along a profile over a topographical feature.

The telluric current method of prospecting has been developed and used with considerable success by French geophysicists. A paper by Mr. M. Mainguy and Mr. A. Grepin (France), describing some practical examples of interpretation of telluric maps obtained in Languedoc (south-east France), was written from the point of view of a geologist, and was therefore of particular interest. The results of telluric surveys in the Beziers and Alés–Maruéjols basins and the Lunel area were described, and compared with gravity and seismic investigations in the same areas.

The outstanding feature of this particular geophysical work is that, in general, the telluric method has apparently furnished more detailed and accurate information than any other method. In the case of the Alés–Maruéjols survey, the results of the telluric observations contradicted to a considerable extent the prevailing geological ideas and the findings of other geophysical methods; but subsequent drilling evidence confirmed the accuracy of the telluric interpretation and resulted in the discovery of oil. In the Beziers basin the telluric results agreed quite well with the gravity findings, but, in common with the seismic work, the method was unable to secure detail from the depths required. The survey in the Lunel area was very difficult to interpret, but despite this the telluric method appears to be the most promising one to employ.

Mr. G. Kunetz (France) dealt with the problem of eliminating the effect on telluric observations of stray earth currents originating from installations such as electric railways, tramway systems, etc. For surveys where the source of disturbance is, say, a large industrial town at a considerable distance, it is possible to represent the disturbing field approximately by a function the parameters of which can be determined experimentally. A 'regional anomaly' map can thus be produced. Where the disturbing source, or sources, are in the immediate proximity, and the parasitic currents are liable to violent fluctuations, much more laborious methods are required, involving numerous field measurements. It speaks highly of the work of our French colleagues that it has been found possible to produce telluric maps of practical value in such difficult circumstances.

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[1] *Geophysics*, **16**, 1, 29 (1951).

CONFERENCE ON FERTILITY

THE scientific proceedings of the third annual Conference on Fertility, held by the Society for the Study of Fertility in London during June 27 and 28, were opened by Dr. Carl G. Hartman (United States), who presented formidable evidence for the theory of germ-plasm defect as a major cause of fœtal wastage. His early studies on the aplacental opossum, in which he found some 10 per cent of all the developing eggs to be grossly faulty, led him to favour the view put forward by Streeter—that early death of the embryo was due mainly to defective germ plasm—rather than the older idea of Mall that implantational defects were chiefly responsible. Later studies on mouse eggs, using intra-vital staining techniques, supported the same view by demonstrating, in many instances, dead and living blastomeres within the same zygote. He referred also to the recent studies by Hertig and Rock of early human ova; in none of the cases wherein these were abnormal did the authors find any evidence of endometrial deficiencies, although Dr. Hartman admitted that Hughes has claimed that a lack of a glycogen could be demonstrated in the endometrium in some cases of early abortion.

Prof. S. A. Asdell (United States) gave a provocative contribution on the effect of intelligence upon fertility, basing his conclusions on a study of the pedigrees of royal houses. Although the assessment of 'intelligence' was made as objective as possible, he admitted the possibility of many sources of error. Nevertheless, with the exception of genius, which appears to make its own laws, definite correlations appeared to exist, many of which were contrary to popular beliefs. Thus, although the incidence of inbreeding decreased with rising intelligence, the proportion of childless marriages was highest with least intelligence and smallest with average intelligence, and the number of children in the family was highest with average intelligence. It seemed that Nature favoured the average in intelligence, as in most other biological attributes. Another finding was that, contrary to Galton's view, the families of only children of high intelligence (judges who had been elevated to the peerage in Stuart and Georgian times) tended to be large, averaging five to six offspring. Naturally, this paper evoked lively discussion.

Prof. S. Zuckerman (Birmingham) reviewed the cellular components of the ovary, particularly from the point of view of their plasticity. He referred to his own recent work, which leads him to conclude that, in the rat at least, no formation of new oocytes from the germinal epithelium occurs in the adult. He considers the function of the germinal epithelium to be mainly protective; it is highly phagocytic and resilient, continually changing in size and shape as follicles mature and corpora lutea develop and regress. He stressed its sensitivity to trauma, to which it responds vigorously by the formation of