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1965/256



RESEARCH IN THE MINING INDUSTRY

by R.W.L. King

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SUMMARY

After a consideration of research currently taking place in the mineral industry in Australia, and requirements for additional research, recent reviews of mineral industry research in South Africa, Canada and Australia are also examined. The conclusion is drawn that the greatest need for more research lies in the field of the methods and techniques associated with mining itself, and that one or other of the recently proposed methods of encouraging research should be applied to the industry.

INTRODUCTION

In recent months the question of encouragement of research in Australian industry has been under review in a number of quarters. The Manufacturing Industry Advisory Council proposed a scheme of semi-automatic grants for research and development of manufacturing processes by Australian companies in Australia. The present paper reviews the scope for the encouragement of research by this or some other method in the Australian mining industry.

CURRENT RESEARCH ACTIVITY

The following divisions and sections of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) conduct research in fields related to the mineral industry:

Physical Metallurgy	-	properties of metals and alloys.
Applied Mineralogy	-	properties and uses of minerals particularly ceramics and cement.
Mineral Chemistry	-	extractive metallurgy.
Mineragraphic	-	mineralogy and petrology of ores and minerals.
Coal Research	-	characteristics and uses of coals.
Chemical Engineering	-	mineral processing and extractive metallurgy.
Soils	-	microbiological oil exploration.
Fisheries and Oceanography	-	marine phosphate deposits.
Physical Chemistry	-	desalination of water.

Results of research are published in technical journals and proceedings of learned societies as well as C.S.I.R.O.'s own publications. Most divisions also publish an Annual Report of work carried out, and regular lists of abstracts of research reports are provided by C.S.I.R.O. as a whole for library purposes.

Joint academic and C.S.I.R.O. Ore Dressing Laboratories at Melbourne (with the University of Melbourne) and Kalgoorlie (with the Western Australian School of Mines) undertake research into specific problems as well as basic principles of ore dressing. Since the establishment of the Australian Mineral Development Laboratories, the emphasis is being transferred from research and testing for flowsheet design to more basic research. Individual reports on projects are issued and circulated to libraries as well as the company or individual directly concerned. Wider distribution is sometimes delayed at the company's request.

The Snowy Mountains Hydro-Electric Authority has done valuable work in rock mechanics in connection with the design of underground structures and it is understood that their programme in this field is to continue for some years. More fundamental work is carried out in the Geophysical Department of the Australian National University. At least one Broken Hill mining company is also active in this field, as are Mt. Isa Mines Ltd.

The Australian Atomic Energy Commission conducts research on nuclear materials and on metals and ceramics used in the production of nuclear power. An independent organization, the Australian Institute of Nuclear Science and Engineering has as its purpose the stimulation of research and training in nuclear science and engineering. Results of research are published in the technical journals.

The Aeronautical Research Laboratories and the Defence Standards Laboratories of the Department of Supply conduct research on the development and testing of metals and alloys for defence purposes, and record the non-confidential investigations in their Annual Reports.

Laboratories associated with the State Mines Departments as well as supplying analytical, mineralogical and petrological services to their Departments also undertake research into ore dressing and sometimes extractive metallurgy. Their activities are published in Annual Reports of the State Mines Departments.

The Universities listed below conduct research in the fields indicated.

Melbourne	- mining, mineral processing, materials science, properties and uses of brown coal.
Sydney	- coal mining.
New South Wales	- mining, mineral processing, properties of coal, extractive metallurgy and metals technology.
Queensland	- mining, mineral processing, extractive and physical metallurgy.

Most large mining and metallurgical companies have research sections including laboratories to deal with the companies' immediate problems and they all include provision for scanning the current scientific and technical literature for items of interest in their own particular fields. In some areas lists of abstracts are available on a regular basis, and this facilitates the work. Even when research developments of interest are noted in this way, it is usually necessary to devote considerable effort to adapt the overseas developments to Australian conditions, particularly in mining and exploration.

Co-operative research laboratories for the coal industry (the Australian Coal Industry Research Laboratories) were originally established as Australian Coal Association (Research) Ltd. by the colliery owners in N.S.W. and Queensland. The laboratories are primarily concerned with research and development in coal production and utilization, and with the additional funds available from industry and State and Commonwealth Governments upon re-organization under the new title, it is intended to expand the laboratories' activities, particularly in the field of coal utilization research.

A number of mining, metallurgical, cement and chemical companies have formed the Australian Mineral Industries Research Association (A.M.I.R.A.) to promote and develop research in the mineral industry. The Australian Mineral Development Laboratories (A.M.D.L.) in Adelaide are controlled by a Council which consists of representatives of the South Australian and Commonwealth Governments and A.M.I.R.A. They undertake confidential sponsored investigations as well as fundamental studies of importance to industry and have recently extended their activities to include secondary metallurgy. A.M.I.R.A. also sponsors or contributes to research projects on mining, geology and ore dressing outside A.M.D.L. such as the Wire Rope Research project at the University of New South Wales; the Bass Becking Geobiological Unit with C.S.I.R.O. and B.M.R. and the Research Fellowship in Structural Geology at the Adelaide University.

A.M.D.L. also undertakes work for companies' and individuals other than the three sponsoring groups represented on the Council. Whenever possible projects carried out are mentioned in the Laboratories' Annual Report, or, if of sufficient originality, may appear in a technical journal. In some cases, however, private company sponsored projects are kept confidential.

The Bureau of Mineral Resources also carries out research in various fields including geology and geophysics.

Many of the smaller companies employ permanent research staffs of one or two who perform valuable work on problems of immediate and local concern, but work of this nature is rarely published. They also adapt results of overseas research to the environment of their own companies.

Generally speaking, where work is not of a confidential nature it is recorded in some way - either in the Annual Report of the organization concerned, or in the technical journal of the organization if it is of a more original nature. Where the research organization is smaller, mention will usually be made of research projects in the house magazine, and more important and original work will appear in the proceedings of learned professional bodies such as the Australasian Institute of Mining and Metallurgy, the Institution of Engineers, Australia etc. Periodicals such as Mining and Chemical Engineering Review, Australian Chemical Processing etc., give space for reports of local research. Some projects of narrower interest may be published in overseas specialist journals. The Newsletter of the Commonwealth Committee on Mineral Processing also covers a part of this field.

For greater detail on some of the research organizations included above refer to the chapter entitled "Mining and Metallurgical Education and Research in Australia" especially pages 104-113 in Handbook Australia and New Zealand (Editor J.M. Dew) published by the Eighth Commonwealth Mining and Metallurgical Congress, Melbourne, 1965.

REQUIREMENTS FOR ADDITIONAL RESEARCH

A committee set up by the Advisory Council of C.S.I.R.O. is at present examining research needs in the area of the mining industry in consultation with other government agencies concerned. It is now planned that some promising lines of C.S.I.R.O. research on mineral treatment in the Division of Mineral Chemistry should be substantially expanded in the forthcoming year.

It appears that the major mining companies feel that their present scale of expenditure on research and development is the most that they can afford under the present circumstances. There is little prospect of further funds being made available by way of industrial contribution other than minor grants for specific research programmes.

The Bureau of Mineral Resources is interested in research into methods of exploration, but priority is being given to the identification of areas in which known methods of intensive exploration might be profitably applied. Ideally, sufficient manpower and money should be available to permit greater effort in both fields.

One area of work in which existing research centres give only a limited cover is that of the application of statistics to mining problems. Some work in this field has been carried out by statisticians of the University of Melbourne in collaboration with, and at the request of, Gold Mines of Kalgoorlie Ltd.

Other fields in which research (as opposed to development of imported equipment and techniques) is lagging in Australia is that of mining itself. There is scope for more original work in applied rock mechanics, drilling for production and prospecting purposes, ventilation problems, environmental and health problems, mining methods, explosives and other methods of rock breaking etc.

RECENT REVIEWS OF MINERAL INDUSTRY RESEARCH

The Fifth Technical Session of the Eighth Commonwealth Mining and Metallurgical Congress, held in Melbourne earlier this year, was devoted to Research in the Mineral Industry.

W.S. Rapsen (Research Advisor, Transvaal and Orange Free State Chamber of Mines, Johannesburg, South Africa) reached the conclusion that the development of hard rock mining techniques suited to conditions in the future deserves far more attention than is at present given to this aspect of research in the mineral industry. He felt that while governments were aware of and discharging their responsibilities as far as exploration and mineral processing are concerned, more generous assistance should be given to industry in respect of long term mining research activities than has been the case in the past.

One interesting point made was that because individual mine managements have tended to rely on suppliers of mining equipment for research and development work, mining engineering had been lowered in the esteem of students, thus reducing the number of potentially research minded entrants to the mining profession.

In another paper, J. Conway and V.A. Haw (Director and Senior Scientific Officer, respectively, of the Mines Branch, Department of Mines and Technical Surveys, Canada) reviewed the expenditure on research and development by the Canadian mineral industry. Stressing the particular applicability to Canada of the remark that "resources are created by research" made by the Director of the U.S. Geological Survey in 1961, the authors pointed out that the Canadian Government had decided to encourage research and development by legislation introduced in 1962. This provided for a 150% taxation deduction allowance for expenditure on research and development incurred in excess of expenditure in the base period, defined as the last taxation year ending before 11th April, 1962. Research grants to industry are also provided by the National Research Council and the Defence Research Board; funds being provided on a dollar for dollar basis in respect of approved projects.

In practice, the authors consider that the research grant scheme has had little effect on the research and development effort of the mineral industries, but that the taxation deduction scheme had provided a considerable increase in the research effort.

The Canadian Metal Mining Association has appointed a research advisory committee, and a permanent position of research co-ordinator with the object of increasing the effectiveness of Canadian research amongst mining and metallurgical organizations throughout industry, university and federal and provincial government research centres. A number of national advisory committees on special fields such as geological sciences, rock mechanics and gold metallurgy have been appointed to stimulate and co-ordinate research in these particular fields in Canada.

In conclusion the authors expressed the feeling that the problems of research and development in the Canadian mineral industry were recognized by government and industry and that corrective action was in fact being taken which would lead to improved productivity in the Canadian Mineral Industry in the future.

A paper prepared by Dr. J.C. Nixon (Manager of Research, Conzinc Riotinto of Australia Ltd., and Honorary Executive Officer, Australian Mineral Industries Research Association) discussed the results of a questionnaire sent to A.M.I.R.A. members to establish the level of expenditure on research among the A.M.I.R.A. group of companies. Expenditure on research and exploration for new orebodies amounted to only 0.93% of the value of production (recorded value of output). The conclusion reached was that expenditure on research and exploration in the mineral industry should be substantially increased by companies, the Commonwealth and at least one of the States. (Presumably the author means New South Wales -- on the figures presented, all other States run their Mines Departments at a loss when income from rent and royalties is set off against expenditure in running the Department, including its research activities.)

As in the case of other papers presented to this technical session the author felt that it was in the field of mining research that the greatest improvement in effort needed to be made. To quote: "In mining although the industry operates efficiently, few important innovations have ever been developed in Australia, most having been adapted from overseas. Our exploration techniques are wholly imported, and no significant new mineral deposit has been discovered from their use whereas in their native Canada success has been outstanding. Our huge deposits of bauxite and iron ore were found by individual prospectors".

While his first statement is undoubtedly true, successes with geophysical techniques have been numerous but not as spectacular as those in Canada. Discoveries which in whole or in part can be attributed to geophysics include Savage River (iron); Corridor area Mt. Lyell (copper); Ronison Bell (tin); Mt. Cleveland (tin); Ardlethan deep lead (tin); Tennant Creek (copper and gold in association with magnetite); Baryulgil (asbestos in association with magnetite) and several extensions of known coal fields. Conditions in Australia are much more difficult than in Canada for the application of geophysical methods because of the deep weathering and high surface conductivity to which most of our mineral fields are subject. This, of course, emphasises the need for research into the development of methods which can cope with these conditions.

CONCLUSIONS

The conclusion is reached that while the full spectrum of fields of research likely to prove applicable is covered by various interested organizations in the Australian mineral industry, there is a need for greater effort in all fields and particularly research into exploration and mining as opposed to ore dressing, extractive and physical metallurgy.

As priority can be more profitably given to the search for localities where detailed geophysical and geological exploration techniques can be fruitfully applied, there is a need for increased effort in this field, and in the field of mining research.

While the large mining companies must play an essential part in research in mining there is scope for additional research into the problems which affect more directly the small syndicate or individual producer. This field is a proper one for Government activity.

Research into the broader aspects of exploration, also, is possibly more appropriately carried out by Government organizations than by individual companies. However, there are a variety of reasons why Governments are unable to maintain an adequate effort in this field and it becomes necessary to devise ways of encouraging industry to do this.

Although Canadian experience seems to indicate that a taxation deduction is the more effective way of encouraging increased research, it would be quite practical, and in the absence of a taxation scheme, certainly desirable to introduce a system of semi-automatic research grants after the style of the Manufacturing Industries Advisory Council proposal.

It would probably be desirable in the event that such a scheme were introduced to set up some form of advisory committee to co-ordinate the research programmes carried out in the various fields applicable to the mineral industry. It would be an advantage in this context to have an industry wide organisation to speak to and co-operate with Government such as is the case in the Manufacturing Industry.