the rate, but a much higher concentration is here needed.

Lastly, Prof. Quastel discussed his work on the metabolism of pyruvic oxime. This is nitrified very rapidly in soil into nitrite and nitrate. The effect can readily be demonstrated by the addition to enriched soil first of hydroxylamine, which is toxic; but on the subsequent addition of pyruvic acid, rapid nitrification ensues. Other oximes (except that of oxalacetic acid) do not show comparable effects. Also, methionine is without effect, showing that this direct conversion of pyruvic oxime into nitrite is not accomplished by *Nitrosomonas* or *Nitrobacter* but by a class of heterotrophic soil organisms which have been isolated. This result shows that nitrification in soil may not be accomplished wholly by the well-known autotrophic organisms but that heterotrophic organisms may play a part in the direct nitrification of an organic nitrogen molecule, although there is, as yet, no proof that pyruvic oxime is a normal metabolic product under soil conditions.

The concluding paper was read by Dr. E. J. Hewitt and was concerned with the importance of molybdenum in the nitrogen cycle—a subject already touched upon by Prof. Virtanen—which is being studied at Long Ashton. Molybdenum is of widespread significance in the plant kingdom. It is needed in certain circumstances by free and symbiotic nitrogen-fixing and denitrifying organisms, by fungi and by representatives of at least ten families of higher plants. The minute amounts of molybdenum needed have rendered progress slow, until recently, when special techniques have been devised. Deficiency and excess symptoms in higher plants suggest that molybdenum influences nitrogen metabolism, meristematic development and water relations. *Brassica* types especially and tomato and clovers seem to be particularly susceptible. Molybdenum is essential for *Azotobacter* and *Rhizobium* when fixing nitrogen. It is also needed by higher plants and by *Aspergillus niger*, denitrifying bacteria and *Azotobacter* when supplied with nitrate nitrogen, but apparently it is not needed at all (or at greatly reduced levels) when nitrogen is given as ammonia or urea. When molybdenum is lacking, nitrate accumulates or persists and is not reduced. Vanadium can replace molybdenum at a low level of efficiency in *Azotobacter*, but not in *Rhizobium* or in the metabolism of fungi and higher plants. The precise step in reduction of nitrogen compounds catalysed by molybdenum is still obscure.

Manganese is also essential for nitrogen assimilation, since nitrate accumulates when manganese is deficient. Manganese, however, has an opposite effect on amino-acid concentration; but the effects due to its deficiency are also partly dependent on the source of nitrogen.

Soil fertility may be influenced by the availability of the molybdenum. This element is less available in acid soils, and such soils are frequently deficient in available nitrogen. Failures in the establishment of subterranean clovers and other legumes in poor acid pastures of South Australia have been traced to unavailability of molybdenum for the root nodule organisms. Such pastures appear nitrogen-deficient, and beneficial results are obtained by application either of large amounts of sodium nitrate or as little as a quarter of an ounce per acre of sodium molybdate. As clovers given nitrate nitrogen in culture experiments still require molybdenum, it is evident that when given sodium nitrate in soil there is sufficient molybdenum for the requirements of the plant, although not enough for those of the root nodule bacteria. In spite of this differential effect on clovers, *Brassica* types may still suffer from molybdenum deficiency in the field; and the condition long known as 'whiptail' in broccoli and cauliflower may be related to molybdenum deficiency and has been reproduced experimentally in sand cultures by omitting molybdenum. Liming greatly increases the availability of molybdenum; its effect may be on *p*H directly or on reducing the availability of manganese (the two elements apparently being antagonistic).

Molybdenum is thus important in three aspects of the nitrogen cycle, namely, fixation, assimilation from nitrate and denitrification; but in all a reduction process seems to be involved.

Following the reading of the papers, a discussion took place during the afternoon, which emphasized the very incomplete present-day state of knowledge of the chemical reactions underlying the nitrogen cycle.

G. R. Clemo
G. A. Swan

CONSERVATION AND UTILIZATION OF WORLD RESOURCES

UNITED NATIONS CONFERENCE

DURING the period August 17–September 6, the United Nations Scientific Conference on the Conservation and Utilization of Resources, convened by the Social and Economic Council, was held at Lake Success, New York. Its deliberations covered a very wide field, in that they dealt with the conservation and utilization of the principal resources affecting human life throughout the world, namely, minerals, fuels and energy, water, forests and land. The Conference was attended by 535 delegates from forty-nine nations, which included various Eastern European countries but not the U.S.S.R.

The Conference was the first one on world conservation ever to be held. It was a first step by the United Nations towards mobilizing the science of the whole world to promote higher standards of living, and towards implementing the programme of technical assistance to under-developed countries which the United Nations Organisation is undertaking. By such means, it is hoped to bring into sustained use resources as yet untapped and to build up more productive and diversified economics. Stress was laid on the part to be played by major concerted undertakings wherever possible.

The Conference was scientific rather than policy-making. It had no power to bind governments, and did not formulate recommendations to them, nor did it attempt to reach international agreements on policies; its task was limited to the exchange of experiences on the techniques of the conservation and utilization of resources. In the course of discussions, however, both formal and informal, questions of policy inevitably crept in, since it is practically impossible to consider the broader problems of conservation separately from those of control. It was generally conceded that in the more compre-

hensive programmes at least some basic government assistance or direction is essential.

The first two days of the Conference were devoted to plenary meetings; addresses of welcome were given by Mr. J. A. Krug, Secretary of the Department of the Interior, United States, who expressed the readiness of his Government to assist in the advancement of the less developed countries, and by Mr. A. Trygve Lie, Secretary-General of the United Nations. There followed addresses on the world resources situation by Fairfield Osborn and Colin G. Clark; and reviews of critical world shortages in the fields of food, forests, minerals and fuels, and energy were given respectively by Sir Herbert Broadley, Marcel Lelrup, H. L. Keenleyside and John C. Parker. The interdependence of resources was considered by various speakers, including Emmanuel de Martonne, Ernest Weissman and L. Dudley Stamp.

During the main period of the Conference the meetings of the various Sections—Minerals, Fuels and Energy, Water, Forests, Land—were held in the mornings, while the afternoons were given to plenary meetings in which symposia and discussions on interrelated problems were held. The subjects discussed in the plenary meetings included soil and forest conservation and the protection of water supplies, estimates of undiscovered oil and gas reserves, metals in relation to living standards, creatable resources, resource surveys, education for conservation, and resource techniques for less developed countries.

The last two days were devoted to plenary meetings in which were discussed the integrated development of river basins, with special reference to the experience of the Tennessee Valley Authority, and public policy. The work of the sections was reviewed by various speakers; and at the concluding session an address on the use of resources for the enrichment of human life was given by Vijaya Lakshmi Pandit, Indian ambassador to the United States, and one, on the contribution of the Conference to the continuing work of the United Nations, by James Thorne, president of the Economic and Social Council of the United Nations.

Minerals Section

Turning now to a more detailed consideration of the Minerals Section of the Conference, it may be said that in this, as in other Sections, there was presented a most valuable series of papers in which were reviewed recent advances over a very wide field, including theory and technology, estimates of reserves, outlook for future discovery, geographical factors in development, conservation in mining and in manufacture, and conservation by corrosion control and by substitution. The papers and the discussions on them are to be published in due course; but unproofed copies of the papers were available at the conference to all participating delegates.

In the course of the opening plenary meetings, H. L. Keenleyside presented a paper on critical mineral shortages, in which he came to the conclusion that while there are in the world to-day no mineral shortages which are critical, this temporary condition should not be allowed to introduce a false optimism as to the future.

The first topic discussed in the meetings of the Minerals Section was the estimate of selected world mineral supplies by cost range, to which papers were contributed by Elmer H. Pehrson and A. M. P. Légendre. The former gave a series of tables of great interest, including estimates of the world production and reserves of the principal minerals, the *per capita* consumption of selected metals and minerals in the United States and other areas, showing relatively extraordinarily high consumption in the United States, and the world reserves in years of supply at the American and other rates. The geographical factors in mineral development were discussed by Alan M. Bateman and other authors.

The topics of increasing mineral resources by discovery and of the possibilities and costs of methods of discovery attracted papers by many authors on mineral discovery and on prospecting methods in many parts of the world, including North America, Canada, Sweden, India, Liberia, Cuba and Latin America.

A symposium was held on the outlook for future discovery. In an introductory paper, F. Dixey showed that, in view of the very active interest now being taken in mineral prospecting throughout the world, and in spite of the probability that all or most of the major mineral fields are already known, there is good prospect of the discovery within the next few years of some important deposits and of numerous medium and smaller deposits that will be of value for local purposes and for export. He referred also to the prospects of mineral discovery in the British Colonies.

In a paper on the outlook for mineral discovery in Great Britain, W. F. P. McLintock showed that in a well-developed country such as Great Britain, where geological knowledge is at a satisfactory level, the discovery and development of new deposits is a long and costly business and can be done only by organisations with substantial capital resources or by the Government, employing modern methods of prospecting and drilling, and that by these means important discoveries of coal, potash and iron ore have recently been made.

W. E. Wrather similarly considered the outlook for future discovery in North and South America; he suggested an appraisal of the prospects of future discovery by assuming that known mineral-producing areas are a general measure of the possibilities of unexplored but geologically favourable regions, and that, if this principle be applied to the porphyry copper areas of the western United States, to the Canadian shield, and to Latin America, there is good prospect of the discovery of important new deposits.

H. G. Raggatt described the outlook for future discovery in Australia. He concluded that, apart from gold deposits and in the vicinity of working mines, most, if not nearly all, of the metalliferous vein deposits that could be discovered by ordinary prospecting methods have already been found, and that further discovery will depend not only on the application of detailed geological techniques and of geophysics, but also upon favourable economic incentives to promote the development of new deposits.

Much new and interesting information was brought together under the general heading of inorganic fertilizers in conservation. J. le Cornec and K. D. Jacob gave estimates of world supplies of the principal plant nutrients, and Sven Nordengren discussed those of Sweden. It appears that while the reserves of medium-grade phosphate and of potash are adequate for several thousands of years, the reserves of high-grade phosphate are relatively very small and will have to be husbanded. Papers on the economics

of world availability and use of fertilizer materials were given by H. A. Curtis, who drew on the valuable experience of the Tennessee Valley Authority on the production and use of phosphatic and other fertilizers, and by R. E. R. Grimmett (New Zealand) and J. N. Ray (India).

Conservation in mining and milling was considered under several sub-heads. R. B. Beilby (Great Britain), Sven Dalhammar (Sweden), Paul Audibert (France) and R. Arce (Bolivia) submitted papers on metallic mine mechanization to increase recovery; L. Blum-Picard and J. A. Barr, and others, on the mechanization of non-metallic mines; and papers from Canada, Great Britain, the United States and Austria were read on new processes for the utilization of low-grade ores.

Conservation in manufacture was a topic which covered such subjects as conservation of iron and steel in production, treatment of waste gas, conservation of non-ferrous metals, and design as a factor in conservation. Conservation by corrosion control was discussed in a wide range of papers.

Under conservation by substitution, papers on the future of light metals were presented by H. Sutton, O. C. Ralston and Jean Matter, in which much interesting new information was given on the properties, uses, manufacture and possible commercial production of titanium. This metal, in the mineral ilmenite, occurs in very large quantities, and it would find extensive application if its price could be reduced to within the range of those of commercial metals. Great interest has recently been aroused in this metal because it is now obtainable in a ductile state, and because iron can now be produced from titano-magnetite (ilmenite), leaving slag very high in recoverable titanium. Ralston suggested that if low-cost electric power for production of magnesium is restricted in supply, it would be better to use the magnesium to produce a like weight of titanium which would be twice as useful for structural purposes and would, if substituted for light alloys, conserve the use of copper and zinc.

P. L. Teed described the production of magnesia and magnesium from sea water. In Great Britain, magnesia, for the manufacture of high-grade refractories, has been obtained from sea water, on a commercial scale, since 1937. During the War, such magnesia was used as a source of magnesium in place of imported calcined magnesite. R. Bloch described the use of solar energy in evaporation from the Dead Sea water in the production of potash.

The recovery of metals from scrap was discussed by H. J. Miller and C. W. Merrill. The latter gave estimates of the quantities of minerals-in-use, and showed that the quantity of metal-in-use is a rough measure of a community's potential capacity for industrialization and its standard of living.

In the course of the afternoon plenary meetings, D. N. Wadia and D. H. McLaughlin read papers on metals in relation to living standards. The latter considered that the correlation between metallic production and living standards is low, and that between consumption and living standards only moderately higher; these standards depend upon productivity, a function of integrated regional economics. Wadia considered that in under-developed countries mineral resources affect standards of living in that they can be exchanged for fabricated metals and other needed products from industrially developed countries. F. Blondel presented a paper on mineral research, in which he made a strong plea for a more intensive prospecting of the under-developed countries by modern methods, and the provision of adequate funds for this where necessary.

Part of the work of the Fuels and Energy Section was closely related to that of the Minerals Section. For example, it included consideration of new techniques for increasing coal production, with particular reference to mechanization and strip mining. One session was devoted to the underground gasification of coal, on which large-scale experiments, with continuous operation for many months, are now in progress in the United States, Belgium and Morocco. Another session considered techniques of oil and gas discovery and production; one paper, for example, by M. H. Parks, dealt with petroleum production from continental shelves (to depths of 60 ft.). The techniques and results of aeromagnetic surveying were described by J. R. Balsley, who considered that the airborne magnetometer provides a low-cost and reasonably accurate magnetic map which can be used to delineate localities for more expensive and detailed ground work, both geological and geophysical, but it does not eliminate the need for ground surveys. Other papers described the production of oil from shale in the United States, in Sweden, and in Brazil, while the papers presented at the plenary meetings included a review of critical shortages in world resources of fuel and energy, by J. C. Parker; and one on estimates of undiscovered oil and gas reserves, by A. I. Levorsen.

The work of the Minerals Section was reviewed by G. C. Monture, Department of Mines and Resources, Ottawa, Canada, at the final session of the Conference. He said that the consumption of minerals is increasing and will continue to increase with improving standards of living, but that, given the essential basis of peace, no immediate shortage of minerals is apparent. There are as yet, however, no reliable estimates of the mineral resources of the world, because any such estimates must vary with changes in costs, with technical advances in mining and metallurgy, and with national policies on taxation. Political and economic stability and national policies are the determining factors in the exploitation and development of mineral deposits. It is none the less important that the appraisal of mineral resources of each country should be seriously attempted, and the basis for this is a well-organised and well-staffed geological survey. We will not begin to know the mineral resources of the world until national barriers are broken down; but if problems are approached in a spirit of international co-operation, the results achieved to date in the mineral field can be increased many times.

F. DIXEY

RADIO ASTRONOMY

DURING recent years important advances in astronomical knowledge have accrued from the application of radio methods of observation. The striking progress in this field has followed largely from the improvements in radio and radar techniques developed during the War. At the British Association meeting at Newcastle upon Tyne, three British research organisations which have played a major part in radio-astronomical research were represented in the contribution of papers before Section A outlining some aspects of recent progress.