DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Record 1973/129

DOCUMENTATION AND ANALYSIS OF THE MINERAL INDUSTRY IN NORTH AMERICA, THE UNITED KINGDOM, FRANCE, AND JAPAN

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SUMMARY

A tour of North America, the United Kingdom, France, and Japan was made to study the organization, role, and methods employed by governments and scientific organizations in the documentation and analysis of national mineral industries, with a view to applying the new ideas and more successful techniques in the operation and re-organization of the Mineral Economics Section of the Bureau of Mineral Resources. While each of the organizations visited contributed new ideas and special expertise in different fields of mineral documentation, assessment and analysis, the Mines Departments in North America, in particular the Canadian Department of Energy, Mines and Resources, provided the more interesting examples of new ideas and developments which could be readily and fruitfully applied to our own organization. The U.K. Institute of Geological Sciences is a world leader in the collection and publication of international mineral statistics on production and trade, but the statistical coverage and documentation of the domestic mining industry is far from complete and attempts to publish a Minerals Yearbook for the United Kingdom are following the lines provided by the Australian Mineral Industry Annual Review. While governmental organizations in France and Japan provided examples of major advances in the collection of mineral statistics and the compilation and documentation of mineral intelligence and resources data, application of the methodology involved is applicable only where the central government is more intimately associated with and has more statutory authority over the domestic mining industry than is the case in Australia.

Basically, the methodology of mineral statistics collections in all the countries visited is similar to that followed in Australia, although differing in detail as to coverage, timing, and responsibility

for collections. Without exception, final annual statistics are not officially available until well into the year following the year to which the statistics refer. Publication of the official minerals yearbook generally lags by 1-2 years. However, in some cases preliminary statistics are published in January or February following the year concerned, and these are estimates prepared by mineral commodity specialists who use official statistics for the period January-October and their own estimates for the remainder of the year. It is noteworthy that the countries visited adhere to annual statistical collections on a calender year basis, the exception being Japan where a fiscal year (April-March) is adopted as the time unit for annual statistical collections.

In the United States particularly, mineral commodity specialists are becoming increasingly responsible for the collection of official statistics relating to their own particular mineral commodity. While this procedure has the advantage of improving the timing of collections and in obtaining data on those facets of the industry in which the specialist is primarily interested, it does little to systematize the overall statistical collection, and in some cases leads to unnecessary imposition on companies' time and goodwill by duplicating requests for certain data.

Another feature of mineral statistics collections in some of the countries visited was the scant regard paid to the ex-mine value of output and production. In fact, ex-mine values are equated with the product of metal content of concentrates produced and the average domestic price of refined metal over the relevant period. While this attitude saves both effort and time, it is conceptually wrong and allows no clear distinction to be made between the contribution to the economy by the mining sector and the metals refinery sector of the industry.

Without exception, commodity studies remain the basis for detailed analysis of the mineral industry, and mineral commodity specialists are relied on to provide documentation and analysis of the industry necessary for authoritative advice to the private and public sectors of the economy both as background for current operations and the basis for forward planning. Close liaison with the private sector of the mining industry is a fundamental feature of commodity studies, and commodity specialists spend up to 8 weeks of the year in the field, visiting mines and plants and discussing current operations and possible future developments with company representatives. The increasing degree of specialization by commodity specialists is a marked feature of the United States and Canadian systems, where the aim is to confine commodity officers to one major mineral. In the U.S. Bureau of Mines, three commodity specialists are assigned to copper alone. This degree of specialization enables commodity specialists to study the economics of any particular mineral in considerable depth and to investigate special facets of the mineral industry beyond the scope of our Mineral Economics Section as currently constituted. The Commodity Division of the U.S. Bureau of Mines has 98 professionals and 118 support staff (research officers and clerks) backed by 38 Liaison Officers spread over the various States and supported by the Office of Technical Data Services (3 professionals and 32 clerical officers) in Washington. The Minerals and Metals Division of the Canadian Department of Energy, Mines and Resources is currently staffed with 19 commodity specialists divided into four sections, each with a sectional head, commodity research officers, and clerical support staff; the sectional heads answer to a divisional chief.

In most of the governmental organizations visited an attempt has been made to set up an economic analysis group to treat the mineral industry as an economic unit and to pursue investigations of the significance of the industry using economic theory and econometrics. This innovation has achieved only limited success. In both the United States and Canada, the economic analysis groups were originally staffed with pure economists whose work was criticized for lack of realistic conclusions and practical application. The objectives and organization of the groups have now been modified, and, while pure economists are still employed and the group is maintained as a unit, the aim is to recruit post-graduates with a mineral economics background and to integrate the work of the economists with special projects undertaken by mineral commodity specialists.

Common to all the organizations referred to is the increasing emphasis on project management and the formation of ad hoc teams with the expertise of various disciplines combined in a special project. In resources work, e.g. delineation of potential mineral resources of a specific primitive or wilderness area, a team may consist of a geologist, geophysicist, mining engineer, geochemist, and mineral commodity experts with additional expertise drawn from universities and other organizations if this is deemed necessary.

Conclusions and recommendations for improved documentation and analysis of the mineral industry within the Mineral Economics Section are listed in the final part of this report.

1. INTRODUCTION

During the period 10 April-30 May 1973 the writer completed a study tour of governmental organizations and semi-governmental groups closely concerned with the mineral industries of the United States, Canada, United Kingdom, France, and Japan. The main purpose of the tour was to study the latest concepts in organization, government role, and methodology of documentation and analysis of national mineral industries. It is hoped that the information and background gained from the study will provide useful guidelines for the reorganization of the Mineral Economics Section currently being undertaken within the Bureau of Mineral Resources. Where time and convenience permitted, the opportunity was taken to discuss with selected companies the current world supply-demand position in certain minerals, e.g. mineral sands, and to canvass the view of consumers and fabricators on future demand trends and technological developments. A detailed list of companies contacted is given in Appendix 1. Recent and possible future developments in the zirconium and titanium industries in the United States and Japan are summarized in Appendix 2.

The principal governmental organizations visited were the Bureau of Mines and the United States Geological Study in the U.S.A., the Department of Energy, Mines and Resources in Canada, the Institute of Geological Sciences in the United Kingdom, the Department of Industrial and Scientific Development, and the Bureau de Recherches Geologiques et Minieres (B.R.G.M.) in France, and the Ministry for International Trade and Industry (MITI) in Japan. Visits to non-governmental organizations dealing with mineral economics included those to Stanford Research Institute at Menlo Park, California, and the Colorado School of Mines at Golden near Denver.

Different facets of the mineral industry were emphasized depending on the organization consulted, and proportionally more time was spent in discussing those areas of mineral economics in which the various groups showed particular expertise. However, discussions generally evolved along four distinct lines:

(1) Statistical coverage of the mineral industry, particularly special collections such as those for secondary and recycled metals, to assist future statistical coverage of the mineral industry within BMR and in co-operation with the Commonwealth Bureau of Census and Statistics and State Mines Departments.

(2) Collection of economic, technical, and operational data from industry.

(3) Study of specific aspects of the industry such as mineral processing, projections of supply and demand, substitution, prices, costs, and the use of mineral economics in regional planning and competitive land use.

(4) Publications and dissemination of information to government and industry.

2. UNITED STATES OF AMERICA

The collection, analysis, and dissemination of mineral supply and demand data in the United States is organized and controlled principally by the Bureau of Mines. However, increasing concern regarding long-term supply of minerals, and environmental and ecological considerations of mining developments, has brought the United States Geological Survey (USGS) more and more into this general field by way of the Minerals Availability System and the Wilderness and River Basin Programs. The two organizations belong to the U.S. Department of the Interior, and by our standards each is huge and diversified in its own right. Currently the USGS has a ceiling of 8007 permanent officers, about half of whom are professionals. Staff of the Bureau of Mines is limited to about 5000. However, these figures do not reflect fully the total availability of professional staff, in as much as both organizations employ many part-time staff classified as I (intermittent) or WAE (when actually employed), and contract out many projects to other scientific organizations. The USGS has always been regarded as a research organization and up till now has been allowed to develop systematically without undue interference from the Administration. The Bureau of Mines on the other hand has been politically oriented and controlled, and its progress has been marked by start-stop programs and organizational changes in planning, alternating between decentralization and centralization, in Washington.

BUREAU OF MINES

An organization chart of the Bureau of Mines is given in Figure 1. Broadly speaking, the Bureau consists of two main divisions headed by Deputy Directors - Health and Safety on the one hand, and Mineral Resources and Environment Development on the other. Currently, there is a strong move in Congress to fragment this structure and retain only the mines administration division - i.e. Health and Safety - directly within the framework of the Bureau. The remainder of the Bureau would be dismembered: research & development, and minerals data collection & analysis being put into separate federal agencies and thus much more under the direct control of Administration advisors.

The group whose functions are most closely allied to those of our own Mineral Resources Branch is Mineral Supply headed by Assistant Director Sheldon Wimpfen. This Division, which is responsible for commodity mineral specialists, statistics, and economic analysis, is headquartered in Washington but also encompasses four field offices at Denver (Colo), Juneau (Alaska), Pittsburgh (Pa), and Spokane (Wash.), each of which in turn conducts one or more field offices at various mining centres. Currently the Division has a staff ceiling of 558, of which 301 are professionals. Duty statements of many of the offices of the Mineral Supply Division are specifically applicable to the work of our Mineral Economics Section, and special investigations being conducted within the Division provide exciting possibilities for future lines of investigation by an expanded and reorganized Mineral Economics Section. The writer therefore concentrated his investigations on organization, procedure, and methodology within Mineral Supply both at Denver and Washington.

Intermountain Field Operation Centre, Denver

This group headed by Ottey Bishop has a staff ceiling of 72, of which 49 are professionals covering the disciplines of mining engineering, civil engineering, geology, physical science, economics, petroleum engineering, and even social science. The main functions of the group are the

- development and assessment of mineral resources information
- maintenance of mine map repositories and drill core libraries
- specific in-depth studies requested by Commodity Divisions
- review and preparation of data for environmental impact statements
- investigation of areas associated with Wilderness and River Basin projects
- negotiation, co-ordination, and monitoring co-operative programs with State and local organizations.

The IFOC, Denver, provides administrative services for Bureau activities west of the Mississippi River with the exception of those of the western States, which are handled from Spokane. The functions of the Denver group have been revised and altered substantially over the last three years. In particular, the work of statistical collections, preparation of individual chapter for the Minerals Year Book, and cost analysis studies have largely reverted to Washington. The work of the group is now concentrated into five sections - minerals availability section, wilderness section, energy section, river basin studies section, and petroleum studies section.

Minerals Availability. Three main sub-sections

(i) Mine map repository: microfilm repository of authoritative maps of all underground mines west of the Mississippi River. The data bank contains details of past and current mining operations, including the areas mined out or back-filled, waste disposal areas, underground geology, assay data, and other pertinent information relative to environmental and resource consideration.

(ii) Mineral development time-frame analysis. The objective of the analysis is to determine the period required to explore and develop a mineral deposit and to construct mining and concentrating facilities at selected major metal-producing mines. Data are collected and computerized under the headings of mine, location of claims to large-scale production, preliminary exploration and evaluation, major exploration, development, beneficiation plant construction, break-in period, beneficiation plant expansion, total designed capacity achievement, mine operating period. The case histories for each mine are analysed to indicate the variable parameters which influence the critical time factors in the development of a mineral property. Results of the study provide a historical background of mine development throughout the nation (copper mines have been completed and work is starting on lead-zinc mines); indicate the time lag which might have to be taken into consideration in a state of emergency; and supply some guide in supply projections as to time lag between mineral discoveries and economic production.

(iii) The economics of by-product metals. By-product metal systems are being investigated under the headings of economic and strategic importance, supply systems, plant locations, supply-

demand patterns. Work has just been completed on the copper system which deals with arsenic, platinum, silver, gold, selenium, tellurium, molybdenum, rhenium, as well as uranium, alumina, magnesium, and by-product copper, lead, and zinc from complex ores.

Wilderness Section. This group is involved in evaluation of mineral resources in primitive and wilderness areas. Under the Wilderness Act (1964) the Bureau of Mines and the USGS were directed to make mineral surveys of 9.2 million acres in 54 wilderness areas. Deadline for the evaluation of the wilderness areas is December 1983. Normally, the work is carried out as a joint investigation by the Bureau of Mines and the USGS. A geophysical survey of the area is followed by geological mapping, outcrop sampling, and geochemical work. Mining engineers trace records of all previous mining in the area, locate the mines, and examine them. The mineral resources report is then discussed with the Forestry Department and other interested organizations before final proposals are made to Congress.

Energy Section. Analysis in the energy fields considers the resource, quality and supply-demand relationships of petroleum, natural gas, coal, and nuclear minerals from domestic sources. Analyses cover a wide range of technical, economic, and engineering aspects of finding, producing, processing, transporting, and utilizing fossil fuels. Efforts of the Section are now concentrated principally on coal - evaluation and appraisal of reserves, and evaluation of surface mined lands for recreational purposes. The Bureau is responsible for compilation of data on former mineral production, field appraisal of minability of deposits including sampling, and engineering appraisals, where needed, of processing requirements, transportation, and other topics relating to marketability.

Petroleum Studies. This group is located at Dallas, Texas, and is mainly involved in the evaluation and appraisal of petroleum resources.

At Denver, a computer based energy data bank - the Merit System (Mines Energy Resources, Information, and Transportation) is maintained to meet increasing demand for data information on the petroleum and coal industries. The Merit System is maintained, updated, edited, and corrected, utilizing the Bureau of Mines Automatic Data Processing (ADP) facilities in Denver. Liaison between the ADP division and the various users and/or contributors to Merits is maintained by the Intermountain Field Operation Centre Energy Group.

River Basin Studies. These are part of the River Basins program which is designed to insure adequate water supplies for the mineral industry and to assess the effects of proposed water-related projects on mineral resources.

MINERAL SUPPLY, WASHINGTON D.C.

The Mineral Supply Division is centred in Washington where the mineral commodity specialists are headquartered and where the final compilation and analysis of statistics are carried out.

Mineral Statistics

In practice the Bureau of Mines is responsible for the collection and compilation of mineral statistics on a national basis. Some of the States do have statutory powers to collect mineral statistics, but experience has convinced the Bureau that, for the sake of consistency and to facilitate administrative procedures, it is simpler and more practical to 'go it alone'. The result is that the Bureau's mineral

data collection is the single federal program directed to canvass industry for such information. However, the Federal Government has no constitutional powers to collect statistics, and in a few cases the response to mineral canvasses is disappointingly poor and the statistical coverage is surprisingly incomplete. For instance, the collection of data for sand and gravel production covers only an estimated 70 percent of total output.

In recent years, the responsibility of statistical collections has passed from a central statistical division to the individual mineral commodity specialists. Each mineral commodity specialist is now responsible for the collection of production, consumption, and stock data of his own specific mineral or minerals. In all, over 200 separate mineral statistical survey forms covering some 90 commodities are distributed to 75 000 respondents and over 150 000 responses to these surveys are received and processed annually. Each commodity specialist has his own statistical assistants - five in the case of copper - and 79 mineral specialists are assisted by 85 statistical assistants and statistical clerks. Forms are sent out mainly on a monthly basis; some distribution, particularly that involving value statistics, is restricted to an annual canvass. Distribution and mailing of forms (as well as the despatch of reminders) are computerized in Denver, but the completed forms are returned direct to Washington for compilation and analysis by the commodity specialists. Statistics of metal scrap production are collected by commodity specialists, but data on consumption by end use are collected by the Department of Commerce. The Bureau of Census carries out an integrated national collection each five years, but much of the mineral data is not in the form required by the commodity specialists and/or does not allow for sufficient dissection. The Bureau of Census publishes a Statistical Year Book, mineral statistics for which are provided mainly by the Bureau of Mines.

There is still considerable controversy as to the pros and cons of transferring the responsibility for statistical collection and compilation to the commodity division. The commodity specialists argue that they, the specialists, are best fitted to say what data are required, in what form the information should be collected, and how the collections should be compiled. Against this is the argument that collections are less standardized than previously, particularly where estimations have to be made, and that commodity specialists may not be collecting certain data which eventually may be required for new lines of investigations. Any new collection involving ten or more respondents has first to be approved and passed by the Office of Management and Budget. Whatever the rights and wrongs of the decision I was struck by the fact that despite the acknowledged breadth and depth of the statistical collections, the commodity divisions in some cases do not hesitate to take statistical shortcuts to achieve deadlines. For example, scant attention is paid to ex-mine values - these are often recorded as the product of metal content of concentrates and the average price of the metal for the period under consideration. Estimations are readily made to fill the inadequacies caused by poor response to questionnaires; and commodity data summaries released in January often rely on statistics covering only the period January-October of the previous year.

In an attempt to rectify some of the shortcomings of the statistical collections referred to above and to provide support services to the Commodity Divisions as well as co-ordinating Bureau data with data from other Government sources, the Bureau of Mines has introduced an Office of Statistics. The group, under the leadership of Willard Hegberg, consists of 19 professionals and 13 support staff.

The group attempts to:

- develop means to improve quality, utility, and timeliness of statistical data.
- standardize reporting forms and to implement standard codes and terminology.
- improve and develop faster and more reliable methods for preliminary estimates.
- and conducts in-house training seminars on statistical methods and techniques.

Commodity Study Division

The statistical work of mineral commodity specialists has been described above. The Division currently has a staff force of 98 professionals and 118 support staff divided into four groups which deal with ferrous metals, fossil fuels, nonferrous metals, and non-metallic minerals. Basically, the work carried out by this group is the same as that of our own mineral economists. Officers have a technical background and carry out mineral intelligence and analysis through close liaison with industry and other government agencies. In effect, the work of the commodity specialist division focuses on the following broad lines of operation:

- continuous mineral intelligence functions on 110 mineral commodities and elements, more than 160 foreign countries, and the individual states, territories, and possessions.
- furnishing reliable, objective, and authcritative statements as a background to Bureau programs and in legislative and executive actions.
- periodic studies on strategic commodities as a base for mobilization evaluations, stockpile transactions, and technical evaluations of industry status.

- periodic publications to inform Government, industry, and the public of trends, impacts, and problems in all phases of the mineral industry.

In addition to his own mineral speciality, the commodity specialist is customarily assigned a U.S. State and a foreign country in the mineral industry of which his own speciality figures prominently. An experiment to divide the Division into two categories covering mineral intelligence on the one hand and mineral analysis on the other has been abandoned, and mineral commodity specialists continue to be responsible for all aspects of their own commodity. Apart from the obvious management problem and the odious comparison between the respective ability of the two groups, it was found that only the specialists had the necessary coverage of mineral intelligence to permit meaningful analytical results.

Other groups within Mineral Supply rely heavily on the data supplied by the Commodity Division as background information for their own particular projects. The Commodity Division in turn is ably supported by two other groups - the Liaison Officers Group and the Office of Technical Data Services. The mineral commodity specialists work closely with State and local agencies primarily through a corps of 38 Liaison Officers who provide coverage in all 50 States and Puerto Rico. Close working arrangements are made with taxation authorities, economic boards, and university staffs, aimed at making State mineral information consistent with national data, and at reducing the burden on respondents by avoiding submission of similar reports to both Federal and State agencies. The liaison officer sends a monthly report of highlights in State mineral industry to the area specialist in Washington.

The Office of Technical Data Services provides support to the Commodity Division by the acquisition, review, and distribution of technical trade publication data and information on overseas mineral industries for mineral commodity specialists. Technical Data Services also compiles Mineral Year Book statistics on world production and trade in minerals, and prepares and publishes Mineral Trade Notes. In addition, the group prepares guidelines and schedules for the Minerals Yearbook, Commodity Data Summaries, and other publications; liaises with G.P.O. (Government Printing Office) and contract printers; and statistically edits and proofreads the yearbook chapters. The office of Technical Data Services consists of 3 professionals and 32 (!) support staff and carries out duties currently distributed amongst our Mineral Economics Section, Publications & Information Section, Statistical Office (Mining), and (hopefully) eventually by mineral indexers and research officers.

Office of Economic Analysis

Although this group has been in operation for some years now, it is still difficult to make any definitive observation as to their effectiveness. Sheldon Wimpfen, who took over the position of Assistant Director - Mineral Supply from Dr W. Vogely, seems somewhat disillusioned with the work results of the group. The mineral commodity specialists complain of communication difficulties between themselves and the economists. Whatever the rights and wrongs of the matter, I think it can be said that the Office of Economic Analysis has not blossomed into the effective force envisaged by Dr Vogely. It is becoming increasingly evident that the economists need some technical background in the mining industry to draw realistic conclusions from their various lines of investigation, and within the group itself there is a move to strengthen the staff with mineral economics graduates

from Pennsylvania State University and Colorado School of Mines. Chief of the group is Mr Robert Johnson replacing Dr Brooks who resigned his position and joined the Canadian Department of Energy, Mines and Resources. The staff consists of 14 professionals (full strength is 21) of whom 10 are economists. Support staff is limited to 2 sub-professionals and 4 clerical assistants. In summary, the work of the group involves

- continuous support to decision-makers in the Bureau and the Department with information, analysis, and methodological guidance.
- mineral resource supply and demand problems with policy implications including those related to the Mining and Minerals Policy Act of 1970, such as
- interaction of mineral industries and overall economic activity.
- impact of international developments on the domestic mineral industries.
- environmental implications of mineral production and processing.

The main lines of investigations currently being undertaken within the groups involve

- preparation of price and production indexes as a background to the revision of long-term forecasts by the commodity specialists.
- preparation of input-output sections for the Minerals Year Book.
- econometric forecasting, e.g. to predict long-term copper prices.
- the effect on international trade in minerals of tariff barriers etc.
- the impact of changes in mining taxation on the profitability of mining companies and the resultant effect on the overall economy.

- environmental implications of recommendations made by the Bureau in connexion with mineral resources in primitive and wilderness areas.

Minerals Availability System

The maintenance of intelligence concerning minerals reserves and the potential commercial availability of minerals from marginal resources is an obvious component of the mineral supply function. In the past the Bureau's primary efforts in this regard were the mineral availability studies that culminated in published reports, either Information Circulars or Reports of Investigation. While these studies were beneficial in providing an analysis of specific elements of present and future economic supply, they are found to be generally inadequate for a quick response to the overall information requirements regarding the availability of minerals, especially for new information obligations such as input to the Mining and Minerals Policy Act evaluations. In recognition of the need for more responsive and dynamic information in this area, the Bureau of Mines has designed a computerized mineral resource inventory designated the "Minerals Availability System" (MAS). The current MAS effort stresses the collection and evaluation of basic information to adapt it to an ADP format.

Strategic Planning

The background to Strategic Planning, the methodology employed, and the objectives of the operation, have been described in some detail by L.C. Noakes (vide Record No. 1969/26). To quote:

"The strategic plan seeks a means of identifying probable and possible changes in mineral supply-demand relationships which might have some significant impact on the economy and

> the wellbeing of the United States. The basic objective is to foresee and define events that threaten an adequate, dependable, timely and efficient flow of those materials which are essential to support national goals and to meet growing and changing industrial and social needs. The essential products form a pattern of guide-lines that suggest where efforts might be effectively applied to minimise the impact of such threats".

Sufficient to add here that the plan is now resulting in a mass of detailed mineral data which is quite staggering in its coverage. Examples of the results are held in our Mineral Resources Branch. Strategic planning is headed by Paul Zinner, who is responsible to the Director of the Bureau of Mines, Dr E.F. Osborn. Mr Zinner acts as Director in Dr Osborn's absence, and it is said by some that Zinner is responsible for much of the long-term planning of the Bureau. The staff of Strategic Planning are few in number, but data from the Minerals Availability System are heavily relied on and the results of virtually all phases of work carried out in the various sections of Mineral Supply are integrated to give a rationale for policy decision making and forward planning unknown in former years.

Publications

Mineral Supply publishes the following on a recurring basis:

Minerals Yearbook

a. Volume I, Metals, Minerals, and Fuels, which contain chapters on more than 80 mineral and mineral fuel commodities essential to the domestic economy.

b. Volume II, Area Reports Domestic, which cover the mineral industries of the 50 States and U.S. territories and possessions.

c. Volume III, Area Reports International, presents the latest mineral statistics for more than 130 foreign countries and discusses the importance of minerals to the economies of these nations.

Information Circulars - which are compilations and reviews of various mineral industry activities and developments to provide concise information for replies to enquiries.

Reports of Investigations - describe principal features and results of minor investigations or phases of major investigations, thus keeping the mineral industries and public informed on the progress of original research.

Mineral Industry Surveys - cover a wide variety of timely statistical reports designed to keep the public, business community, and Government informed on trends in production, distribution, stocks and consumption of selected mineral commodities. Prepared on a monthly basis.

Mineral Trade Notes - a monthly compilation of information on foreign minerals (excluding fuels) obtained from foreign service despatches and other sources that may not otherwise be made available promptly.

International Coal Trade - a monthly inventory of information on coal from foreign service offices and other sources that may not otherwise be made available promptly.

Commodity Data Summaries - released in January, this publication is the earliest Government report providing mineral industry data for the preceding year.

International Petroleum Annual - provides worldwide data on production, supply, demand and trade of crude petroleum and refinery products.

Mining and Minerals Policy Act of 1970 - Mineral Supply provides support and contributes analytical inputs to the annual report of the Secretary of the Interior to Congress on the state of domestic mining, minerals and mineral reclamation industries.

Of particular interest was the background to the preparation and timing of the Minerals Yearbook, a diagrammatic representation of which is given in Figure 2. Volume I, Metals, Minerals, and Fuels, closely parallels our AMI Review, and in practice, preparation of chapters for this volume is along the following lines. Manuscript of each chapter after approval by the head of the commodity specialist is passed direct to Technical Data Services for reconciliation of text and statistics. The manuscript then goes to a Central Division of Technical Reports for editorial review, is marked up by TDS and sent to Printer. The galley proof is checked by the author and TDS and returned for final printing. No page proof is pulled. As far as timing is concerned, preparation of manuscripts commences in late April and runs through to June. Each manuscript takes about a fortnight to clear the division, and blocks of manuscripts are sent to the Printer at regular weekly intervals. Preprints become available beginning in early September, i.e. about four months after the submission of manuscript, and the overall aim is to publish the Year Book by Christmas, i.e. about eight months after the first manuscripts are made available. On the other hand if some printing mix-up occurs (often because only one galley is prepared and checked), the Year Book may be delayed a further 4-6 months. It should be emphasized that publication of the Year Book within twelve months of the year which it covers has seldom been achieved, and in some cases publication has been

delayed by up to two years. In contrast, Mineral Industry Surveys generally appear in January, but generally are based on statistics for only January-October.

Timing of publication of the U.S. Minerals Year Book and the Australian Mineral Industry Review is compared below:

	Year Book	AMIR
M/S submitted	April-July	August-November
Preprints available	September-December	November-December
Final publication	December-June	March-April/May

It is interesting to note that

(1) Preparation of Year Book chapters can be commenced earlier than for the AMI because of the earlier collection (albeit less precise) made by mineral commodity specialists within the Bureau of Mines.

(2) The far greater coverage (in number) of preprints for the Year Book extends the period of their release.

(3) Publication of the AMI usually precedes the Year Book.

USGS - COMMODITY SPECIALISTS

The USGS features an Office of Mineral Resources (see Figure 3) which includes a group of about 60 geologists listed as specialists on mineral commodities. Commodity specialists and the mineral commodities for which they are responsible are listed in Appendix 3. The specialists operate from Washington, Denver, and Menlo Park & Spokane. The group is concerned essentially with mineral resources rather than reserves, which are largely the preserve of industry and the Bureau of Mines. In essence, the mineral inventories carried

out by the Bureau of Mines cover the known mineral reserve position of the nation. The work of the USGS will concentrate more on "Hypothetical Resources" - potential latent ore in known mining areas, and "Speculative Resources" - mineral resources in non-mined areas, possible occurrence of which is based on environmental geological evidence.

The Office of Mineral Resources is undertaking a new program to assess the mineral resources of the United States and selected foreign areas. The program is divided into two phases:

Phase I. A list of some 65 commodities has been selected and one or more geologists have been assigned to prepare a short summary report, averaging about twenty pages for each commodity. Phase I was commenced in mid-1972 and is now ready for publication as Geological Survey Professional Paper 820 - U.S. Mineral Resources.

Phase II. Thirteen top-priority commodities of the 65 reported on in Phase I have been selected to receive more in-depth appraisal down through paramarginal reserves, submarginal reserves, and hypothetical and speculative resources. Phase II is programmed for completion by mid-1974.

Commodity studies and staffing of individual commodity projects and regional evaluation of exploration by industry are being carried out in regional branches, e.g. Central Mineral Resources Branch. Resources analysis and compilation of results of Phase II are to be carried out by a special group in Washington - the Office of Resource Analysis. This unit will contain a computerized data bank, a resource map section, a mineral economist, and eventually a geostatistician. The mineral economist will introduce a new set of evaluation parameters to provide guidelines as to what part of commodity resources may become economic within future periods and at what specific price levels. The geostatistician will be introduced to evaluate geologic and mineral resource data by statistical methods.

OTHER ORGANIZATIONS

While in the United States, short visits were made to two other organizations involved in work on mineral economics - Stanford Research Institute at Menlo Park, California, and the Colorado School of Mines at Golden, Colorado.

Stanford Research Institute is one of the largest independent research organizations in the world. Its product is applied and basic research, performed under contract for clients in business industry and government throughout the United States and 65 other countries. Of a staff of more than 2600, about two-thirds are professionals. They work in interdisciplinary teams in research projects in the physical and life sciences, electronics, radio sciences, information science, urban and social systems, economics, management sciences, and engineering systems.

Founded in 1946 under the auspices of Stanford University and a group of West Coast industrialists, SRI was affiliated with Stanford for nearly 25 years. In march 1970 the institutions legally separated. SRI is now a wholly independent, self-contained, non-profit, research organization.

I visited the corporations headquarters at Menlo Park, a suburban community about 35 miles south of San Francisco and a few miles from the Stanford University campus, on 11-12 April.

My principal interest was in the Mining and Mineral Economics Branch of the Energy and Resources Economics Division (the latter is under the direction of Sherman H. Clark). Discussions were held with:

Dean Beakerdite - Director, Mining, Resources & Metals Department

William V. Morris - Manager, Metals Economics

F. Alan Ferguson - Senior Industrial Economist, Industrial Economics Division

E. Riggs Monfort III - Manager, Long Range Planning Service.

Staff and Organization. Professional staff of the Mining, Resources and Metals Department usually have a degree in mining engineering, metallurgy, or chemical engineering. In addition most of the members have a Masters Degree in Business Administration. A prerequisite for employment within the groups is seven years experience in industry.

Projects are essentially a team effort, and while permanent, professional staff of the Mining and Mineral Economics group is presently limited to eleven, 40-50 experts in related fields are available to the group from within the SRI organization. In some cases experts outside the SRI may be invited to join the team on special projects. It is interesting to note that no pure economists are employed in the group, and only rarely are their services sought. The thinking is that pure economists are too theoretical in their approach to mineral economics and that meaningful dialogue is difficult. The SRI therefore restricts staff in this field to industrial economists or occasionally so-called applied economists, i.e. those who have applied their economic background to specific industrial problems.

The project leader for an investigation is chosen on an ad hoc basis and is selected because of special expertise in a particular line of research and because of managerial ability. The project leader prepares a "proposal" for the investigation and submits copies of this to the Director and the client. The "proposal" when approved is passed on to research assistants for complete literature check and compilation of relevant published statistics. Contracts for investigations are written on a fiscal period basis and prices come high at about $350 per day.

Statistics. Basis statistics are collected and collated mainly from government and institutional publications and company reports. Our Mineral Industry Reviews, both annual and quarterly, are eagerly sought

and appreciated. Members of the group dealing directly with mineral commodity investigations were enthusiastic about our regular publication of mineral statistical bulletins, e.g. mineral sands, lead-zinc-copper, tin, phosphate rock, and sulphuric acid, and are keen to see an extension of this service.

Fieldwork. Individual members of the team conduct their field investigations along very much the same lines as our own mineral economists and mining engineers with person-to-person interviews with governmental and semi-governmental groups and organizations and company representatives, supplemented where possible by visits of inspection to mining operations and plant installations.

As can be readily appreciated, researchers retained by a particular company or group experience considerable difficulty in obtaining some forms of company information, particularly in cases where intra-industry competition is evident. For example, SRI when retained by the Australian Rutile and Zircon Development Association to carry out a survey of demand for and supply of zirconium and titanium minerals found it almost impossible to get any information from DuPont concerning flow sheets of TiO_2 pigment production, costs of production, or even projected demand for rutile and ilmenite by this major world consumer of titanium ores. It is not surprising then that researchers prize highly a reliable and approachable contact and (as in our case) confidences are meticulously observed.

Editing & Publication. The project leader is responsible for the preparation of the final report. The draft report is passed to the manager for technical comment and to the Department head for consideration of legal implications and results and recommendations, e.g. pollution aspect and land use conflicts associated with the development of a new

mining project or processing plant. The draft is passed to a central editorial group, returned to authors for any necessary changes, and printed by SRI at Menlo Park. Distribution of printed copies is strictly policed by the project leader, and the report is retained within the Department involved in the investigation and does not find its way to the central library. A large proportion of the reports are transferred to microfilm, and the master copy includes a complete set of all work sheets and background information used in the preparation of the report.

Colorado School of Mines

The Colorado School of Mines at Golden, just outside Denver, has recently introduced a post-graduate course in mineral economics leading to a Masters degree in Mineral Economics. Up until now, one Ph.D in mineral economics has been conferred. The course is under the supervision of Dr Alfred Petrick, ex-Bureau of Mines, Denver. The course, which is becoming increasingly popular, is designed for graduates in geology, mining engineering, metallurgy, and kindred sciences. The full-time course can be completed in three semesters and covers a crash course in micro- and macro-economics and more detailed treatment of the theory of international trade, discounted cash flow, corporate borrowing, company financing, metal pricing, and statistical methods.

COMMENTS

During my stay of three weeks in the United States, talks and interviews were held with between 50 and 60 individuals concerning organization of staff, methodology, mineral intelligence and analysis, forecasting, developments in mineral commodities, and mutual problem areas. Information, comment, and personal views were presented by a mixed group of governmental and institutional officers ranging from the Assistant Director in the Bureau of Mines, through division and branch chiefs, commodity specialists, statisticians, economists, editors, research officers, and data processing experts. It is not surprising that with such a cross-section of informants there was quite a diversity of areas of interest, and priorities differed depending on the officer interviewed and the specific sector of the mineral industry discussed. At times there was apparent conflict in opinion between certain groups as to what duties and functions the relevant organization should attempt to cover. However, a set of basic principles and agreement on common grounds emerged from the diversity of views and comments.

(1) The reliance on the background knowledge of mineral commodity specialists for the provision of basic data for mineral intelligence, mineral industry analysis, and formulation of government planning. In many cases commodity specialists are able to concentrate on one major mineral alone, and with the support staff provided, it is not surprising the depth and coverage of the mineral industry achieved within the commodity divisions. The participation of commodity specialists in official canvasses of mineral statistical data has certainly improved the coverage and timing of these collections but has possibly impaired the standardization of statistical collections.

(2) Continued emphasis on economic analysis of the mineral industry. However, in the U.S. Bureau of Mines, at least, there has been a marked revision as to the role and background of the economic analysts. This stems from the growing conviction that economists must have a working knowledge of the mineral industry and some technical background if they are to come up with meaningful and realistic results and projections. The visitor gets the impression, from various groups within the Mineral Supply Division of the Bureau of Mines, that the division is only now recovering from a traumatic experience when official policy was to emphasise the role of economic analysis at the expense of mineral intelligence and to follow the line that what the Bureau needed was not mineral commodity specialists, but a group specializing in the mineral industry as a unit. The result was some confusion within the economic analysis group resulting in loss of key staff, Dr Brooks to the Canadian Department of Energy, Resources and Minerals, Dr Petrick to the Colorado School of Mines, and a move to recruit mineral economists rather than pure economists.

(3) The flexibility of various groups within a division and the integration of these groups. It has become common practice to combine the expertise of several disciplines, on both an intra-group and an inter-group basis, for a specific project under the supervision and direction of a project leader selected ad hoc. A similar degree of integration, however, does not extend to larger divisions of a department, e.g. USGS and the Department of Mines. In the latter there is apparent overlap in the work of the mineral inventory groups in the two organizations, the exception being in joint

investigations undertaken to assess the mineral resources and potential of primitive and wilderness areas.

(4) The computerization and centralization of data banks for input of mineral statistical and intelligence data from miscellaneous sources. Output from the data banks provides the data for such systems as MAS and MERIT described previously and the background and intelligence information for strategic planning, which as reached such a high level of sophistication within the Bureau of Mines.

3. CANADA

In Canada, involvement in and control of the mineral industry at Federal level closely follows the lines of that in the United States, and it is evident that many of the Canadian concepts have been borrowed from and developed on guidelines provided by experience in the United States. However, the development of mineral policy in Canada has been facilitated by the benefit of some degree of hindsight, and the Canadian groups dealing with mineral intelligence and analysis appear to be more compact and co-ordinated than those of the United States. Like ourselves, Canada is a major world producer and exporter of minerals and metals and the proximity of such a large producer/consumer nation as the United States has resulted in both benefits and problems concerning Canadian policy in the development, processing, trade, and control of its mineral resources.

While each of the ten Provinces of Canada has its own autonomous Mines Department and Geological Survey, jurisdiction of the large North-West Territories and offshore areas comes under Federal control, and there is no doubt that the Federal Government in Ottawa has played a major and influential role in the development of Canada's mineral resources.

The broad organization of the Department of Energy, Mines and Resources (EMR) is given in Figure 4. The three main groups dealing with the mineral industry are Mineral Development, Science and Technology, and Energy Development, each with its Assistant Deputy Minister answering to the Deputy Minister (Mr J. Austin who succeeds Dr Isbister). Documentation and analysis of the Canadian mining industry are the responsibility of the Mineral Resources Branch of Mineral Development, and in Ottawa my attention was centred on this Branch.

MINERAL RESOURCES BRANCH

The Mineral Resources Branch has been involved in the collection and publication of mineral statistics and mineral commodity analysis for well nigh 100 years, first as the Mineral Resources Division created in 1886 as a division of the Geological Survey of Canada, then as the nucleus of the Mines Branch created in 1906, then as an independent division in 1956, and as an independent branch in 1968 currently with status equal to that of the Mines Branch and Geological Survey of Canada.

The broad organization of the Branch is given in Figure 5. The three divisions dealing directly with documentation and analysis of the Canadian mineral industry are those of Minerals and Metals, Resource Development, and Mineral Economics Research, each headed by a Chief who reports to the Branch Director (Mr Keith Buck).

The Branch is about to be reorganized, emphasis being on a lateral spread of responsibilities rather than up through a vertical line of command. It is claimed that this will result in greater flexibility in special project work, but I feel it will complicate overall administrative organization. In the new organization, up to seven policy advisers will communicate directly with the Deputy Minister. Two separate committees will be formed to co-ordinate the new organization - a Policy Committee to allot priorities, and a Management Committee to co-ordinate and direct the work of the various newly-created groups. Present staffing level of 150 (about two-thirds of whom are professionals) will be increased to about 230. However, as at the time of writing (May 1973) the organization of the Mineral Resources Branch was essentially that as described in Figure 5, and it is on this basis that the following notes have been prepared.

The Mineral Resources Branch currently has a staff of about 100 composed mainly of geologists, mining engineers, metallurgists, and some geographers. However, because of salary and promotional considerations, most of the positions within the Branch are classified as ES positions, i.e. economic statisticians. Some comparison of salary levels for various classifications is given in Appendix 4. Reorganization is likely to lead to major staff changes and the introduction of policy advisers from industry. In addition, the Branch will lose key men to the Mineral Attache Service. Up until now, mineral attaches in Washington, Tokyo, and Brussels have been provided by the Department of Industry, Trade and Commerce. Similar positions have now been created in London and Canberra and will be filled respectively by Mr Keith Buck, Director of the Mineral Resources Branch and Mr Allen Killin, head of the industrial minerals section.

Although discussions were held with sectional officers within all divisions of the Mineral Resources Branch, the following notes have been condensed and confined to those sections whose operations are similar to those of our own mineral economics and mining engineering sections.

Statistics Section

For organizational convenience this section is in the Mineral Economics Research Division, but perhaps would more logically appear in the Minerals and Metals Division. The section is headed by Mr P. Goddard with a staff of 12, of whom 7 are statisticians with an economic background. The section liaises with Statistics Canada (formerly Dominion Bureau of Census) and assembles, evaluates, and integrates mineral statistics into the national system and covers commodity and industry investment, employment, output, trade, consumption, prices, and profits, on a regional, national, international, and corporate bases. Statistics Canada collects a wide range of mineral statistics

both monthly and annually, and the annual returns contain detailed information on stocks, consumption, and even costs, although the cost data do not allow a precise cost of production to be determined. Close liaison on statistical matters is maintained between federal, provincial, and industry interests, and regular meetings are held between the groups to co-ordinate collections and to standardize forms. Copies of annual returns collected by Statistics Canada are distributed to provincial census bureaus, provincial mines departments, and to the statistical section of Energy, Mines and Resources. It is again noteworthy that scant concern is shown for reliable ex-mine values, which are generally equated with the refined value of contained metal; production statistics are generally mine shipments.

Preliminary annual statistics are collected by Statistics Canada late in the calendar year, and this official statistical body actually publishes estimated annual statistics often based on preliminary statistics for the nine months January-September. This collection, supplemented by personal collections undertaken by specialists in the Metal and Minerals Division, provides statistical background for a preliminary statement on the year's performance of the mineral industry, issued in January. It is interesting to note that, because of its long association with the collection of mineral statistics dating back to the 1880s, the Department of Energy, Mines and Resources is still empowered with statutory authority to collect mineral statistics.

Minerals and Metals Division

This division is headed by Dr W.C. Jeffery and comprises the mineral commodity section and a small group which administers the Emergency Gold Mining Assistance Act (EGMA) and carries out engineering examinations of gold producers in order to assess allowable expenditures

under the Act. In addition, the Division includes a Special Studies Section which maintains economic studies in the development of substitutes and inter-material competition; initiates studies, monitors research, and analyses the economic impact of technological developments on mineral and metals economics; and analyses secondary metal markets and trade in their relation to mineral supply and demand.

The mineral commodity specialists are divided into four sections - Industrial Minerals Section, Ferrous Section, Nonferrous Section, and Mineral Fuels Section staffed with 24 mineral economists supported by 3 commodity research officers. Each commodity specialist monitors one major commodity. Minor commodities are grouped and spread over the commodity specialists in the four sections. The intelligence work of the commodity specialists is basically along the lines carried out by our mineral economists, but, as might be expected, in greater depth particularly in consumption, fabrication, and developments in metal research. Commodity specialists maintain close liaison with industry, and a flood of two-way information is maintained between industry and Government. Commodity specialists spend up to two months in the field each year, usually in periods of 1-2 weeks. As with our own section, the intelligence, documentation, and analysis of the Minerals and Metals Division provide the basis for advice to Government. This takes the form mainly of recommendations on federal mineral policy matters affecting specific minerals or groups of minerals, and analysis and advice on existing and proposed policy and its implications on mineral resource development and exploitation in Canada, taking into account foreign government policies and such factors as domestic and foreign mineral supply and demand, and changing technology and markets. The Division provides advice and co-ordination between government departments and agencies in mineral projects of mutual interest, and mineral commodity specialists represent the Department and/or Government on committees and international groups related to the mineral industry.

Commodity specialists do not compile national mineral inventories, but their background knowledge and mineral intelligence are used widely by the Resource Development Division in compiling these inventories.

The main published output of the Minerals and Metals Division is the Canadian Minerals Year Book, individual chapters of which are prepared by the mineral commodity specialists. A preliminary summarized version of the Year Book is published by the Canadian Mining Journal in its February edition following the close of the calendar year. The material for this summary is prepared by the Minerals and Metals Division and must be in the hands of the CMJ editor by the latter half of January. As a quid pro quo, the CMJ publishes this material as an official bulletin of the Department of Energy, Mines and Resources in March. Statistics used are estimated on the basis of preliminary data from Statistics Canada, provincial government sources, and compilations prepared by commodity specialists from company sources. Advance chapters of the Yearbook are prepared early in the year following the calendar year concerned and are published as separate loose-leaf pamphlets in the period May-September. Statistics in the preprints are all preliminary and in some cases incomplete. Complete, official statistics based on the official Statistics Canada collections do not appear until publication of the Minerals Yearbook. Deadline for this is set as December following the year concerned, but, as in the case of our own AMI, the Yearbook is not generally available until 3-6 months after the deadline.

All commodity chapters included in the Minerals Yearbook are technically edited within the Minerals and Metals Division. It is interesting to note that the policy content of the chapters is also cleared for publication within the Mineral Resources Branch without recourse to higher authority.

Resource Development Division

This division contains the National Mineral Inventory Section and the associated Evaluation and Development sections, the Resources Potential Evaluation Section, and the Northern and Regional Development Section. The Division also co-ordinates the Department's foreign aid activities, and provides authoritative advice in the field of mineral taxation and legislation.

National Mineral Inventory Section. The systematic recording of information of Canadian mineral occurrences was begun prior to 1900 by the Mineral Statistics and Mines Division, the predecessor of the present Mineral Resources Branch. The advent of World War I, and with it the shortages which developed in some essential mineral commodities, demonstrated the inadequacy of information on mineral deposits, and the system was revised in 1918. However, the recording of information was sporadic and it was not until 1959 that a reassessment of the inventory resulted in its being reactivated under a revised format and system that, with a few minor changes, is still in effect. In the past, the national mineral inventory program of the Mineral Resources Branch has focused on a inventory of known occurrences of each mineral commodity in Canada. The current inventory aims at assessing the reserves of the various mineral commodities and will form part of a computerized data bank on the Canadian mineral industry. Physically, the Inventory consists of cards ($8\frac{1}{2}$"x11") each of which contains a description of a particular mineral occurrence. The cards are filed under mineral commodity by province and by National Topographic System Unit (N.T.S.), and are cross-referenced by name and N.T.S. area.

Descriptions of occurrences are broken down under the following headings:

1. Commodity
2. Name
3. Location
4. Reference No.
5. Owner or Operator
6. Description of Deposit
7. Associated Minerals or Products of Value
8. History of Exploration and Development
9. History of Production
10. Remarks

The section is headed by Mr Ken Ewing supported by 6 professionals (geologists and mining engineers). Close liaison is maintained with provincial authorities, and external ad hoc professional staff are widely employed to retrieve and compile mineral reserve data on a provisional basis.

Resource Potential Evaluation Section. The section headed by Dr Jan Zwartendyk develops and maintains a comprehensive knowledge of Canada's economic mineral potential of both known reserves and latent resources as a basis for regional and national economic planning and policy formulation. To achieve the latter objective it formulates, implements, and evaluates program plans and policies to obtain an optimum level of exploration, production, and further processing based on integrated analysis of possible government action, including infrastructure investment, legislative and institutional changes, and social and physical science research programs and priorities. Some of the staff have formal training in geology or mining engineering but their interest is mainly academic, and the disciplines are chiefly economics, geography, and social science.

The Resource Potential Evaluation Section monitors the nation's changing mineral resources position and co-ordinates the work of the National Mineral Inventory Section and the various provincial departments in the compilation of mineral reserves, and the work of commodity geologists in the Geological Survey of Canada and other scientific organizations in the delineation of areas of latent resources. These background data provide the basis for the evaluation and implementation of the optimum level of exploration, and for the indentification and evaluation of national mineral development opportunities and constraints.

Northern and Regional Development Section. The work of this section is really an extension of the operation of the Resource Potential Evaluation Section more directly applied to the North-West Territories and Yukon Territory. The section plans, implements, evaluates, and co-ordinates programs to improve the contribution of mineral resources to northern and regional growth in the provinces through exploration, production, further processing, transportation, and shipment. Programs are designed to take account of economic, social, and legislative viewpoints, in harmony with environmental and resource development objectives. The work of the section is basically one of planning and co-ordination, and fieldwork undertaken by officers of the section is on an ad hoc basis only.

Mineral Economics Research Division

The Economics Research Division headed by Dr David Brooks comprises a professional staff of 20, of which about two-thirds have a technical background mostly in geology or engineering, the remainder being economists who have been connected with natural resources in some form or other. The latter group from time to time are subjected to crash-courses in the earth sciences, and overall, there appears to

be much better liaison and rapport between the Economic Research Division and other divisions within the Mineral Resources Branch than is the case with corresponding groups within the U.S. Bureau of Mines.

The Division is divided into four main sections - futures research, economic analysis, environmental and social studies, and statistics - the work of which has been described previously in this report.

Futures Research Section. The original aim of the section was to co-ordinate and integrate the activities and opinions of various groups within the Mineral Resources Branch and to maintain a comprehensive long-term model on the outlook for the Canadian mineral industry, the major technical, economic, corporate trends and relationships within the industry, and the key national and international factors affecting development of the industry and management of the nation's mineral resources. In practice, the section's main role is concerned with the preparation of long-term projections of levels of demand for minerals and metals on a domestic and world scale. In this, close liaison is maintained with mineral commodity specialists in the Minerals and Metals Division and with the Resource Potential Evaluation Section which deals with the long-term supply position. The section is also responsible for the preparation of the General Review section of the Minerals Yearbook.

Economic Analysis Section. In broad terms, the work of the section falls into three main categories:

- research on the realized and potential economic performance of mineral resource development and mineral industry behaviour on the economy relative to mineral policy objectives and national goals.

- identific tion, evaluation, and recommendation on broad mineral policy alternatives and other policies affecting minerals, concerned with capital, investment, and finance; manpower supply and demand; research innovation; further processing, marketing, and trade; multinational corporations; pricing and contractual arrangements.
- development of a competent and specialized economic research team for use throughout the Mineral Resources Branch, employing quantitative methods and economic concepts, and maintenance of professional liaison with counterparts in other organizations.

The Economic Analysis Section is subdivided into the micro- and macro-economics groups. The macro-group are currently producing a paper on 'National impact study effects of mineral industry on a variety of national economic and social indicators and multipliers'. The micro-group are involved in financial and corporate analysis of selected sections of the minerals industry, and the expansion of a mining firm model to better reflect different sectors of the minerals industry.

Environmental and Social Studies Section. Research is directed towards:

- measurement and economic importance of the impact of the mineral industry on environmental quality; evaluation of environmental standards on mineral development; and analysis of harmonization objectives with non-renewable resource objectives.
- assessment of and a recommendation on mineral development proposals relative to environmental objectives and regulations.
- the relation between mineral industry and the social aspirations of workers and communities in remote and single-enterprise towns. This line of research also attempts to define and evaluate the problems facing economic and social adjustment from mine closure.

The section is currently carrying out a comprehensive survey of recycling of scrap metal in an attempt to compare conventional and social costs of using new and recycled materials.

COMMENT

The work of the Mineral Resources Branch falls into three well defined areas - mineral intelligence, mineral inventory and regional development, and economic analysis and forecasting. As in the case of the U.S. Bureau of Mines, output of the mineral commodity specialists is regarded as indispensable background for most projects undertaken in other divisions of the Mineral Resources Branch. Mineral economists, the commodity specialists of the Minerals and Metals Division, have a technical background but are encouraged to undertake some formal training in economics if they have not already done so. Work coverage of the mineral economists is basically the same as our own, but the larger numbers in the Canadian systems allow for a greater degree of specialization and mineral intelligence work in greater depth. The mineral economists prepare individual chapters of the Canadian Minerals Yearbook, but the General Review which describes the performance of the Canadian mineral industry in the context of the national economy is prepared within the Mineral Economics Research Division. The mineral economists are well supplied with statistics (although few official statistics are available any earlier than our own), and many of the preprint chapters of the Yearbook are published within six months of the close of the calendar year concerned. However, the Yearbook itself is not published until up to 18 months after the close of the year. In addition, the mineral economists publish articles on particular facets of the mineral industry at irregular intervals, provide advice to Government and industry, and represent the Department

and/or Government at interdepartmental meetings and on international mineral committees. However, the mineral economists are not directly concerned with the national minerals inventory nor long-term demand projections, for which the Resource Development Division and the Mineral Economics Research Division are responsible.

Liaison within the Mineral Resources Branch is well developed and there are many examples of integrated team work using the special expertise of several groups within the branch on specific projects. The liaison and co-operation stem, I think, mainly from the efforts of the Director, Mr Keith Buck, and his enthusiasm for regular interdivisional meetings and seminars. Even so, one hears complaints from some sections that projects undertaken by the Mineral Economics Branch Division are too theoretical and have no practical application, and reference is made to 'those boys up there in their ivory tower'.

4. UNITED KINGDOM

INSTITUTE OF GEOLOGICAL SCIENCES

Following recommendations of the Brundett Committee in 1965, the Geological Survey of Great Britain, the Museum of Practical Geology, and the Overseas Geological Surveys were incorporated to form the Institute of Geological Sciences. Organization of the Institute is summarized in Figure 6.

The work of the Institute is considered in detail by an advisory committee upon which industry, government departments, the universities, and senior officers of the Institute are represented. The committee reports to the Natural Environment Research Council (N.E.R.C.). The Institute is funded by the Department of Education and Science, but, following recommendations of the recent Rothschild Committee, other government departments which receive direct aid from the Institute contribute to its budget; e.g. Department of the Environment finances assessment of British construction materials resources undertaken by the Institute.

Of particular interest to the writer was the Mineral Resources Division of the Institute, which developed from the Mineral Resources Department of the former Overseas Geological Surveys formed in 1947 to provide liaison between, and scientific services for, geological survey organizations in British territories overseas. While sections of the Mineral Resources Division continue to collect and compile mineral intelligence on overseas mineral resources, the main activities of the Division are now assessment of domestic mineral resources and compilation of data on the domestic mineral industry.

The Mineral Resources Division headed by Mr A.A. Archer is divided into three sections - the Mineral Intelligence Unit and the Mineral Statistics & Economics Unit, housed at the Institute's London headquarters at Exhibition Road, and the Mineral Assessment Unit at Knightsbridge.

Mineral Intelligence Unit

The unit consists of 9 geologists and 4 indexers supervised by Mr W.A. Campbell. Some of the unit's work is closely allied to that of our own mineral economists and consists basically of the documentation of details of mining, processing, trade, marketing, and utilization of economic minerals. However, the Mineral Intelligence Unit places considerably more emphasis on the geological occurrence and prospecting aspects of mineral deposits than does the Mineral Economics Section in BMR. The difference in emphasis is not surprising when it is considered that few if any members of the unit have formal training in economics and, logically enough, they function as geologists rather than as mineral economists.

The Mineral Intelligence Unit continues the work of the Mineral Intelligence Section of the former Overseas Geological Survey in the preparation of world reviews of particular mineral commodities which are published as monographs, the latest being a study of 'Phosphate'. However, priority for this work has been superseded by that entailed in the preparation of 'dossiers' on minerals produced in the United Kingdom or of importance to the U.K. economy. This work is carried out on behalf of the Mineral Resources Consultative Committee and in co-operation with other government departments. The first dossier produced was that on 'Fluorspar' published in September 1971. Subsequently, dossiers on sand and gravel, barytes, celestite, fullers earth, tungsten, and sulphur have been prepared.

In mid-1971 the U.K. Government announced that financial assistance to the extent of 35 percent of costs would be provided to companies exploring for deposits of non-ferrous metals, fluorspar, barium minerals, and potash. As a result, there was a marked increase in interest by mining and prospecting companies in the search for such deposits, with increased demand for mineral intelligence and advice from the Mineral Intelligence Unit. In this work the unit works closely with the Department of Trade and Industry, which is responsible for the administration of the incentive scheme.

The Mineral Intelligence Unit maintains a classified mineral index which now contains upwards of half a million entries. The card index is based on mineral categories subdivided under some 40 headings covering country, uses, mining, metallurgy etc. Several attempts have been made to computerize the system, but the index continues to function successfully, if not wholly efficiently, as a simple card index. A similar card index system was initiated by the BMR Mineral Resources Branch in 1968.

Mineral Statistics and Economics Unit

The Unit is headed by Mr R.A. Healing, an economist, who is supported by three scientific staff (2 geologists + 1 geologist with a geographic background) and 6 research officers. The group is responsible for the preparation and publication of the annual 'Statistical Summary of the Mineral Industry' which has been recognized internationally as a mineral statistics reference since 1921. Data for this publication are compiled from official production and trade statistics for most countries in the world, supplemented by statistics obtained from commercial and industrial sources. Mr Healing expressed his regret at the increasing trend in Australian mineral export statistics to lump exports of certain commodities into one cell, e.g. bauxite, nickel, and manganese ores.

After several frustrating years of attempting to standardize and compile domestic mineral production and trade statistics, and after innumerable interdepartmental meetings, the Mineral Statistics and Economics Unit now considers it is finally in a position to publish a Statistical Minerals Year Book for the United Kingdom.

Over the years, collection of domestic mineral statistics has been badly fragmented, with the Board of Trade (now under the Department of Trade and Industry) collecting some production data, the Department of Environment collecting quantum data for construction materials, and the Department of Customs and Excise collecting trade statistics which in many cases did not allow the extraction of data on individual minerals. Although the Business Statistics Office (formerly the Census Office) each five years undertook a Census of Production, which included some value data as well as quantum data, much of the information was confidential, coverage was restricted to major producers, and the latest Census is for 1968 only. As far as domestic production of refined metals was concerned, the Department of Trade and Industry depended on data published by trade associations and world metal associations e.g. ITC and WNFS.

However, under pressure from the I.G.S., the Business Statistics Office will now undertake an annual collection of 'Minerals Raised' which, while not providing value data will give some coverage of mineral production and consumption. This information, supplemented by trade data provided by Customs and Excise, will bring together in one volume mineral statistics currently scattered over several publications, as well as data not currently published. The Statistical Minerals Year Book will cover calendar year 1972 and is planned for publication in late 1973.

The Mineral Economics work of the unit is concerned chiefly with forecasts concerning trends in processing, balance of trade and payments, consumption, and end-use patterns. Considerable effort has been put into an attempt to analyse the long-term effects on mineral trade of the United Kingdom's entry into the EEC.

Mineral Assessment Unit (Dr R.G. Thurrell)

The Mineral Assessment group was set up in mid-1968 to meet the needs expressed by several government departments for more precise data on the availability and distribution of domestic supply of industrial minerals, particularly of building aggregates, long-term supplies of which were in some doubt. Sand and gravel was chosen as the first subject for investigation, and results of the work are now being published progressively under the general title of 'Assessment of British Sand Gravel Resources'. The work is supported by the Department of the Environment in co-operation with the Sand and Gravel Association of Great Britain, and aims at not only providing information on indicated reserves of sand and gravel, but also provides additional data in forward land use planning. Geological mapping of known occurrences is carried out at a scale of 1:25 000. Drilling on a contract basis is undertaken with conventional shell and auger rigs. Assessment of sand and gravel will be followed by a similar assessment of limestone resources. The Geochemical Division is currently undertaking a regional survey of resources of nonferrous metals.

COMMENT

There is little doubt that the I.G.S. is a world leader in the collection and publication of mineral statistics on production and trade. However, the Statistical Unit of the Mineral Resources Division sees increasing difficulties in the collection of some world trade statistics, and it is likely that publication of the S.S.M.I. will be further delayed over and above the current delay of about 18 months. Statistical coverage and documentation of the domestic mining industry is far from complete, and the publication of a Minerals Statistical Yearbook in 1973 is an effort to improve the position. It is interesting to note that the Australian Mineral Industry Annual Review has been chosen as a model for this work. However, I think we can certainly learn from the Division with regard to the mineral index and the assessment of construction material. Although officers within the Mineral Resources Branch of BMR keep their own index based along the lines of that of the Documentation Unit in the I.G.S. Mineral Resources Division, the completeness and the systematic approach to the latter highlights the necessity of full-time indexers to achieve these ends. The intensive campaign being mounted by the Assessment Unit of the Mineral Resources Division on domestic resources of construction materials points up our deficiencies with regard to production and resource data of these 'bulk' materials, although some State surveys are tackling the problem.

5. FRANCE

Two and a half working days were spent in France, one full day with the Ministry of Industrial and Scientific Development (MISD) in Paris and the remainder with the Bureau de Recherches Geologiques et Minieres (BRGM) at Orleans La Source.

The documentation, analysis, and planning of the mineral industry in France is mainly under the control of MISD and BRGM. My visit to the relevant sections was organized by Mr C. Beaumont, Director-General of BRGM.

Ministry of Industrial and Scientific Development

The Ministry is a French Government department staffed by civil servants, an important function of which is the administration of the mining industry in France and in its overseas territories. The three divisions of MISD directly concerned with the mineral industry are Industrial Mobilization, oriented towards emergency planning in the sense of the U.S. Office of Emergency Preparedness (OEP); the Planning Division, which is also responsible for the collection and compilation of French mineral statistics in co-operation with the National Institute of Statistics; and the Division of Technology and Mining, which includes groups dealing with and administering the supply of minerals, metals, and construction materials, providing geological services and monitoring technological investigations and environmental facets of the mining industry, and administering the French Directorate of Mines. The latter consists of 12 provincial Mines Departments which administer the mining act throughout the 95 departments of metropolitan France.

The Division of Technology and Mining headed by Mr Isautier, has the overall responsibility of mining and geological services in France, monitors the operations of BRGM, and provides a policy secretariat to the Minister concerning mining and environmental problems and the long-term supply of minerals.

Until recently, compilation of mineral statistics and mineral documentation were carried out within the Department by the Bureau of Mineral Documentation. However, the National Institute of Statistics has now integrated its statistical collections and mining statistics which are published in Statique de L'Industrie Minerale are not available now for about two years after the close of the calendar year concerned. Mining statistics are presented in considerable detail and are compiled from information provided on standard forms by mining companies, Mines Department representatives in various centres, Chambers of Mines, and government agencies. Of course, the limited number of operational mines and smelters in France facilitates the collection and compilation of mining statistics. As is the case in most countries, lack of comprehensive quarry statistics is the main gap in the overall collection.

Mr Francois Callot is the Director of Mineral Documentation within MISD and the Editor of the periodical 'Annales des Mines'. This is a monthly review of the mining industry which in the August-September edition produces an annual review along the lines of our Australian Mineral Industry Annual Review. The annual edition of 'Annales des Mines' covers mineral commodities under the headings of salient statistics, production, prices, trade, consumption, and world situation, but the list of mineral commodities covered is not as comprehensive as that of the AMI nor is the information as detailed. Previously, mining statistics were channelled directly to Mr Callot's group by

the National Institute of Statistics. Introduction of the integrated census seems likely to adversely affect the timeliness of the 'Annales des Mines'. Emphasis on the work of the Bureau of Mineral Documentation has now been shifted to the collection and compilation of information on mining developments overseas, which is fed into the BRGM computer at Orleans.

BRGM

The BRGM is a semi-governmental body which carries out the fundamental duties of a national geological survey and which undertakes exploration for and development of mineral resources, except hydrocarbons and radioactive materials, both in France and abroad. Its activities are very broad, but can be summarized as follows:

- fundamental studies concerning geological mapping, general and applied geology, geophysics, geochemistry, geological documentation, mineralogy
- mining, research, general prospecting, study, and exploitation of ore deposits
- study and search for underground waters
- engineering geology, public works, civil engineering, roads etc.

These BRGM activities are channelled into two distinct lines of service:

- in France, the Direction du Service Geologique National acts for the Government in various public services related to earth sciences.
- in France and overseas, the Direction des Recherches Minieres et des Travaux a l'Etranger undertakes mineral prospecting, either or its own account or in association with French or foreign partners. However, while BRGM can initiate exploration

and form exploration groups in foreign countries, BRGM seldom holds a controlling equity in an operating mining company. Apart from its agencies in French-speaking Africa, in Madagascar, and in overseas French Departments and Territories, BRGM has set up agencies in various countries not within the franc area, such as Saudi Arabia, Australia (Serem), Canada, Brazil, Greece, Libya, Malaysia, Peru, and Turkey.

The BRGM annual budget is about 138 million francs (about $A23 million), finance being provided by the French Government as a direct subsidy, international funds for technical co-operation (U.N.O., F.A.O.), foreign governments (Gabon, Saudi Arabia), and from various public and private companies in which BRGM has equity or for which work is carried out.

Permanent staff numbers 1300, about half of which are professionals. In addition, BRGM has on call experts in the fields of geology and mining who may act as co-ordinating advisors in various disciplines.

My two chiefs contacts in BRGM were Mr Robert Lautel, the BRGM representative for Australia, and Mr Jean-Pierre Gautsch at Orleans La Source. Mr Gautsch with a team of 6 mining engineers co-ordinates the work of the Mineral Studies group of Mr Bedouret and the statistical compilation and documentation of Mr Callot in Paris with economic studies and feasibility studies of the mineral deposits group and the documentation and computer groups in Orleans.

The main role of the mineral deposits group headed by Mr Lammore, is to define and compare potential new areas of mineral exploration and development, and to investigate the possibility of BRGM participation in selected mining companies. Some aspects of the work cover that of the roving commission of the so-called 'Promoteurs', but the duties of the mineral deposits group go much farther. A

team generally comprising a geologist, a mining engineer, a 'mineral economist', and a legal officer have overall supervision of defining action areas, general prospecting, assessment of the deposits, studying the economics of production, and arranging participation in joint ventures if desirable. The mining deposits group is supported by the work of the mineral studies group, who, like our mineral economists, keep in close touch with the world mineral industry and specific mineral commodities. However, officers of the mineral studies group appear to approach commodity studies somewhat on an ad hoc basis, depending on which minerals have a high priority for mineral search. As would be expected the groups are directly involved in feasibility studies, and the compilation of comprehensive cost data is a feature of their work.

At Orleans the documentation group headed by Mr Dellas collects and collates data on geosciences from many sources from the BRGM representatives in overseas countries, from mining and technical journals and reports, and from data collected by BRGM under statute - in France, subsurface data on mining or drilling deeper than 10 metres are by law collected within BRGM by the 'Banque des Donnees du Sous-Sol' group. Information is computerized and put on magnetic tape for retrieval, and the documentation group each month publishes a bibliographical series of earth sciences. The monthly bulletin on exploration and mineral economics is particularly relevant to our own work.

The data bank maintained and controlled by BRGM provides background data for the newly appointed Commission on Mineral Supply, of which Mr Gautsch is the secretary. Over the years, mineral production in metropolitan France has waned, and, with the loss of French colonies and increasing domestic consumption, the deficit in mineral trade has increased progressively. A Commission on Mineral

Supply has therefore been set up to co-ordinate the planning of both public and private sectors of the industry, and to keep the Government informed on developments in this area. The Commission aims to represent Government at the political and administration levels, semi-public organizations, and private industry. In addition to the Department of Industrial and Scientific Development (which provides the Commission's president) other departments involved in mineral supply have one or more representatives. Included are the Departments of Defence, Foreign Affairs, and Economy and Finance. On the administration level, the industrial mobilization and planning divisions also have representatives - in all 11 members. Semi-public organizations - Committee for International Trade (C.F.C.E.), the Metals Import Distribution Board (G.I.R.M.) and BRGM - send observers as does the Federation of Metals and Raw Minerals Corporation (F.M.M.B.), which represents private industry.

COMMENT

Involvement of the French Government in its mineral industry is oriented mainly towards the problem of supply, and the main objective of the Ministry of Industrial and Scientific Development is the identification and development of deposits and the procurement of metal supplies both in Metropolitan France and abroad. BRGM plays a vital role towards this end. Most minerals are imported as concentrates, e.g. lead, zinc concentrates, for domestic processing; the main exception is copper imports, which because of lack of domestic smelting capacity are largely in the form of refined metal.

The sophisticated index maintained by BRGM at Orleans provides a comprehensive bibliography and documentation of geosciences, which covers the geosciences not only in France but also overseas. Statistical coverage of the domestic mineral industry follows the same pattern as our own, and like our own suffers from unavoidable delays in the finalization of annual data. However, collection of domestic mineral statistics in France is facilitated by reason of the comparatively limited number of mines and smelters operating in France, and by the ease of obtaining data from the various Government agencies connected with the mineral industry. Of particular interest to our Mineral Resources Branch is the impressive collection of mining cost data available for feasibility study projects.

The intimate association of the Government and the private sector of the mining industry is exemplified by the concept of BRGM and its operations, and the organization of the Commission for Mineral Supply. While inter-government and industry committees and groups of this nature are by no means unknown in Australia, e.g. Australian Tin Advisory Committee, Australian Copper Producers Association, AMSES, Joint Coal Board, Lead-Zinc Study Group, we have nothing to approach the broad integration of the public and private sectors within the French system. Of course, the virtual nationalization of the French mining industry undoubtedly lends itself to this form of central administration.

6. JAPAN

In Japan the mining and metals industry is largely controlled and monitored by the Ministry of International Trade and Industry. This is a mammoth department subdivided into numerous bureaus covering a ministerial secretariat, international trade, trade and development, industrial policy, environmental protection and safety, heavy industry, chemical industry, textile and general merchandise, minerals, oil and coal mining, public utilities, industrial science and technology, as well as a number of agencies such as the patent agency, and the metallic minerals exploration agency.

The areas of most interest to the writer were the Minerals, Oil and Coal Mining Bureau (soon to be combined with the Public Utilities Bureau), and the Research and Statistics Department.

Research and Statistics Department

The department is responsible for the compilation of statistics covering commerce, industry, and mining in Japan, and is subdivided into eleven divisions with separate divisions for coal, iron and steel, chemicals, and the mining industry in general. Each division distributes standard forms, and collation and compilation of relevant statistics are generally made monthly. The result is a mass of mineral data, most of which are published on a monthly basis and collated into a statistical yearbook. In particular, the department publishes Industrial Statistics Monthly, which provides integrated statistics of the mining and manufacturing industries. Non-adjusted and seasonably adjusted index series are available covering mineral production, shipments, consumption, inventories, and capacities as well as value added. Mining and metal statistics are subdivided into gas, coal, petroleum, general minerals, iron and steel, non-ferrous metals, fabricated metals, stone and clay, and chemicals.

Quantum and value data are available for coal, gold, copper, zinc, pyrophyllite, dolomite, silica sand, limestone, crude petroleum, natural gas, and refined non-ferrous metals. Data on domestic consumption on a monthly basis are available for iron ore and pellets; ores of manganese, nickel, copper, and lead; limestone, asbestos, phosphate, ilmenite, and salt. Separate monthly statistical bulletins are published for coal, coke, petroleum, steel, and mining in general. On an annual basis, the Research and Statistics Department publishes a comprehensive coverage of the domestic mining and refining metals industries as the Mining Yearbook of Japan, and Yearbook on Non-Ferrous Metal Products Statistics. Unfortunately, both these Yearbooks are published only in Japanese. In addition, The Japan Mining Industry Association, closely linked with MITI, annually reviews the performance of copper, lead, zinc, and nickel in Japan (in English) and provides full production, consumption, and trade statistics for these metals.

Jetro (Japan External Trade Organization) is largely responsible for the co-ordination and compilation of comprehensive mineral trade statistics, available on both a monthly and an annual basis.

Mineral, Oil and Coal Mining Bureau

The Bureau is subdivided into departments dealing with mining policy, the mining and metals industry, petroleum planning, administration and development, and a separate department dealing with policy, administration, rehabilitation, and mine safety as applied to the coal mining industry.

The Minerals, Oil and Coal Mining Bureau is shortly to combine with the Public Utilities Bureau, which currently controls and administers power and electricity under the divisions of water, thermal, nuclear, and gas power.

The principal contact in the Minerals, Oil and Coal Mining Bureau was Mr Y. Takemura, Director of the Mining Policy Division of the Bureau. The Mining Policy Division is involved mostly in the general co-ordination of activities of the Bureau, review of policy of the Mining and Quarrying Laws, and administration and review of the Export and Import Trade Law as it applies to metals and minerals. The Mining Policy Division is also responsible for the development of long-term forecasts of supply and demand for minerals, and in this work is in close touch with the Economic Planning Authority (EPA), which is responsible for industrial forecasts for Japan as a whole. It is interesting to note that forecasts by the EPA are based on economic and econometric analysis techniques, and once economic growth patterns are established the Mining Policy Division is required to tailor projected metal supply/demand projections to conform to these economic patterns. When projections of the overall growth pattern are revised, modifications to mineral supply/demand forecasts are necessary; this at times leads to some startling revision in the published projections of mineral demand, even in the short term.

The Mining Policy Division for the most part is staffed with economists, mining engineers, and legal officers. The mining engineers are called upon to comment on the feasibility of projections prepared by the economists, but normally do not initiate studies on future levels of mineral supply and demand.

The Mining Policy Division is closely associated with the Mining Industry and the Metal Industry Divisions, which in many ways carry out mineral industry studies similar to those of our own mineral economists. As its name implies, the Metal Industry Division is more concerned with processed minerals and concentrates and refined metals from primary refined shapes through semi-fabricated products. One of its main lines of study is the reclamation of non-ferrous metals.

The Mining Industry Division monitors mineral production and supply, usually up to the concentrate stage. Officers of the division are allotted specific groups of minerals, e.g. non-metallics, construction materials, non-ferrous, and do not as a rule specialize in any particular mineral commodities. This division administers the Gold Control Law, and, through regional bureaus of MITI, establishes mining rights and mining leases throughout the various prefectures in Japan. An important aspect of the Division's work is the survey of mineral reserves which is maintained in close co-operation with the Metallic Minerals Exploration Agency of Japan.

The Metallic Minerals Exploration Agency of Japan (MMEA) dates from 1964 when it superseded the Metallic Minerals Exploration Financing Agency, formed to provide exploration finance for Japanese enterprises. The new agency extended its financing to cover detailed geological surveys and later, regional surveys, formerly the domain of the Geological Survey, Institute Agency of Industrial Science and Technology. In Japan, MMEA provides loans to eligible individuals and enterprises to finance exploration activities; finances regional geological surveys on copper, lead, and zinc ores as part of the ten-year national program to accelerate exploration by mining companies for base-metal resources in Japan; and finances follow-up detailed geological exploration of potential mineralized areas delineated by regional surveys. Exploration costs are contributed 60 percent by the central Government, and 20 percent each by the prefectural government and the mining companies concerned. Overseas, MMEA finances exploration of Japanese metal mining companies on a 'repay on your success' basis, subsidizes geological surveys of selected areas, and co-operates with the Governments of developing countries in appraisal of mineral resources and in the evaluation, planning, and development of mining projects.

In addition to this, MMEA maintains a Mineral Resources Centre, which provides a data bank, bibliography and documentation of overseas exploration and development of mineral resources, mining legislation, environmental developments, supply/demand balance, and activities of foreign enterprises. With the objective of establishing a worldwide system of mineral intelligence, the Centre has established mining specialists in the United Kingdom, Australia, Canada, Peru, Zaine and the Philippines.

COMMENT

MITI, in its all-embracing role of a department of trade and industry, not only monitors the overall Japanese economy but also acts as a federal bureau of mines and a geological survey for the domestic mining and mineral industry. The Japanese mineral industry is oriented towards the acquisition and consumption of raw materials and the fabrication of metal products. Japanese statistical collections are therefore most comprehensive in the field of production and supply of mineral ores and concentrates as well as in consumption, stocks, and end-use statistics of refined metals and processed non-metallics. While the Japanese statistical and intelligence coverage of both the domestic and overseas mining industry must be envied, and to some extent copied, forward projections of mineral requirements issued by MITI leave much to be desired and should be treated with a certain degree of caution. Raw material requirements of the metal fabricating industry are integrated into projected economic growth patterns, and as such are subject to frequent and substantial revisions. In addition, MITI has considerable statutory authority in dictating the level of production capacity utilized in various sectors of the manufacturing industry, and because of this, the normal balancing factors of supply and demand for raw materials become subject to arbitrary government decisions.

7. CONCLUSIONS AND RECOMMENDATIONS

Statistics

All countries visited have continuing difficulty in obtaining basic statistics on the mineral industry as comprehensive and as quickly as they would like. As in our own case, areas not covered in as much detail as desired are those of stocks, costs of production, end-use statistics, and recovery and consumption of secondary metals. Complete, detailed, official statistics of the mineral industry are not available for publication for about twelve months after the close of the calendar year to which they refer. However, in most cases, preliminary estimates of the country's mineral industry performance are available, and are published on the basis of 9-month estimates supplemented with statistical intelligence collected by mineral commodity specialists. Statistical coverage of domestic mineral production and trade along similar lines is produced in the March edition of the Australian Mineral Industry Quarterly Review, which however, is not usually published until April-May. To hasten the availability of these statistics to the public, consideration should be given to the preparation of a summary printed within BMR, and probably ready for publication and distribution towards the end of February. Expansion in the number of special mineral collections already undertaken on behalf of BMR, e.g. lead, zinc, copper, tin, mineral sands, and secondary lead and zinc, would certainly speed up the collection of salient statistics and would provide a more realistic basis for 'end-of-year' estimates.

Publications

The standard publication of the mineral industry for most countries is a Mineral Yearbook which follows the general lines of our Australian Mineral Industry Annual Review. The coverage achieved in the latter compares most favourably with mineral yearbooks in other countries except perhaps in the coverage of actual consumption data and end-use statistics. While continuing efforts are made to publish the yearbooks as quickly as possible, the publication is regarded as an historical document and most government organizations seem resigned to the fact that the yearbook will not be available until at least 12 months after the calendar year concerned. However, as mentioned above, abridged preliminary versions of the yearbook are available within a matter of weeks after the end of the year. In the United States and Canada preprinted chapters have been extended to cover all the more important mineral commodities, and issue of these preprints commence about six months after the close of the calendar year. The preprints are later updated for inclusion in the yearbook. In our case eleven preprints of AMI chapters are now published in November-December. A position similar to that in the U.S.A. and Canada could be achieved within our own group with increased staff and the use of preliminary statistics. Worthy of attention is the arrangement in Canada whereby a preliminary review of the mineral industry is published in the February edition of C.M.J. and as a quid pro quo, the review is printed and issued as a separate by the C.M.J. on behalf of the Department of Energy, Mines and Resources. Perhaps a similar arrangement could be made with some national mineral publication in Australia, e.g. Australian Mining, or Proceedings of Australian Institute of Mining and Metallurgy.

Neither the U.S.A. nor Canada publishes the equivalent of our AMI Quarterly Review. Rather, monthly summaries covering statistics and developments in specific minerals are issued, and articles on special facets of the mineral industry are published as a separate issue, e.g. the Mineral Bulletin (MR) series of the Mineral Resources Branch of the Canadian Department of Energy, Mines and Resources. While this approach certainly provides up-to-date mineral data, I think our Quarterly series can achieve the same results as long as quarterlies can be published without unreasonable delay.

Mineral Commodity Specialists and Commodity Studies

Commodity studies remain the basis of the documentation and analysis of the mineral industry, and commodity mineral specialists in the United States and Canada have functions similar to those of our own mineral economists. Mineral commodity specialists maintain a close liaison with industry and work in a technical environment. Their academic background is generally one of economic geology, mining engineering, or metallurgy and most have had considerable experience in private industry. Normally, each commodity specialist is allotted only one major mineral for his full attention, and with this degree of specialization, a most impressive coverage of the mineral is maintained from exploration right through to consumption of the refined metals. Particular aspects of the industry can also be examined in much greater depth, for instance the collection of basic cost data for which commodity specialists, generally with a mining engineering background, visit mines and plants and even examine company accounts.

Mineral commodity specialists are more directly involved in policy advice than our mineral economists, and commodity specialists often represent their Government on international mineral committees; e.g. the lead specialists represent the Canadian government on the International Lead-Zinc Study Group.

There is no doubt that to achieve a coverage of the mineral industry comparable to that in Canada or the United States further specialization is required within our Mineral Economics Section. For this, additional professional staff with experience in industry will be required. As a guide, the Minerals and Metals Division of the Mineral Resources Branch in Canada, which monitors the domestic mineral industry, is staffed with about three times as many professionals as our Mineral Economics Section, which performs equivalent duties. However, support staff are equally important to the efficient operation of the Section, and sub-professionals such as indexers and research officers must be provided if mineral economists are to give their undivided attention to commodity studies. It is interesting to note that in Canada and the United States, after the commodity chapter for the Yearbook has been written and cleared by the central technical editing group, the commodity specialist's only further involvement is in checking the first galley proof.

Economic Analysis of the Mineral Industry

While commodity studies are recognized as the basis for documentation and day-to-day analysis of the mineral industry, there is a growing conviction in most countries that a more sophisticated economic approach to the industry as a whole and its long-term trends and problems is also required. Attempts to achieve this in government organizations in the United States and Canada have not been an unqualified success mainly, I think, because of an over-emphasis on economic qualifications at the expense of technical training, and the comparative isolation of the economic analysis group from mineral commodity specialist divisions and the private mining sector. These short-comings are being rectified progressively and I feel it is fair to say that economic

analysis groups are now making worthwhile contributions to the analysis of the mineral industry in the countries referred to. As an example, the Mineral Economic Research Division of the Mineral Resources Branch in Canada is now responsible for long-term demand projections which are carried out in close liaison with mineral commodity specialists.

The Australian mineral industry has now developed to a stage which calls for sophisticated economic analysis of the contribution made by the industry to the national economy, possible future trends in the industry, and an economic approach to problems restricting the full development of the industry. The time is opportune to introduce a special project group into the Mineral Economics Section, staffed with geoscientists with an interest in applied mathematics and (hopefully) some formal training in economics.

Mineral Resources Inventory

In most overseas countries there is a growing awareness of the importance of the mineral industry and the need to establish not only the extent of economic reserves but also to indicate the potential extent of mineral resources or the nation's 'mineral endowment' as it is sometimes referred to. In the United States particularly, assessment of the nation's mineral resources is allotted a high level of priority, and extensive surveys are being undertaken in both the Bureau of Mines and the USGS to achieve this aim. The assessment of reserves, including paramarginal and submarginal reserves, is generally undertaken by mining engineers liaising with commodity specialists, and usually takes the form of compilation of published data, additional information supplied by Mines Departments and company representatives, and personal inspection of mine development and company records and

drilling results; in a word, along the lines of assessment of economic and submarginal reserves as currently undertaken within our Mineral Resources Branch. However, estimation of the possible extent of speculative and hypothetical resources is normally the responsibility of commodity geologists, and the possibility of developing this degree of specialization within the Geological Branch should be considered.

8. ACKNOWLEDGEMENTS

Discussions with company representatives tabulated in Appendix 1 were most useful, and the friendly co-operation of these gentlemen is gratefully acknowledged. Special mention must be made of the thorough planning and faultless arrangements made on my behalf by the Trade Commissioners (Minerals) in both London and Tokyo. The fact that I was able to accomplish so much in England and Japan in such a short period was due mainly to their efforts. The co-operation and hospitality of government officials (and others) in all the countries visited was overwhelming, and it is difficult to single out individuals for acknowledgement. However, I feel that special mention should be made of the following:

Stanford Research Institute	Menlo Park	Dr F. Alan Ferguson
U.S. Bureau of Mines	Denver	Mr O.M. Bishop
	Washington	Mr P. Zinner
		Mr S.P. Wimpfen
		Mr J. Pennington
USGS	Denver	Dr R. Parker
	Washington	Dr E. Tooker
Colorado School of Mines	Golden	Dr A. Petrick
Canadian Department of Energy, Mines and Resources (Mineral Resources Branch)	Ottawa	Mr W.K. Buck
		Mr A.F. Killin
United Kingdom		
Institute of Geological Sciences	London	Mr A.A. Archer
		Mr W.A. Campbell
		Mr R.A. Healing

France

Ministry of Industrial and Scientific Development	Paris	Monsieur Isautier
BRGM	Orleans La Source	Monsieur R. Lautel
		Monsier J.P. Gautsch

Japan

MITI	Tokyo	Mr Y. Takemura

APPENDIX 1 - COMPANY LIST

Company	Contact	Official Position
U.S.A.		
E.I. Du Pont de Nemours (Inc.) Wilmington, Del.	R.A. Hageman	Production Manager - Minerals
N.L. Industries Inc., 111, Broadway, New York, N.Y. 10006.	N.R. Swensen	Senior Marketing Analyst
U.K.		
Britannia Lead Company Ltd, Adelaide House, King William Street, London, E.C.4.	R.C.R. Toller	Director
J.H. Little Metal Co., 80, Coleman Street, London, E.C. 2R 8BR.	P. Gadsden	Director
Consolidated Gold Fields Ltd, 49, Moorgate, London, E.C.2.	B. Heron	Manager of Australian Section
Tennant Trading Ltd, 9, Harp Lane, Great Tower Street, London, E.C.3.	A.W. Yates	Director
Imperial Metal Industries, I.C. House, Millbank, London, S.W.1.	Dr Butler	Head, Research Department
Japan		
Hokuetsu Metal Company Ltd, 3-3-1, Zao, Nagoaka City, Niigata Pref.	T. Watanabe	Managing Director
Japan Titanium Society, Konwa Building, 1-12-22, Tsukiji, Chuo-ku, Tokyo.	H. Kodama	Director-General
Tokyo Yogyo Co. Ltd, 1-8-2, Marunouchi, Chiyoda-ku, Tokyo.	S. Ushigome	Director, General Manager of Sales

Company	Contact	Official Position
Sekisan Trading Co. Ltd, Daido Building, Tosaboridori, 1-chome, Nishi-ku, Osaka.	R. Takouchi	Chief, Foreign Trade Section
Ishihara Sangyo Kaisha Ltd, 1-11, Edobori Kamidori, Nishi-ku, Osaka.	I. Komatari	Chief Geologist, Corporate
Toho Titanium Co. Ltd, Nikko Building, 3, Akasaka Aoicho, Minato-ku, Tokyo.	S. Shimizu	Managing Director
Nippon Steel Corporation, 6-3, Ohtemachi 2-chome, Chiyoda-ku, Tokyo.	S. Sugamata	General Manager, Mineral Resources Research Office
Mitsubishi Chemical Industries Limited, 5-2, Marunouchi 2-chome, Chiyoda-ku, Tokyo.	P.T. Kuga	General Manager, Planning Department

APPENDIX 2 - DEVELOPMENTS IN THE TITANIUM AND ZIRCONIUM INDUSTRIES OF THE UNITED STATES AND JAPAN

Titanium

In the United States and Japan the position of over-supply of titanium dioxide pigments in evidence during the period 1970-1972 has swung sharply to one of under-supply, and both countries are now importing considerable tonnages of pigment from Europe as well as small amounts from Australia. In the United States, the current shortfall of about 100 000 tons of TiO_2 pigment a year is to be met by expansion in chloride production capacity by Du Pont at its Edgemoor and New Johnsonville plants. Meanwhile, pigment prices have been increased by 1-2 cents per pound, and high-grade TiO_2 pigment in the United States is now selling at 28 cents per lb. There is little doubt that all new pigment capacity in the U.S.A. will be based on one of the chloride processes using natural rutile and/or upgraded ilmenite, or possibly a mixture of rutile, leucoxene, and ilmenite by direct chlorination, the method currently employed by Du Pont.

Japanese pigment capacity, all based on the orthodox sulphate route, has been frozen at about 180 000 t.p.a. by MITI because of pollution considerations. In some cases domestic producers have solved the problem of ferrous sulphate and sulphuric acid effluent by the conversion of the sulphate to artificial gypsum ($CaSO_4$), mixing of ferrous sulphate with pyrite for burning to sulphur dioxide, and the recycling of the spent acid. However, these attempts to neutralize the effluent have been successful only in selected areas, and most Japanese pigment producers to expand capacity will be forced to replace ilmenite in their flow-sheets by a feed lower in iron, e.g. Sorel slag,

or to switch to chloride-type pigment plants. Ishihara Sangyo Kaisha Ltd plan to commission 50 000 t.p.a. of chloride-type pigment capacity in 1975. The company currently produces about 40 percent of Japanese TiO_2 pigment production by the sulphate method using ilmenite from Cable (1956) ltd and from India and Sri Lanka. Ishihara is now producing 2300 tons of upgraded ilmenite (96% TiO_2) a month using hydrogen reduction and acid leaching (spent sulphuric acid from its sulphate operations). Production capacity for upgraded ilmenite is to be expanded progressively to 70 000 t.p.a.

The use of rutile for electric welding rod coatings has not increased to the extent indicated by the recent growth in the world steel industry. Rutile is used only in selected types of welding rods, and is vulnerable to substitution by other forms of TiO_2, e.g. ilmenite. The increased landed cost of rutile, particularly in the United States, has caused welding rod manufacturers to become even more selective in the use of coating materials. Upgraded ilmenite has been tested as a substitute for rutile in welding rods, with somewhat discouraging results. The upgraded ilmenites tested have proved unsuitable either because of chemical (two high in sulphur or phosphorus) or physical reasons (because of its porous nature). The upgraded material tends to become 'gummed-up' with the bonding resin, which interferes with the arc and the resulting weld.

There is evidence of a sustained recovery in demand for titanium sponge following the nadir of 1972. However, world demand is not expected to recover to the early 1970 levels until about 1975. Japanese sponge producers see the United States aircraft industry continuing as the major outlet for their sponge, but Japanese domestic demand for titanium in chemical hardware, e.g. desalination plants and heat-exchange tubes, is expected to provide an increasingly important

outlet. Demand for rutile in metal production is comparatively inelastic with regard to rutile prices and rutile remains the raw material preferred for sponge production. Both United States and Japanese sponge producers are of the opinion that the low price of titanium sponge of Russian origin (until recently less than $US1 per pound landed in the United States) has little if any relation to actual production costs. Russian sponge is thought to be produced from titanium slag, and as such is inferior in grade to rutile-based sponge.

Zirconium

World demand for zircon has improved impressively even within the last six months, and consumers of zircon for foundry sand and refractories in both Japan and the United States are now somewhat apprehensive as to their long-term supplies. United States domestic production of about 60 000 tons of by-product zircon from ilmenite operations in Florida by Du Pont is to be augmented by 20-25 000 t.p.a. from new alluvial operations in Florida being undertaken by Titanium Enterprises. However, increased output will account for only half of domestic demand projected for zircon. Japanese consumers are obtaining a small proportion of their zircon requirements from Malaysia and India, but do not expect any significant increase in supplies from these sources. Australian producers will obviously be called upon to supply the bulk of world zircon requirements for the foreseeable future. In contrast to most other industrialized nations, which use between 60-70 percent of total zircon consumed for foundry sand, Japan consumes about half for refractory purposes. Japanese zircon consumption in refractories in recent years has increased at an annual rate of almost 20 percent, and although the growth rate for refractories is expected to ease to 5-10 percent per annum, an overall increase of at least 5 percent per annum can be expected in Japanese zircon requirements.

Actual level of zircon consumption in Japan is estimated to be about 100 000 tons per annum. In 1972, Japan imported a massive 141 000 tons of zircon concentrates from Australia to replenish depleted stocks and to build stocks up against a projected zircon shortage. It is interesting to note that Japanese manufacturers of zircon refractory bricks for furnace linings and pouring nozzles are now using foundry grade zircon, previously considered to be too high in iron (up to 0.3% Fe_2O_3) for this purpose.

APPENDIX 3 - USGS - COMMODITY GEOLOGISTS

Commodity	Geologist
Abrasives	Robert E. Thaden
Aluminium	Sam Patterson
Antimony	Mary Miller, D. White
Asbestos	Andrew Shride
Barite	Don Brobst
Beryllium	Wally Griffitts
Bismuth	Bill Hasler, Mary Miller
Carbonates	George Ericksen
Chromium	Thomas P. Thayer
Clay	John Hosterman
Cobalt	Don Brobst
Construction materials	Robert Laurence
Copper	Dennis Cox
Diatomite	David Durham
Fillers and pigment	E. Brown
Fluorspar	Ronald Worl, Ralph Van Alstine
Geothermal energy	L.J.P. Muffler
Gemstones	Robert E. Thaden
Gold	Frank Simons, Bill Prinz
Graphite	Paul Weiss
Helium	Ken Pierce
Iron	Harry Klemic, Hal James, Richard Baley
Lead	Hal Morris
Lithium	J.J. Norton
Manganese	Jack Door

Commodity	Geologist
Mercury	Ed Bailey
Molybdenum	Bob King
Nickel	Henry Cornwall
Niobium-tantalum	Raymond Parker
Thorium	Mort Staatz
Uranium	Arthur Butler
Coal	Paul Averitt
Gas	Thane McCulloh
Oil	Thane McCulloh
Oil shale	Bill Culbertson
Tar sands	Bill Cashion
Pegmatite minerals	Frank Lesure
Phosphate	Jim Cathcart
Platinum	Norman Page
Rare earths	Jack Adams
Kyanite & other Al silicates	Gil Espenshade
Mg refractories	Al Bodenlos
Salines (gyp, B, Cl., I, K, salt, Mg, anhydrite, Sr)	G.I. Smith
Nitrates and iodine	George Ericksen
Trona-natrolite	John Dyni
Silica	Keith Ketner
Silver	Allen Heyl
Sulfur (incl. byprod.)	Al Bodenlos
Talc	E. Brown
Tellurium, Selenium, etc.	Bert Lakin

Commodity	Geologist
Tin	B. Reed
Titanium	Eric Force
Tungsten	Warren Hobbs, Jim Elliott
Vanadium	Dick Fischer
Zeolites	Dick Sheppard
Zinc (incl. Cd)	Helmuth Wedow
Zirconium-hafnium	Harry Klemic

APPENDIX 4 - SALARY RATES FOR DISCIPLINES WITHIN MINERAL RESOURCES BRANCH (EMR)

SOCIAL SCIENCE GROUP

1 8037-8352-8666-8979

2 9550-9924-10298-10671

3 10283-10684-11085-11487

4 11770-12231-12690-13152

5 13663-14198-14732-15267

6 15963-16586-17210-17836

7 18399-19118-19838-20557

8 20831-21646-22461-23278

Recruiting level $5520 to $8760 in increments of $60.
Effective: 5 July 1971.

RESEARCH SCIENTIST

SE-RES 1 11100-14632

2 14352-22111

3 20810-25685

4 24398 and up*

*rates of pay in excess of 5350 above minimum must be approved by Treasury Board.
Effective: 5 July 1971.

ECONOMISTS

ES 1 — — — — — $12415-$13007-$13596-$14192

ES 2 $15236-$15840-$16506-$17172-$17836-$18222-$18891-$19729-$20557

ES 3 $20750-$21594-$22436-$23278

ES 4 $23220-$24073-$24926-$25785

ES 5 $22000 to $27250 (with intermediate rates at intervals of $250).

Effective: 1 July 1971.

PHYSICAL SCIENCES (GEOLOGISTS)

PC 1 6900 to 12720 ($60 steps)

2 12274-12913-13553-14191-14830-15468

3 15189-15928-16668-17409-18148-18888

4 18078-18939-19800-20661-21522

5 21408-22381-23353-24326

Effective: 28 August 1972.

SENIOR EXECUTIVE OFFICER (SX)

Level 1 $22000 to $28000 (with increments in multiples of $290).

2 $25000 to $31000 (with increments in multiples of $290).

3 $28000 to $35000 (with increments in multiples of $290).

4 $34000 to $40000 (with increments in multiples of $290).

Effective: 1 January 1972.

ENGINEERING AND LAND SURVEY GROUP

A - Effective 6 July 1970

B - Effective 5 July 1971

Level 1

A - $7800 - $9480 (with $60 increments)
B - $8220 - $9960 (with $60 increments)

Level 2

A - $9606 - $10044 - $10480 - $10918
B - $10086 - $10546 - $11004 - $11461

Level 3

A - $11752 - $12286 - $12822 - $13356
B - $12340 - $12900 - $13463 - $14024

Level 4

A - $13852 - $14482 - $15111 - $15741
B - $14545 - $15206 - $15867 - $16528

Level 5

A - $15953 - $16677 - $17402 - $18126
B - $16751 - $17511 - $18272 - $19032

Level 6

A - $18749 - $19602 - $20454 - $21306
B - $19686 - $20586 - $21477 - $22371

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E.F. OSBORN

ENGR SERV OFFR
C.P.CARLUCCI JR

ASSISTANT DIRECTOR PLANNING
P. ZINNER

STATE LIAISON PROGRAM OFFICE
P.H. MOTE

DIV OF BUDGET
E. THOMSON

CHIEF SCIENTIST
E.T. HAYES

OFFICE OF UNIVERSITY RELATIONS
A. VAN VALKENBURG

STAFF ASSOCIATE TO THE DIRECTOR

OFFICE OF ASSESSMENT & COMPLIANCE ASSISTANCE
P.J. MUCHUNAS

OFFICE OF MINERAL INFORMATION
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M. JACOBSON

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H.H. POTTER

COAL MINE HEALTH AND SAFETY
FIELD INSTALLATIONS

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J.B. SHUTACK

DIST NO2 OFF PITTSBURGH, PA
R.E. BARRETT

SUBDIST OFFICES
PITTSBURGH, PA
J.E. TISDALE
JOHNSTOWN, PA
W.H. DEVETT

DIST NO3 OFF MORGANTOWN, W.VA.
J.D. MICHEAL

DIST. NO4 OFF MT. HOPE, W.VA.
W.R. PAPP

SUBDIST OFFICES
PRINCETON, W.VA.
S.E. GASPERSICH
MADISON, W.VA.
J.C. BLANKENSHIP
MT. HOPE, W.VA.
J.E. WEEKLY

DIST NO5 OFF NORTON, VA
W.R. COMPTON

SUBDIST OFFICES
NORTON, VA.
G.L. MEARS
RICHLANDS, VA
W.L. WEST

DIST. NO6 OFF PIKEVILLE, KY
R.G. ROSS

DIST NO7 OFF BARBOURVILLE, KY
O.W. HUNTLEY

SUBDIST OFFICES
BARBOURVILLE, KY.
T.R. MARK
MADISONVILLE, KY
W.M. CRAFT
BIRMINGHAM, ALA
C.E. HYDE

DIST NO8 OFF VINCENNES, IND
W.S. CHILDERS

SUBDIST OFFICES
VINCENNES, IND
P. WILLS
ST. CLAIRSVILLE, O
R.T. DAVIS

DIST NO9 OFF DENVER, COLO.
JOHN W. BARTON

SUBDIST OFFICES
PRICE, UTAH
J. FREEMAN
MCALESTER, OKLA
M.J. TURNIPSEED
DENVER, COLO

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DIV. OF EDUC & TRNG OPNS
R. GRAMES

DIV. OF EDUC & TRNG SVCS PITTSBURGH, PA.
S. SAPPO

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FIELD INSTALLATIONS

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J.R. O'NEAL

TRAINING CENTERS
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PITTSBURGH, PA.
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NORTON, VA
A.A. SINICROPE
BIRMINGHAM, ALA.
J. NELSON
CHICAGO, ILL.
C. DOVIDAS
DALLAS, TEX.
T. KESSLER
DENVER, COLO.
J. KELLY
BOULDER, CITY NEV.
O.L. WILCOX
ALBANY, ORE.
J. ENGLISH

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A. GOODWIN

DIV. OF SAFETY
T.C. LUKINS

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PITTSBURGH, PA.
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ALBANY, N.Y.
E.J. POGORSKI

NCENT. DIST. OFF DULUTH, MINN.
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SUBDIST OFFICES
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H.L. SCHELL
VINCENNES, IND.
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C.O. WEDELL

SUBDIST OFFICES
BIRMINGHAM, ALA.
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KNOXVILLE, TENN.
H.D. GRAHAM

SCENT DIST OFF DALLAS, TEX.
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SUBDIST OFFICES
DALLAS, TEX.
J.B. STEPAN
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SUBDIST OFFICES
ALAMEDA, CALIF.
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SEATTLE, WASH.
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RENO, NEV.
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PHOENIX, ARIZ.
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T.A. HENRIE

SPECIAL ASSISTANT INTERNATIONAL ACTIVITIES
L. HAMAI

SPECIAL ASSISTANT ENVIRONMENTAL ACTIVITIES
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PROCESS EVALUATION GROUP MORGANTOWN, W.VA.
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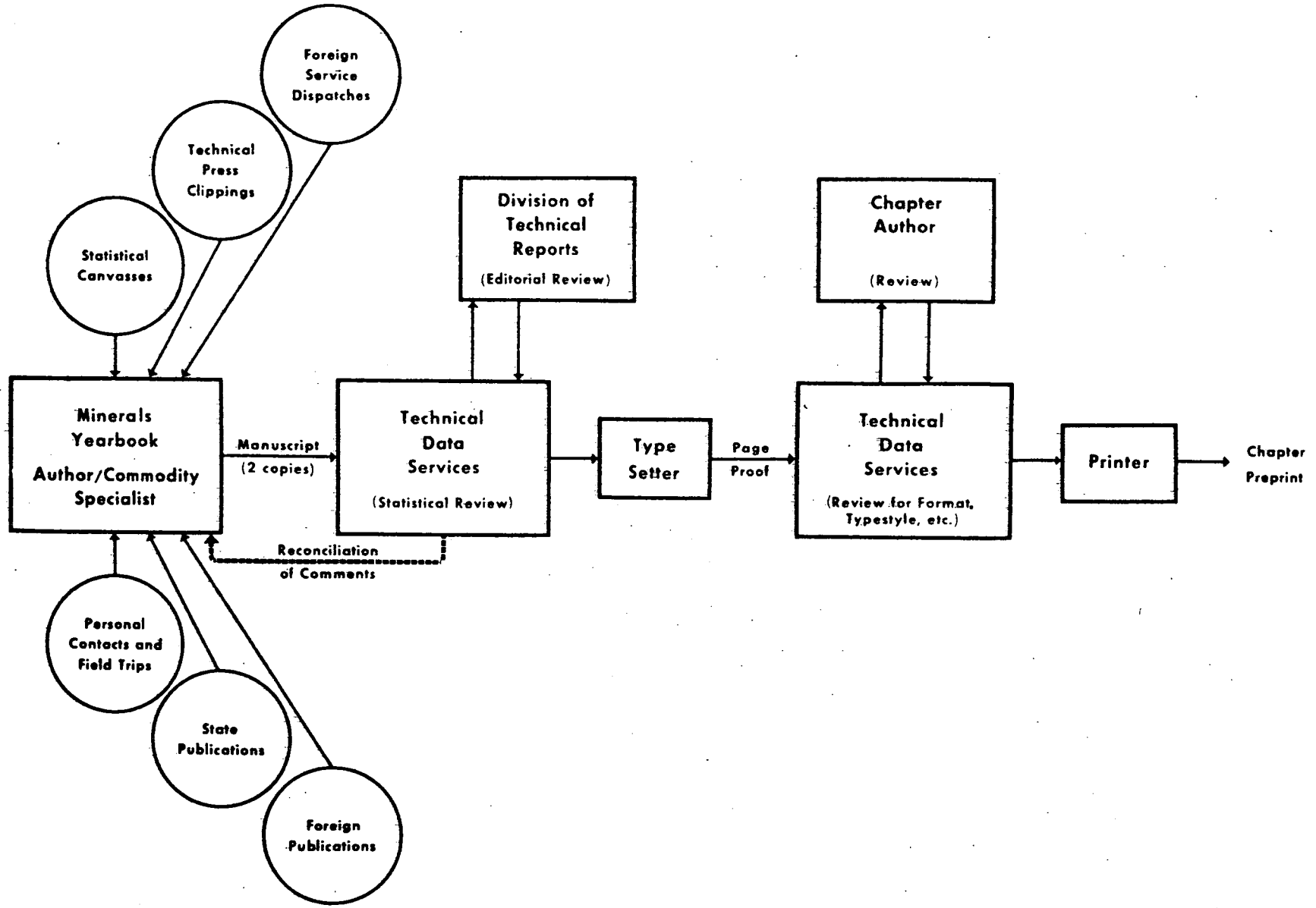
Fig. 1. DEPARTMENT OF THE INTERIOR — BUREAU OF MINES

To accompany Record 1973/129

M(O)77

Fig. 2 GENESIS OF THE MINERALS YEARBOOK



To accompany Record 1973/129

M(0) 72

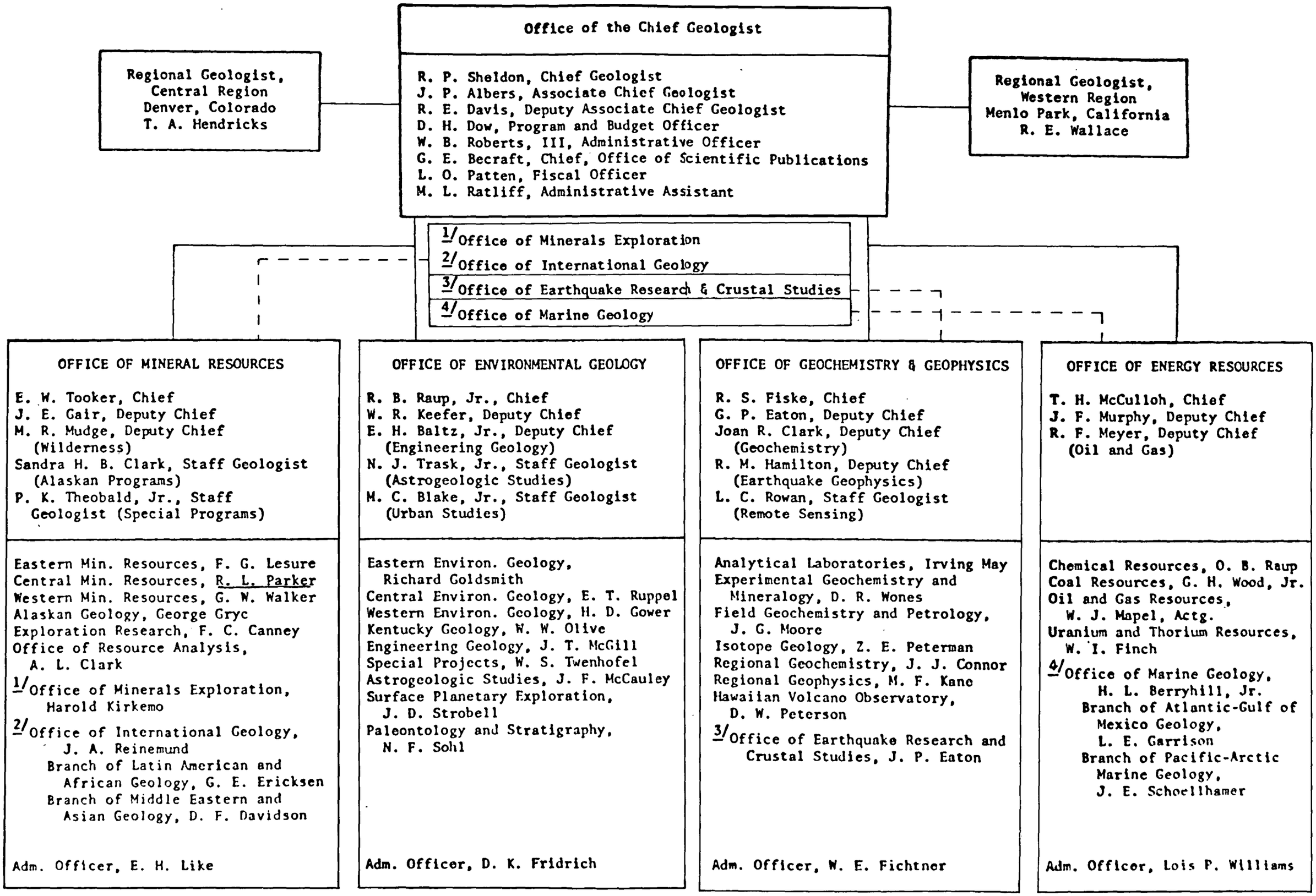
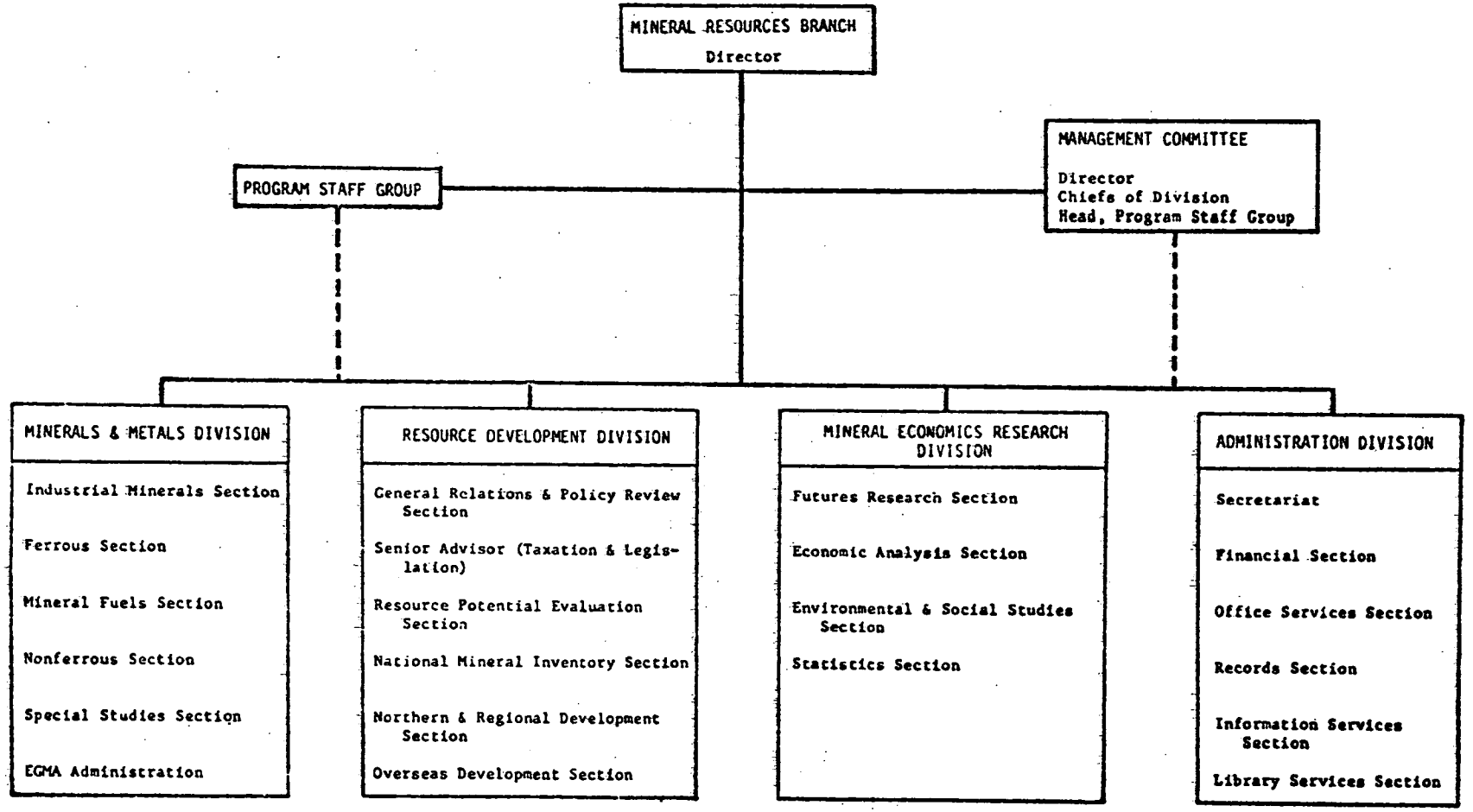


Fig. 3 U.S.G.S. ORGANIZATION — GEOLOGIC DIVISION

To accompany Record 1973/129

M(O) 73

Fig. 4 CANADIAN DEPARTMENT OF ENERGY, MINES AND RESOURCES.



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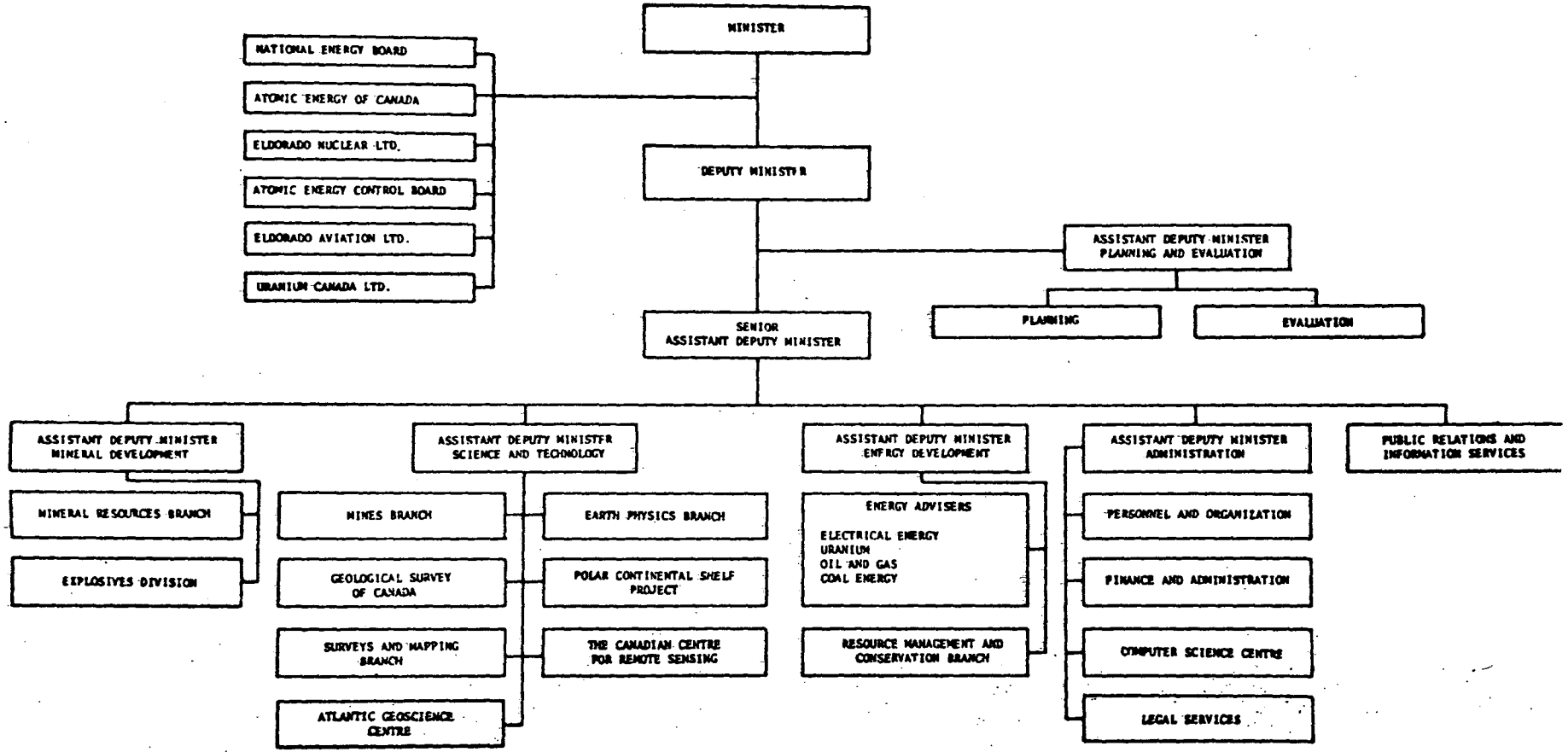
January 1971
M(O) 74



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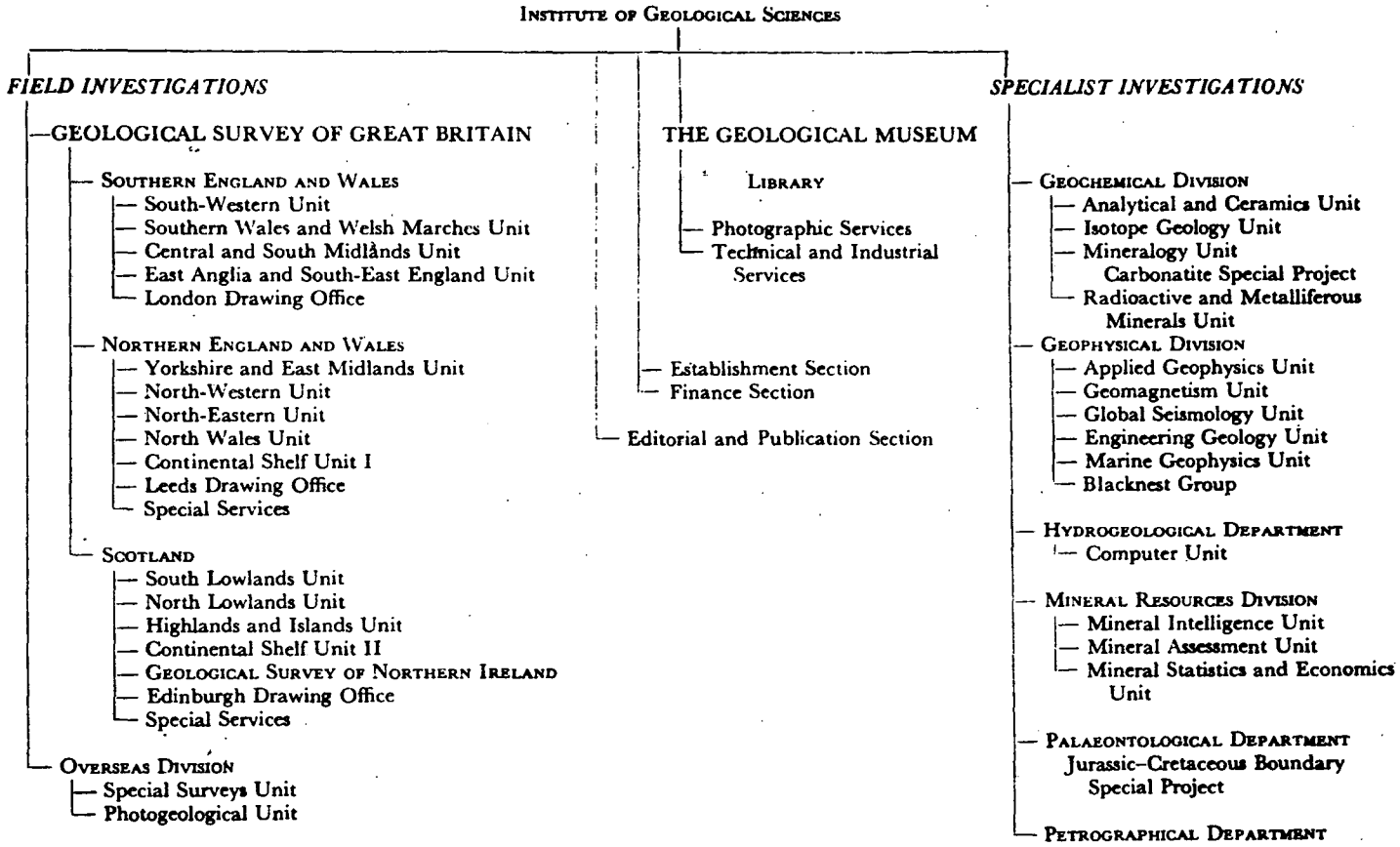
M(O) 75

Fig. 5 MINERAL RESOURCES BRANCH (E.M.R.)



To accompany Record 1973/129

M(0)76

Fig. 6 The organisation of the Institute of Geological Sciences at the end of 1971.