Hints Fault. In this boring were proved 30 ft. of workable coals at depths of less than 3,000 ft. The succession encountered can be correlated closely with that of the Cannock area, thus suggesting the existence of a considerable concealed coalfield extending from the north-eastern margin of the South Staffordshire coalfield into the Lichfield area.

Prof. W. G. Fearnsides next gave some details of explorations carried out in the West Midlands by the National Coal Board during the past few years. He dealt first with the area to the north-east of Cannock Chase where, about two years ago, a boring programme was started in the hope of reinforcing the dwindling resources of Brereton Colliery, south-east of Rugeley. Almost at the same time as the Survey boring at Whittington, the first boring outside the eastern boundary fault was drilled at Redhill. This entered the Coal Measures at considerably less than 1,000 ft., afterwards proving the full Cannock succession of coals. Further borings to the north and north-east all proved the workable coals, which appear to lie in a shelf at least two miles wide and thrown down about 1,000 ft. from those of the exposed coalfield. In this area the quality of the coals is good, and seam gradients, indicated by the boreholes, extremely low. Prof. Fearnsides went on to describe the explorations by which new resources have also been proved east of the Coalbrookdale coalfield in areas north-east of Lilleshall and in the Madeley syncline. Further explorations are being made in several areas west and east of the South Staffordshire coalfield and south of the Warwickshire coalfield. Up to the present, from twenty deep borings in the West Midlands, considerable new resources have been proved.

The final speaker, Dr. G. H. Mitchell, dealt with the area east of the Warwickshire coalfield, and summarized information which has recently been made available from operations in that area by the National Coal Board and the Directorate of Opencast Coal Production. Recently, the limits of the South Derbyshire–Leicestershire coalfield have been proved to run from Desford, through Nailstone, Heather and Snarestone, to Netherseal. North-east of Netherseal the coals lie in a roughly basin-like structure, interrupted by many local contortions and faults. The basin is broken on the west by large faults beyond which the Coal Measures have not yet been proved. On the east side of the coalfield the Thringstone Fault is now known to be a large reversed fault. Between the South Derbyshire–Leicester coalfield and the Warwickshire coalfield, borings at Market Bosworth have proved Cambrian strata. The eastern extension of the Warwickshire coalfield is still unproved.

In the open discussion which followed, Mr. W. Bullerwell displayed maps showing some results of a gravimetric survey made by the Geological Survey over an area connecting the Coalbrookdale coalfield and the northern parts of the South Staffordshire and Warwickshire coalfields.

Dr. C. J. Stubblefield stated that the southern coalfields of the Midlands appear to be faunally connected with a province south of the Brabant Massif, and that certain differences between their marine faunal assemblages and those of the South Derbyshire coalfield suggest that in Coal Measure times a barrier may have existed between the coalfields of Warwickshire and South Derbyshire. Supplementing Mr. Eastwood's remarks on the Whittington boring, Dr. Stubblefield added that the lower section has proved fossiliferous Millstone Grit, Carboniferous Limestone of northern facies, and—a rarity in the Midlands—fossiliferous Upper Old Red Sandstone.

Dr. P. E. Kent said that from the investigations east of Charnwood by the Anglo-Iranian Oil Co., it appears possible that a deep syncline containing Coal Measures exists near Grantham. Coal Measures may also be present in the Melton Mowbray area in troughs adjacent to the boring at Sproxton which, drilled on an anticline, has proved Millstone Grit.

Prof. L. R. Moore outlined similarities between beds which were deposited about the time of Malvernoid movements in the South Wales–Bristol district and corresponding sections in the Midlands which had been described by Prof. Wills.

The large and representative audience was a clear indication that the meeting had aroused wide interest. From the particular point of view of a geophysicist, the proceedings demonstrated forcibly the absolute indispensability of the classical methods of pure deductive geology in the search for new coal resources, and also afforded a clear statement of the many questions which geophysical techniques must be able to answer before they can be considered to have graduated in coal measure problems. While present geophysical methods may assist greatly in the reconnaissance for new coalfields, the geologist and mining engineer require extremely detailed information before seam correlation, gradients and quality can be established firmly enough to support constructive planning. Only in exceptional circumstances can current geophysical methods give sufficiently accurate information at this stage, and there is therefore a need for further application and refinement. In view of this, it seems appropriate to conclude by expressing good wishes to the Department of Geophysics newly established under the Department of Geology at the University of Birmingham. In the light of the discussion, this new Department is not likely to be short of problems close at hand.

EXPERIMENTAL WORK WITH ATOMIC PILES

At the Birmingham meeting of the British Association, four papers were presented in a discussion arranged by Section A (Mathematics and Physics) on "The Application of Atomic Piles to Experiments in Nuclear Physics". The experiments related to the properties of the neutron itself, the properties of atomic nuclei and the application of the atomic pile to the study of solids.

Dr. R. E. Bell, of the Chalk River Laboratory, Canada, described an outstanding piece of experimentation in which Robson has measured the energy spectrum of the beta-rays emitted by the natural radioactive decay of a strong beam of neutrons, and has identified the protons produced. He has verified in detail the predictions about the radioactive properties of the neutron. Bell and Elliott have redetermined the binding energy of the deuteron by studying the capture gamma-rays from hydrogen. The new value obtained for the binding energy is considerably larger than the previously accepted value, so that the accepted mass of the neutron has to be raised by about forty parts in a million.

The energy-levels of nuclei have been studied by Kinsey, Bartholomew and Walker, who measured the spectra of capture gamma-rays emitted by a large

selection of elements throughout the periodic table. They measured the energy of electron-positron pairs produced by the gamma-rays. The spectra become more and more complex as the capturing material is made heavier. Lead and bismuth, however, have simple spectra. The reasons for this behaviour are at present unknown.

The neutron cross-sections of nuclei have been studied at the Argonne Laboratory, Illinois, using three different methods. Dr. D. R. Inglis described the different methods used to select neutrons of a single energy. Narrow slits in a high-speed rotor chop neutron beams emerging from slits in a similar stator into short bursts. The reflexion of a light beam by the rotor on to a photo-cell triggers a multi-channel counting system which selects neutrons by their time of flight. The small area of cross-section of the neutron beam between rotor and stator makes possible the study of small samples of separated isotopes which are inadequate for the pulsed cyclotron technique. Nuclear cross-sections at a definite neutron energy can also be studied using resonance scattering of a beam of neutrons from the pile. The sharp scattering resonance of xenon has been used to determine the absorption cross-section of boron at this energy. For higher energies the pile cannot be used to provide a source of monochromatized neutrons. Neutrons with energies between 5 keV. and 1 MeV. can be produced by bombarding lithium with protons, using very careful voltage regulation of the electrostatic accelerator. This is necessary because the reaction threshold is 1·88 MeV.

Beams of monochromatized pile neutrons can also be used for reinforcing the older technique of X-ray diffraction in the study of solids. Mr. G. E. Bacon, of the Atomic Energy Research Establishment, Harwell, described a double-crystal neutron spectrometer in use at Harwell. The first crystal, a few inches square, is used as a monochromator to select neutrons with wave-lengths lying within a narrow band from a collimated beam emerging from the thermal column of the pile. The neutrons diffracted from a second crystal are detected by a counter mounted on a rotating arm.

A comparison of the intensities of lines in the X-ray and neutron diffraction spectra of graphite confirms that anomalies in the X-ray intensities are due to the anisotropic distribution of electrons in each atom and not to any peculiarities of crystal structure. The neutrons scattered by the atomic nuclei show no anomaly.

Whereas the scattering of X-rays increases rapidly with atomic number, the scattering of neutrons is about the same for all elements. Neutron diffraction has therefore the advantage that light elements can be detected in the presence of heavy ones.

The fast neutrons in a pile can cause interesting changes in the physical properties of solids. Mr. T. M. Fry, of the Atomic Energy Research Establishment, Harwell, referred to the experiments of Lark-Horovitz, which demonstrated the production of electron-traps in germanium irradiated in the Oak Ridge pile. Siegel found that samples of Cu_3Au were disordered after prolonged irradiation at Oak Ridge. Dugdale at Harwell, on the other hand, has found that the resistivity of annealed samples of Cu_3Au falls as a result of short irradiations in the pile. This suggests that the degree of order of these samples is increased by the bombardment.

Berman, at the Clarendon Laboratory, Oxford, has observed that the thermal conductivity of a quartz crystal is reduced by successive irradiations at Harwell until its behaviour is more nearly that of a glass. These changes can be attributed to the scattering of thermal waves by clusters of interstitial atoms and vacant lattice points.

Experiments of this type should throw light on the structure-sensitive properties of solids.

T. M. Fry

MANAGEMENT BEHAVIOUR AND FOREMAN ATTITUDE

In a large-scale business enterprise there are many levels of administrative work. The administrator has responsibility for the process of blending productively the economic, technical and business requirements of complex situations. Some of the most perplexing human relations problems in industry, however, are faced by foremen, supervisors, and others in middle management groups, and to observe at first hand some of these problems of human relationships, Messrs. D. R. Ulrich, D. R. Booz and P. R. Lawrence, of the Graduate School of Business Administration, Harvard University, recently spent eight months in a factory in the United States.*

The particular plant chosen for study reflected many of the tensions and instabilities of an intensely competitive industry. It was one of many plants operated by a company with headquarters in New York. The products of the department were four models of a small, delicate instrument which had been invented and produced for only about two years. A great many technical engineering aspects in the production of this instrument were causing trouble continually.

A new general manager had called upon his immediate associates to operate as a management team. These men, all specialists in their fields, met at the manager's call to make or review all decisions concerning the plant.

Between the management team and the direct labour operators was a thin bridge of supervisors, foremen and staff specialists. At the work bench the company employed a large number of semi-skilled workers. These operators worked on production lines that were continually being revised according to the dictates of the engineering department as interpreted by the foremen.

Preoccupied with the demands made upon them by the hourly employees and the staff specialists, the supervisory personnel felt they did not themselves have adequate capacity to deal with these demands. Yet their efforts to get the help they needed from general management were not successful; instead, 'management' made the strongest demands of all.

The research group felt that a close knowledge of the personnel at each level would be necessary to understand the reasons for the gap between general management and other personnel. The team therefore spent about half its time in the plant talking with, and observing the activities of, thirty-six women who were hourly-paid employees in one department.

Although none of the women ever stated their problems in these words, it seemed to the observers that the only way the women felt they could make their factory life interesting and meaningful was

* Management Behavior and Foreman Attitude: a Case Study. By David N. Ulrich, Donald R. Booz and Paul R. Lawrence. Pp. vii+56. (Boston, Mass.: Graduate School of Business Administration, Harvard University, 1950.) 75 cents.