

THE BAAS BECKING BIOGEOLOGICAL RESEARCH LABORATORY, CANBERRA, AUSTRALIA

THE Baas Becking Biogeological Research Laboratory, which will shortly move into its permanent home at the new Bureau of Mineral Resources Building in Canberra, was established in July 1965, under the joint sponsorship of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.), the Bureau of Mineral Resources (B.M.R.) and the Australian Mining Industry Research Association (A.M.I.R.A.). The broad objective of the research work is to investigate the biological and chemical processes associated with the formation of mineral deposits and with other geological phenomena.

The Laboratory is named after the late Dr. L. G. M. Baas Becking, who was one of the first to recognize the possibility that biological, in particular microbial, activity may play an important part in the genesis of sulphide ores.

Laurens G. M. Baas Becking was a research scholar of wide interests, equally renowned in the United States, Java, Australasia and his native Netherlands. His investigations of microbial involvement in the syngenetic deposition of minerals arose from an interest in the milieu of life and its environmental limits. This interest first brought him to Australia in 1936 to investigate, in collaboration with Dr. J. Reuter, life in salt lakes, as part of his research into the effect of organisms on changes in soil, lakes, estuaries and on mineralization.

For a long period, the mode of deposition of certain types of large base-metal ore deposits was open to conjecture; two theories were advanced, sedimentary deposition and hydrothermal emplacement. By the early part of the twentieth century, the hydrothermal theory was widely accepted. Most ore deposits, and virtually all sulphide ore deposits, were believed to have been formed by a process of hydrothermal introduction of the ore minerals at high temperature, into fractures and by metasomatic replacement, and it was assumed that the textures of the ore minerals were the result of this emplacement. It followed that these textures could therefore be used to determine the depositional history of the deposits.

In the 'fifties the view gained ground that this was not the only way in which base metal ore deposits were formed. Some of the ore deposits emplaced in sedimentary and metamorphic rocks were in fact laid down with these rocks. This process was termed syngensis. The mechanisms of syngenetic deposition are still mostly unknown, but the possibility has been recognized that biological factors might be involved.

In Australia, during the late 'fifties and early 'sixties, some investigations into the general problem of syngenetic sulphide ore formation were initiated. Laboratory research was pursued into the low-temperature formation of sulphide minerals, crystallization of amorphous base metal sulphides at high temperature under defined conditions and the biological formation of mineral sulphides. The biological studies were undertaken by Dr. Baas Becking, who succeeded in demonstrating the formation of a number of metal-sulphide minerals by sulphate-reducing bacteria in artificial sea water at room temperature.

In 1960, a number of mining companies, operating through the Australian Mineral Industries Research Association, joined with the B.M.R. and the C.S.I.R.O. in financing a small research unit to enable Dr. Baas Becking to pursue his studies. Ill health unfortunately prevented Dr. Baas Becking from doing this, but his work was generally confirmed and appreciably extended by Dr. K. L. Temple during the period 1961-63. In general, the work reached the stage where it could be visualized that under certain conditions the biogenic formation of sulphides might be an important factor in the formation of some economic ore deposits. As a result of this work, it was decided to embark on a more ambitious research programme and the three supporting organizations formed the Baas Becking Biogeological Research Laboratory.

Initial emphasis will be placed on investigations to establish the relationship of biological factors to the natural physico-chemical environment with particular reference to the possible role of these factors in the formation and transformation of sulphide minerals. Investigations will include the response of micro-organisms to heavy metals; biochemistry and physiology of oxidative and reductive sulphur transformations; role of organisms in the concentration of mineral elements; physico-chemistry of low-temperature mineral synthesis; mobility of sulphides under the influence of temperature and pressure and the interaction of mineral types; and biological leaching of low-grade sulphide minerals.

It is planned to extend research at a later stage to include other important minerals of possible biogenic origin such as carbonates and phosphates. Dr. P. A. Trudinger and Mr. W. M. B. Roberts will be in charge of research operations, responsible to a committee of management under the chairmanship of Mr. Haddon F. King.

J. E. FALK

LOCAL HEALTH SERVICES

EXPENDITURE on health by local authorities has been rising faster than expenditure on the National Health Service as a whole. The National Health Service accounted for more than 10 per cent of the total expenditure in 1964, compared with little more than 7 per cent in 1949. Expenditure on health services by local authorities more than trebled between those years, to reach a total of £107 million for the United Kingdom in 1963-64. This information is given in an Office of Health Economics report* which emphasizes the changing pattern of work now being carried out by local health authorities.

* Office of Health Economics. *The Local Health Services*. Pp. 40. (London: Office of Health Economics, 1965.) 2s. 6d.

The largest proportional increases in expenditure are due to the provision of more 'home helps' (from £2.3 million to £12.3 million) and to extending the services for the mentally ill in the community (from £1.2 million to £9.3 million). The number of 'home helps' employed rose from about 19,000 in 1949 to more than 60,000 in 1964. Four-fifths of all their work is looking after elderly people at home; the report points out that, for every elderly person visited by a 'home help', there are two others who need help with their housework and are not getting it. Practically no community care was provided for the mentally ill before the start of the National Health Service. By 1964, 156,000 people outside hospital were benefiting from local mental health services.

The largest actual increase in expenditure has been in the ambulance services. This has risen from £6.5 million in 1949 to £18.8 million in 1964. The total number of patients carried has risen even more, from 7 million in 1949 to almost 20 million in 1964. Four-fifths of ambulance work consists of carrying patients to and from out-patient departments, and a much larger proportion of such patients are now travelling by ambulance. At the start of the Health Service only one out of every ten journeys between the home of an out-patient and the hospital was made by ambulance; now, one in every four journeys is by ambulance.

The report emphasizes how difficult it seems to be to persuade people to accept immunization against infectious diseases. Only 66 per cent of infants born in 1961 were immunized against poliomyelitis. It comments that "the dangers of infectious diseases have diminished to an extent undreamed of 30 years ago; but there can be one disadvantage of a successful vaccination campaign. This is the comfortable but false assumption by the general public that it has been a once-for-all battle which has eliminated the threat forever".

The report directs attention to the large differences between local health expenditures in different parts of Britain. They range from the expenditure by Northampton County Council of £1 3s. per head of population to that of £3 1s. 2d. by the Cardigan County Council. In terms of personnel, this means a two-fold variation in numbers of health visitors, and a three-fold variation in numbers of 'home helps', nurses and midwives. The report comments that "in this case, geographical factors are undoubtedly important; but, in general, it is not easy to say whether variations between the level of provision in different areas are due to differences in need, differences in financial resources, or differences in the appreciation of the value of the services". These differences in levels of expenditure between different parts of Britain are expected to continue during the next ten years.

The report calls for "a substantial operational research programme" to "evaluate in depth the services actually provided by typical high spending and low spending areas". The results, it says, could be coupled to those of community studies; these have already suggested that

there are many needs unmet, especially in the case of the elderly at home.

Commenting on plans for the future, the report points out that "the trend towards community care and the consequent necessity for close co-operation between the various sections of the tripartite Health Service have provided an opportunity for the local health authorities to play a more prominent part". However, the plans for the next ten years prepared by the local health authorities "imply a slackening rate of expansion in their local health services which becomes very marked after the end of this decade".

The report suggests that the falling off in expansion of the services planned by the authorities must be taken primarily as a reflexion of the difficulty of forecasting for a situation in which there are still so many unknowns. The changing responsibilities of the general practitioner, the increasing skill in early diagnosis and the development of day hospitals are but a few of the external factors which must affect the function of the local health authority. What is important is to maintain flexibility, and, above all, to avoid recrimination if the present rate of expansion of the local health services in fact continues far into the 1970s. Those who framed the National Health Service made a "miscalculation of sublime proportions" in assuming that its costs would not rise as the Service developed, and much criticism of actual expenditure resulted. The ten-year plans of the local health authorities inevitably appear to contain a similar fallacy, and it would be unfortunate if these were eventually to result in similar misunderstanding.

"In this connection", says the report, "it is encouraging to note that the new National Plan takes a more expansive view of the local health services in the future. While the local authorities forecast an increase in current expenditure of only 4 per cent in 1968-69, with an annual average of 1.5 per cent in the following five years, the National Plan refers to the annual rate of increase having risen to 6.5 per cent in 1969-70. Whereas local authorities forecast an increase in net revenue expenditure of 30 per cent in the decade from 1964-65, the National Plan forecasts an increase of 34 per cent within the first five years."

THERMODYNAMICS OF NEW GENERALIZED TRANSPORT LAWS FOR LIQUIDS, GASES AND ELECTRONS IN MATTER

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IT is well known that thermodynamics constitutes the foundation of numerous conventional principles and theories in the physical, life and engineering sciences. Some important parts of thermodynamics are the criteria of thermal equilibrium. It has been almost invariably assumed that for any thermodynamic system in thermal equilibrium, the chemical potential is constant everywhere in the system for each constituent. Such a criterion, as will be shown in this article, can only be justified if the particle concentration in the system is uniform everywhere for each constituent. The last statement is substantiated by at least one case treated in the classical work of J. W. Gibbs, to be referred to later in this article.

For the particular case of electrons in solids, it is well known that these particles obey the Fermi-Dirac^{1,2} statistics, and that at constant temperature the Fermi-level is equal to the chemical potential. Thus, it has been conventionally concluded that in thermal equilibrium the Fermi-level for electrons must also be constant through-

out any solid. This assumption alone constitutes a foundation for much of the transport theory of electrons in solids as it is known to-day.

It has been pointed out that the validity of assuming that the Fermi-level is constant in thermal equilibrium would not be justifiable for electrons in non-degenerate *p-n* junctions³. Similar objections have been raised for electrons in any heterogeneous solid⁴. If the arguments in refs. 3 and 4 are valid, one would expect that the conventional criteria of thermal equilibrium as a whole might involve some basic misconceptions. If so, it should then be possible to show these misconceptions by new direct arguments and conventional thermodynamics. Attempting to point out and treat this serious matter will be the main objective of this article.

To investigate the criteria of thermal equilibrium, new phenomenological laws will be formulated. These will describe the transport of conduction electrons in any form of matter, and more generally the transport of particles in fluids enclosed in stationary containers, under