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ASSESSMENT AND DOCUMENTATION OF MINERAL RESOURCES
IN THE UNITED STATES AND CANADA

by

J. WARD

A.P.S. Senior Executive Fellowship

April-June 1985

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ABSTRACT

Geoscience organisations in the USA and Canada were visited during April-June 1985 to observe, document and discuss with leading experts developments in fields such as

-- assessment and estimation of mineral resources;
-- compilation, storage, retrieval and dissemination of geoscientific data particularly concerning mineral resources and their availability;
-- relationship between scientific and technical government organisations in these fields, policy makers, and the mining industry.

While the mineral industry in both countries is market oriented, emphasis in the US is on strategic requirements and favourable sources of supply; in Canada (as in Australia) concern is for mineral export markets, the nation's competitive position in those markets, and the level of mineral resources required to adequately meet demand by both domestic and overseas consumers. The minerals industry plays a more important role in the overall Canadian economy than it does in the US where concern focuses more on the security of mineral supply and strategic implications of possible disruptions to supply.

Basic political and procedural differences between the parliamentary and the Congressional/Executive government systems also affect the capacity of the respective governments to provide guidance on mineral resource issues. In Canada greater Provincial authority over mineral resources has led to concentration of federal responsibilities for particular policy areas in a single Department - i.e. in the Department of Energy, Mines and Resources, whereas the US has somewhat disjointed policy areas and mineral policy responsibilities spread throughout numerous Federal agencies. However, as has been the Australian practice, the national policy in both countries is for the relevant department (Energy, Mines and Resources in Canada, and Interior in the USA) and their agencies to cover mineral resource assessment and development through to smelting and refining at least.

The Canadian system facilitates more regular policy contact between mineral analysts, agency officials and policy makers and results in a broader background to policy discussions in contrast to the US where policy

decisions on mineral resources are based mainly on the internal policy of the strongest agency. The high quality of expertise devoted to mineral-resource analysis in Canada and the emphasis directed towards this end results from -

-- importance of the mineral industry to the national economy;
-- constitutional framework that encourages provincial interest in policy-oriented research;
-- rapport which exists between government officials and researchers and their counterparts in industry.

In both countries the short-term goal of Wilderness/National Parks and other Federal land surveys by earth science organisations is to provide data for competing land-use decisions; long-term goals are to provide data for strategic planning for the mineral resource base, and to add to scientific knowledge, and to improve the understanding of geological environments favourable for resource occurrence.

The US and Canadian experience provides background for improving efficiency in collection and compilation of Australian mineral industry and resource statistics, and in the publication and dissemination of this type of data; monitoring supply/demand and availability of minerals through time; improving the assessment of identified mineral resources in the shorter term, and in the longer term the development of techniques for qualitative and quantitative estimation of undiscovered resources on a regional scale as an aid to formulation of Government policy on competing land use.

INTRODUCTION

A Senior Executive Fellowship program was introduced by the Public Service Board in September 1983 in recognition of the need to upgrade the development of senior Public Service managers. The program enables senior officers to undertake overseas visits of up to three months to participate in 'state of the art' activities of broad concern to their departments and the Service. The program is intended to provide participants with a range of opportunities to observe latest overseas practices and to discuss recent developments with leading practitioners in relevant fields.

The writer was awarded a Fellowship to be taken up during the fiscal year 1984-85. The Fellowship was awarded to study 'Mineral resource assessment, data collecting and the dissemination of information'. In particular, the main thrust of the exercise was to study -

-- the different conceptual approaches to, and methods used for, the assessment of mineral resources;
-- the methods used for compilation, analysis, retrieval and dissemination of geoscience data, and the use made of these data, particularly concerning mineral resources and their availability through time;
-- the relationships established between scientific and technical areas of Government responsibility for mineral resource assessment and the mining industry on the one hand, and the policy makers and the administrators on the other.

While BMR is well advanced in the collection, interpretation and dissemination of mineral commodity data and has already undertaken some work in resource assessment and has established some geoscience databases, it was considered that considerable time and effort could be saved by drawing on the experience and expertise of long established kindred geoscience organisations in the United States and Canada. My studies were therefore concentrated on relevant areas of the Federal Bureau of Mines and the Geological Survey in the USA, and on the Mineral Policy Sector and Canadian Geological Survey of the Department of Energy, Mines & Resources in Canada. While in Washington DC discussions were also held with

-- Mineral Management Service and the Bureau of Land management of the Department of the Interior, and
-- the Industrial and Strategic Materials Division, Bureau of Economic and Business Affairs, Department of State.

I also took the opportunity to attend (as an invited guest) two prestigious mineral industry meetings in Ottawa, viz:

-- Mineral Outlook Conference, and
-- Mining Association Annual Meeting.

During my stay in North America I was called on to present several informal talks on Australia's mineral resources and their development.

The study tour covered the period 9 April-23 June 1985. Details of the itinerary are attached as Appendix 1.

In this report I have attempted to provide a descriptive account summarising the objectives and modus operandi of the various sectors with which I had in-depth discussions; each major section of the report lists my conclusions and recommendations resulting from an analysis of the strengths and weaknesses I perceive in the oversea organisations.

Considerable documentation and various papers associated with the work and responsibilities of the groups involved have been collected and in due course will be sorted and directed to the BMR Library if of general interest, or maintained in the Minerals Branch sub-library if they have a more specific relevance to the work of that Branch.

The Fellowship was a most outstanding and rewarding experience. It provided me with the opportunity of discussing at length areas of mutual interest with leading experts in the fields of mineral resource assessment and studies and analysis of the mineral industry in North America; and how government bodies in these fields are tackling and coping with the problems involved. Much of the information acquired will be of direct relevance in further reorganising the Minerals Branch within the Resource Assessment Division of BMR. I am most grateful to the Australian Public Service and to my Department for providing such an opportunity.

UNITED STATES OF AMERICA

In the United States the collection, analysis, and dissemination of mineral supply and demand data as well as policy advice on, and administration of, the mineral industry, are in the general domain of the Department of the Interior. This is a large and diversified organisation of which permanent staff number some 50 000. A general organisation chart of the Department is attached (Appendix 2).The Department operates under five Assistant Secretaries. Geoscience responsibilities and mineral policy advice and administration come under the Secretariats of Water and Science and of Land and Minerals Management. I concentrated my efforts at the Bureau of Mines in Washington DC, at the Geological Survey, Reston, Virginia, and at field offices at Denver, Colorado and at Menlo Park, California.

BUREAU OF MINES

Over the years, the USBM has been subject to close political controls and its development has been marked by start-stop programs, frequent changes in directorship, and organisation changes in planning, alternating between decentralisation and centralisation in Washington.

An organisation chart of the Bureau of Mines (Appendix 3) is attached.

Prior to World War II, the United States was largely self-sufficient in most minerals. Since then the US has become a major importer of many mineral commodities basic to its industrial economy, and in the process has built up a formidable deficit in its balance of trade in minerals. As a net importer of minerals, the US has entered into direct competition with other nations for foreign sources of raw materials supply, and competition for mineral resources at times has become intense. Select divisions within USBM are responsible for maintaining a continuing review of the domestic supply and demand of mineral commodities and for compiling and analysing data that can serve as a basis for the formulation of mineral policy.

My main interests lay in -

-- the statistical coverage of the mineral industry, collection, compilation, analysis, dissemination and use of production and consumption data;

-- collection of technical and operational information from industry;
-- studying of broader aspects of the industry commencing at the retrieval and interpretation of data on identified resources and leading to supply/demand projections;
-- publications and other methods of dissemination of information to industry and the public;
-- the use of technical and scientific advice in the mineral policy forming process.

I therefore concentrated my attention on the Minerals Information, and the Mineral Data Analysis Directorates; meetings were also arranged and discussions undertaken with Senior Advisory Staff, Office of Congressional Liaison, Division of Publication, and Office of Technical Information, as well as regulatory and administrative areas in other Interior agencies, and
in the Department of State - e.g. Mineral Management Service in Interior, and the Bureau of Economic and Business Affairs in the Department of State.

Minerals Information

The Assistant Director for Minerals Information (V. Anthony Cammarota) is responsible for five divisions: Nonferrous Metals; Ferrous Metals; Industrial Minerals; International Minerals; and Minerals Information Systems. Personnel roster of the Divisions as at February 1985 is attached (Appendix 4).

The objective of the Divisions dealing with the domestic program (Branch of Domestic Data) is to provide a reliable base of information to support an effective national minerals policy by collecting, interpreting, and disseminating data and information on the domestic production and consumption of non-fuel minerals. Staff ceiling is about 140, comprising 50-60 commodity specialists together with statistical assistants and clerical support staff. The Branch canvasses mineral producing and mineral-consuming companies for about 100 commodities through 170 formal surveys (monthly, quarterly, six-monthly, and annually). The data from these returns are edited, tabulated, and interpreted by commodity specialists and their staffs. Commodity specialists also maintain personal ongoing contacts with industry, trade associations, other government

agencies, the technical and economic press, and universities. This information is augmented by state mineral specialists located at Bureau field operations centres. In addition to production and consumption data, the commodity specialists are also responsible for information for domestic identified resources of their particular commodities. They derive a 'reserve base' from on-site deposit evaluations and from published information - company reports, etc. - as well as from private communication.

The domestic information is disseminated through an established series of publications, reports, talks and through technical assistance and consultant services by the commodity specialists and state mineral specialists. Sources, synthesis and dissemination is diagrammatically illustrated in Appendix 5 and standard publications into which commodity specialists have a major input are listed (Appendix 6).

The International Minerals Division provides a base of international information and intelligence to support the national minerals policy by collecting, interpreting and disseminating data and information on foreign production, consumption, and trade in non-fuel minerals. About 45 people are employed as country specialists, geographic statistics staff and clerical support staff. The position of the mineral industry in foreign countries is evaluated on the basis of mineral publications, reports from foreign countries; interpretation of direct observations and returns and mineral intelligence from the State Department's Foreign Service posts - e.g. Ted Rumme in Canberra.

Production estimates and overall mineral evaluation for specific minerals are prepared for each country, consumption data is reported where possible, and estimates of mineral trade between countries are prepared. The foreign information is disseminated through channels similar to those of the Branch of Domestic Data; International Minerals is responsible for Vol.III of the **Minerals Yearbook** which covers country chapters, and the international production tables for specific minerals in Vol.I. It also issues **Mineral Industries** reports from time to time which summarise the mineral industries of specific countries.

Division of Minerals Information Systems with a staff of about 25 of whom about one-half are computer systems analysts, is responsible for the Automated Minerals Information System (AMIS) which is intended to be a computerised source of minerals information for problem and policy analysis and which would allow the retrieval of much of the data collected for MAS (Minerals Availability System) as well as the data canvassed by the Domestic Data Branch. Originally, the Division was developed also to provide statistical advice to the Directorate of Mineral Information and to take some responsibility for forms management and clearance.

Mineral Data Analysis

The Assistant Director, Mineral Data Analysis (Dr Hermann Enzer) heads four divisions: Minerals Availability; Minerals Land Assessment; Minerals Policy and Analysis; State Activities, as well as a small staff responsible for special projects.

Division of Minerals Availability is responsible for developing and maintaining the computerised Minerals Availability System (MAS). This system is an information file for individual mines and mineral deposits and is used to produce availability curves and to perform a range of sensitivity studies to support federal mineral policy formulation. Salient points concerning operation of the 80 staff are:

- system is directed and coordinated by the Division Chief in Washington;
- resource classification and supply analysis is carried out by the Minerals Availability Field Office in Denver (about 30 staff);
- domestic deposit evaluations are made from USBM field operations centres in Spokane, Denver, Pittsburgh and Juneau;
- foreign deposit evaluations are carried out under contract - e.g. Kaiser Engineering, under a rigorous set of guidelines laid down by MAS, and under critical supervision by MAS officers. The current objective of MAS is to determine existing and potential domestic and foreign supply of 34 mineral commodities. Evaluation includes a detailed analysis of capital and operating costs for each deposit.

All data are stored in deposit files in the MAS database to be used in the Supply Analysis Model (SAM) the heart of which is MINSIM, a comprehensive financial simulator enabling a discounted cash flow rate of return (DCFROR) analysis to be carried out on each deposit. MINSIM is used to determine the commodity selling price that each property would require to obtain a target rate of return (nominally 15%). Individual evaluations are aggregated into availability curves for each commodity and cumulative price/availbility curves are constructed.

Division of Mineral Land Assessment operates under the Wilderness Act, 1964, and the Federal Land Policy and Management Act of 1976. Under the Acts, areas recommended as suitable for wildlife refuges, parkland and wilderness designation are required to have mineral surveys conducted by the Bureau of Mines and the USGS. A total of 55M acres of Forest Service, 12.8M acres of Bureau of Land Management and 7.8M acres of interior lands have up to now been designated for mineral surveys.

The assessment of mineral potential of public lands is done jointly by USBM and USGS.

-- USBM does background search for mining claims and base information, past production, abandoned mines and prospects, and carries out on-site examinations including sampling of mineralisation. No drilling is carried out except on Indian Reserve Land where USBM has to be invited to make a survey of mineral potential;
-- USGS is responsible for regional reconnaissance including limited geophysical and geochemical work;
-- the two agencies study subeconomic identified resources jointly.

Product of the work is a joint USGS/USBM Report in the USBM open file report series indicating mineral resources and mineral potential of the area. Reports on Indian Reserve Lands are confidential.

Division of Minerals Policy and Analysis has 38 staff distributed among three Branches

-- economic analysis
-- policy analyses
-- technical analysis.

The Division

-- carries out long- and short-term economic analyses;
-- conducts minerals and materials related technical studies;
-- responds to ad hoc requests and provides input to policy studies and legislation review.

Typical projects undertaken by the Division include:

-- developing a demand analysis capability which complements the MAS analysis, as part of an integrated USBM supply/demand analysis system;
-- identifying and quantifying structural changes occurring in the industry, and examining the causes and estimating their impact, and examining policies that can mitigate the impacts;
-- refining the methodology for quantitatively assessing the economic value of undiscovered mineral resources of nonfuels within a mineralised terrain;
-- copper S201 action and subsequent studies.

About 10% of the Division's budget, which totals $3M/year is allocated to contract work.

Much of the ongoing data used is computerised in the Bureau's ADP Division, but increasing use of PC's is being made by analysts for specific projects.

A short discussion was also had with the Special Projects staff which is more of a secretarial group dealing with the broader issues of the Bureau and the mining industry. One of its main functions is the annual preparation of the **Report of the Secretary of the Interior under the Mining and Minerals Policy Act of 1970.** The Act calls for an annual report of the Secretary of the Interior on the state of the domestic mining, mineral, and mineral reclamation industries, including a statement of trends in utilisation of mineral resources. Major problems facing US policymakers and that directly affect the US minerals industry and the nation's vulnerability to foreign mineral supply disruptions are also discussed. The publication is really an annual manifest of the State of the Nation - as it affects the minerals industry. It does, in fact, highlight for the legislators the supply position of essential minerals, and to some extent, suggests remedies for mineral related problems as they arise.

Division of State Activities controls the State Liaison Office in Washington DC with regional offices at

-- Denver, CO.
-- Pittsburgh, PA.
-- Tuscaloosa, AL.
-- Twin Cities, NM.
-- Spokane, WA.
-- Juneau, AK.

Liaison officers at these stations maintain intimate contact with state mineral officials, mineral associations, and the mineral industry in the relevant State.

While the liaison group does not become directly involved in the collection of State mineral statistics (that is the responsibility of the commodity specialist), it is the local source of mineral intelligence and local trouble shooter. It prepares such timely information as the Mineral Industry Survey for the State, and supplies the relevant information for Part II of the **Yearbook.** In a word, the State Liaison Office provides a contact point, advice and assistance in mineral matters to State and local governments.

OTHER GROUPS CONTACTED WITHIN USBM

Discussions were arranged with three advisory groups who report to and advise the Director

-- Senior Advisory Staff
-- Office of Congressional Liaison
-- Office of Technical Information

The Senior Advisory Staff consists of

-- Dr John D. Morgan, Chief Staff Officer
-- Dr Thomas A. Henrie, Chief Scientist
-- Gordon M. Miner, Chief Mining Engineer.

My main contact was Dr John Morgan, the senior advisor, who prepares most of the technical submissions (by USBM) to Congress. He relies heavily on data and analysis prepared by the Minerals Information and the Mineral Data Analysis Directorates, as well as resource data provided by USGS. Submissions are usually built up in consultation with Cabinet Council groups which prepare submissions to Cabinet (Departmental Secretaries who often report direct to the President). Dr Morgan was instrumental in the formation of Interagency Mineral Commodity Committees. Those committees provide a quick mechanism for obtaining the latest coordinated information on commodities available within government to help in developing recommendations for dealing with actual or foreseeable problems. A meeting of an interagency commodity committee can be called by any agency having a need, and that agency normally chairs the committee for the business in hand. In the mineral field, the Bureau of Mines provides its commodity experts to serve as Executive Secretry of the interagency committees covering their respective commodity.

Dr Morgan is also directly involved in assisting in submissions and drafting of bills on GSA stockpile matters, in Government/Industry/University Research Cooperation, and as a PR representative of USBM in such areas as delivering lectures to organisations such as Army Colleges, etc.

The Office of Congressional Liaison maintains contact with members of Congress, provides information to their questions, and in one way and another, attempts to get the views and aspirations of the USBM across to the lawmakers when legislation is being prepared. Staff have an economic/political science-type background; no technical background because, as they put it, there is no need, as they are usually dealing with non-technical people. Any requests for technical information or explanation, particularly for Senate Committees are referred back to relevant areas within the Bureau.

Office of Technical Information (formerly known as Office of Mineral Information) is staffed by about 15 public administration and technical/ sub-technical officers.

Main responsibility of the Office is to check all USBM publications for policy statements and implications. General checking and publication procedure is:

-- clearance of manuscript for technical content by Chief of Division;
-- clearance of manuscript for policy content by Office of Technical Information;
-- editing on style and presentation;
-- to author for discussion and correction;
-- to editor for marking up for printing.

For smaller publications manuscript is sent out as camera ready copy to USBM printing office at Pittsburgh where it is printed under contract. Major publications (e.g. **Minerals Facts and Problems; Yearbook**) are sent on floppy disk/tape to GPO, Washington, for printing by GPO or by sub-contract. Aim is to have **Yearbook** printed within 12 months of close of relevant year; turn around for monthly and quarterly publications now has limit of 45 days. Editorial staff which was formerly in Office of Technical Information has been moved out to Avondale just across the Maryland border.

OTI also

-- prepares senior officers' - e.g. Director public speeches;
-- inputs BOM's (Bureau of Mines) material into Secretary's speeches;
-- vets seminar and conference papers by BOM staff for policy implications;
-- is responsible for technology transfer.

The latter responsibility represents a continuing effort to keep industry abreast of developments resulting from the Bureau's research programs. Technology transfer films are used to disseminate information about the Bureau's advances in mining and mineral technology and are aimed at engineering and technical audiences interested in mine safety, environmental protection, and in mineral production and processing.

The Office is also responsible for preparation and release of press statements by the Bureau.

OTHER GROUPS CONTACTED WITHIN INTERIOR AND STATE

In Interior, I had discussions with

-- the Minerals Management Service, and
-- the Bureau of Land Management.

The Minerals Management Service is concerned mainly with offshore petroleum particularly in the Gulf of Mexico. The sale of offshore leases and production royalties is a substantial income earner for the Federal Government.

While little if any non-petroleum minerals are being mined offshore, the MMS has requested comment and information from interested parties to assist in delineation of offshore areas to be included in more detailed resource, environmental and economic reviews for possible leasing of minerals other than oil, gas, and sulphur in the Exclusive Economic Zone (EEZ), and Outer Continental shelf (OCS). This information will be used to establish priority areas for such reviews for the possible leasing of areas for

-- construction materials;
-- placer deposits;
-- phosphorites;
-- polymetallic sulphides;
-- cobalt-manganese minerals;
-- other non-energy minerals

within the EEZ and OCS on a case-by-case basis. John B. Rigg, Associate Director, Offshore Management Service, considers that the best chances for economic deposits are

-- the cobalt-rich (up to 1.5% Co) manganese crusts on the ocean rises off the Hawaiian archipelego particularly on the seamount tops in waters less than 2500 m, and
-- the shelf extension of the Florida phosphorite deposits.

Of course, while the main objective of MMS is the development of the mineral resources of Federal lands and the recovery of capital from lease titles and subsequent royalty payments, overall land and mineral development calls also for the protection of the environment. Thus, calls

for information on possible leasing areas provides an opportunity for environmentalists to put forward their view on possible environmental effects and use conflicts which can be used in the analysis of specific environmental conditions within the relevant area so that the potential effects of exploration, development and mining other than "the benefits accruing to the nation as a result of inventorying and producing minerals" can be assessed.

The Bureau of Land Management (BLM) also comes under the Assistant Secretary, Land and Minerals management and is involved mainly in the leasing of, and royalty collection from, Federal lands onshore. They have close liaison with the USBM Division of Land Assessment in determining mineral resources and potential of Wilderness Areas, and Forestry and Indian Reserves.

It is interesting to note that up to about three years ago the Interior groups referred to above were in the USGS within the Conservation Division, However, their regulatory responsibilities, in some cases their conflict with the private sector, collection of royalties, etc., was somewhat of an embarrassment to a scientific organisation like USGS, and the groups were moved into Interior under the Land and Minerals Management Secretariat.

Department of State - Industrial and Strategic Materials Division, Bureau of Economic and Business Affairs. The main area of concern for this group, as far as minerals are involved, is the General Services Administration (GSA) Government stockpile, and the effect that mineral disposals have on both domestic producers/consumers, and those in foreign countries.

Staff have an economic rather than a technical background, rely on a centralised economic analysis unit to predict impacts of disposals on domestic industry, and work in close cooperation with the Department of Commerce, and to a lesser degree with the USBM (on technical aspects). For information on, and effects of disposals and reaction to them in foreign countries, they draw on reports from the US commercial attaches overseas.

Synthesis and Discussion

While the USBM is large by Australian standards it is relatively small compared with other US Government agencies. It has only about one-third (2200) of the staff numbers of say the USGS and its budget is only one-third of the Survey's. In common with most other government organisations in the USA it is under increasing financial restraints; both staff and budget are being reduced in 1986 and 1987. Notwithstanding interest and publicity in strategic minerals and the large deficit in the balance of mineral trade, the mining industry has become relatively unimportant in the overall US economy. This in turn reflects on the public importance of the Bureau which in addition has been bedevilled with frequent changes in its administration over the years - senior executive staff are mainly political appointees - stop-start policies and numerous staff reorganisations. There appears to be a certain lack of cohesion between divisions working in common areas, databases are somewhat uncoordinated, and each sector maintains and retains databases directly applicable to its own area of responsibility.

As far as mineral information, data analysis, and policy advice are concerned, commodity studies remain the basic building block. Commodity specialists are responsible for collecting, interpreting and disseminating data on world production and consumption of nonfuel minerals, and, in liaison with other groups, on the 'reserve' sector of mineral resources. Over the last ten years commodity specialist groups have been through several phases of reorganisation and even changes in philosophy as to their modus operandi. One such change envisaged withdrawal from study of individual commodities to a general approach to the economics of the mineral industry where the impact of individual commodities played a relatively minor role. This philosophy was quickly abandoned, and an attempt was made to reorganise commodity specialists into two groups

-- surveillance
-- analysis

Work of the surveillance group was to be confined to the collection and interpretation of basic mineral data. The analysis group was to be responsible for the analysis of mineral data, provision of policy advice,

and for in-depth studies on particular facets of the mineral industry. The plan was unsuccessful mainly because background experience and expertise of the commodity specialists did not lend themselves to analysis and policy advice, and because surveillance group members considered themselves 'second-class citizens' vis a vis the analysis group. The result has been the concentration of the commodity specialists, both those concerned with domestic data and those working on international minerals, in the Minerals Information Directorate, physically separated from the Minerals Policy and Analysis Division in the Mineral Data Analysis Directorate. The position is not unlike that of the commodity specialists in the Minerals Branch of BMR and the Mineral Policy Division of our Department (DR&E).

The commodity specialists' (C/S) approach to mineral information and intelligence as practised by USBM has its strengths and weaknesses. On the plus side:

-- use of questionnaire for which C/S are responsible ensures comprehensive coverage of commodities from production to consumption;
-- C/S are directly involved in, and responsible for, the veracity and interpretation of statistical data and this combined with their personal contact with industry makes for expertise of a high degree in individual commodities;
-- distribution of questionnaires by C/S at the end of September, covering company actual data for the first nine months of the year, and company educated estimates for the last quarter, provides data for an early start to compilation of such regular, comprehensive publications as the **Minerals Yearbook**, improves their timeliness and helps meet tight deadlines which are a continuing problem.

On the minus side:

-- commodity specialists are not usually knowledgeable about statistical techniques associated with data collection;
-- statistical procedures for each mineral commodity are largely determined by individual C/S, and there is disparity from commodity to commodity in statistical practices employed and in the resulting quality of statistics;
-- distribution, collection and processing of questionnaire forms accounts for a substantial proportion of total manpower resources of the commodity divisions.

On balance I consider that statistical procedures within our Minerals Branch should continue broadly along current lines. Attractive as canvassing and collation of comprehensive statistical data by C/S may be, we just would not have the resources to attempt such a procedure. Also, there are very real advantages in ABS continuing as the statutory collector of official mineral statistics. However, I suggest that:

-- commodity specialists within the Minerals Branch become more involved in the collection and interpretation of statistics covering their particular commodities;
-- more direct and regular contact be made with statistical areas of the State Mines Departments to overcome confidentiality restrictions imposed under the Census and Statistics Act;
-- thought be given to using 9 months actual statistics combined with commodity specialist/company originated final quarter estimates to improve timeliness of publications such as the **Australian Mineral Industry Annual Review.**

The main policy advisory group in the Minerals Information and Analysis Directorate is the Minerals Policy and Analysis Division. This Division covers areas of the work carried out by the Minerals Branch of BMR and sections of policy divisions in the Department although its studies seem to be in greater depth and perhaps better documented in published form. It has good liaison with the Division of Minerals Availability (in the same Directorate) which can supply detailed information on domestic and world mineral resource data, costs of production, and availability of supply. Liaison with the Minerals Information Directorate is less impressive although the expertise and knowledge of commodity specialists are called upon as an input into special mineral economic studies. The commodity specialist groups maintain that their role is to present commodity facts and data scientifically and impartially, and for others to use this information for analysis and policy advice as they see fit. The main complaint of the commodity specialists seems to be that while analysts and policy advisers are dependent on the commodity specialists for raw data and interpretation, scant acknowledgement is given to this input in the resulting papers and publications.

I see a real need for the Minerals Branch to involve itself in the economics of special facets of the mineral industry such as the technical economic aspects of the cost of exploration and discovery of ore deposits,

and I urge that we continue our attempts to staff an Assessment Research Section as planned for in the reorganisation of the Mineral Commodities Branch.

The USBM's Minerals Availability System concept is ambitious, comprehensive and has the potential of being a most important policy tool, although as yet this potential does not appear to have been realised fully. The system and its computerised models not only make possible forward supply curves for mineral commodities at specific prices, but also the databases contain details of resources, production rates, capital and running costs of active mines and potentially economic deposits on a world scale. The system does, however, have its shortcomings; supply curves indicate maximum production - i.e. rated capacity; no account is taken as to what the market can bear at certain prices - i.e. there is no corresponding demand curve to match the supply curve - the Division of Minerals Policy and Analysis is working on this aspect of the system; an important link in the cost chain is missing, viz: the cost of exploration and discovery. The Division of Minerals Availability is examining the possibility of introducing this type of information into its Supply Analysis Model.

The Minerals Branch of BMR already has the embryo of an Australian-oriented MAS based on the data being collected by commodity specialists for MNDEP and more recently ISMI. It is hoped that these systems will be expanded and supplemented by cost data to be provided by the Mining Engineering Section. While in Denver I examined the possibility of obtaining individual cost data and summary deposit reports from the MAS field office, It appears that much of the cost data can be made available to us. While this data may have its shortcomings in coverage and may be somewhat dated at this stage, it should provide a substantial amount of basic detail on deposits and production costs, and save our officers from reinventing the wheel.

AMIS, the Automated Minerals Information System, controlled by the Division of Minerals Information Systems has been under development for the last five years. The original concept was to design a system to support all of the information and analysis responsibilities of the USBM from exploration and discovery through to recycling of metal scrap. AMIS was designed to:

-- provide an integrated, multi-commodity, shared database system to support analytical functions of USBM;
-- analyse a series of commodity data systems to support the commodity specialists and statistical staff, and
-- provide an information system to support planning and management responsibilities of the USBM executive.

AMIS appears to have been moderately successful in achieving the second objective above in replacing former canvass processing systems and providing computerised tables for publications such as the **Minerals Yearbook.** However, even in this area commodity specialists do not appear to avail themselves fully of the AMIS facilities, preferring to maintain their own databanks sometimes with the use of personal computers. This despite the fact that USBM management generally discourages the development of separate commodity data systems mainly to protect the integrityof the central database. Perhaps the overall objectives of AMIS were too ambitious, but whatever the reason, it appears that AMIS is far from achieving its original goals and that its position will need to be reviewed and user requirements taken into account.

The Minerals Branch (BMR) is currently developing a computerised system for statistical input into such publications as the **AMIAR.** MNIND is also being developed to provide on a modest scale, statistical data covering the current and historical position of the Australian minerals industry. Eventually it could be expanded to cover the more ambitious goals set for AMIS, as they apply to the Australian experience.

US GEOLOGICAL SURVEY (USGS)

The USGS was established in 1879 as an agency of the Department of the Interior. The agency is defined primarily as a scientific fact finding and research organisation, as contrasted to a developmental or regulatory one. It is the principal source of scientific and technical expertise in the earth sciences within the Department of Interior and the Federal Government.

The USGS is organised into a directorate and five subordinate divisions. Three are major program divisions - National Mapping, Water Resources, and Geologic - the other two are support Divisions, Administrative and Information Systems (Appendix 7).

The agency employs about 7900 permanent full-time scientific, technical, administrative, and clerical personnel of which about 2100 (21%) are in the Geologic Division. Funding for the agency is about $550M/year of which about 40% ($160M) goes to the Geologic Division.

The **Geologic Division** conducts a broad spectrum of earth-science investigations mainly in the US and its territories and on its continental shelves to

-- determine the geologic structure of these lands;
-- assess their energy and mineral resources;
-- establish the geological factors that bear on the use of the land and continental shelves and on the maintenance of environmental quality;
-- study the nature of, and mitigate the impacts of, geological hazasrds such as earthquakes, volcanic eruptions and landslides.

My main interests lay in the second function of this mission which involves the collating and synthesis of geological information on energy and mineral resources to develop a comprehensive background on which to base resource and potential resource assessments and estimations. In the USGS much of this work is done in the Office of Mineral Resources, particularly by mineral resource geologists, and by researchers in the Branch of Resource Analysis.

The Office of Mineral Resources (OMR) headed by Glen Allcot is responsible for estimating the nonfuel-mineral potential of the US by the use of geological, geophysical, and geochemical studies; researching the mode of occurrence and origin of mineral deposits, implementing concepts and devising techniques to aid in the search for new deposits; conducting geophysical investigations.

The Geologic Division's principal onshore activities in Alaska, and the general chemical laboratories of the Division are managed by OMR.

The Branch of Alaskan Geology conducts geological surveys and investigations to determine and appraise the energy and mineral resources of Alaska in compliance with the Alaska National Interest Lands Conservation Act of 1980. This involves, inter alia, research into the types and models of mineral and hydrocarbon deposits; and collating and synthesising of geological knowledge of energy and mineral resources. Although the headquarters of the Branch is in Anchorage, Alaska, much of the workforce is centred in Menlo Park, California.

Branches of Eastern, Central and Western Mineral Resources investigate mineral resource potential of lands in their respective regions of responsibility (Appendix 9) using geological, geochemical, geophysical, geochronological, isotopic, and remote-sensing studies. The Branches conduct research on mineral deposits, using deposit types within their Regions to achieve improved understanding of their mode of occurrences and genesis and to contribute to new exploration models. Branch personnel also carry out land assessments and research outside their own Regions to meet the needs of nationwide programs. The Branches maintain comprehensive files on mineral occurrences in their Regions and use these data for studies relating mineral potential and ore-forming processes to petrogenesis and tectonics on a regional scale.

The Branch of Resource Analysis integrates economic geology, geochemistry and mineralogy, metallogenesis, mineral economics and statistical analysis to develop techniques to assess the mineral resources potential of the United States. A major supporting function of the Branch is the collection, storage and analysis of data on mineral occurrences, production and resources. The development and uses of models of ore deposit occurrences and the identification of these in geological terranes are central elements in the assessment process. The resulting assessments range from estimates of potential resources of supply for single and multiple mineral commodities to general assessments of the mineral resource potential of regions. Studies relating to the exhaustion of mineral commodity resources are also produced by means of many of the same techniques.

The Branch is composed of five main groups:

Data Systems

Main responsibility is organisation of the Mineral Resources Data System (MRDS) which in 1982 replaced the Computerised Resources Information Bank (CRIB). MRDS is a computerised system designed to store, organise and retrieve large amounts of mineral data. All data in MRDS are organised into records that define individual mines, mineral occurrences, districts or regions. The MRDS master file now contains about 72 000 records. MRDS contributes to several current USGS programs including the Federal Mineral Land Information System (FMLIS), the Conterminous United States Mineral Assessment Program (CUSMAP), and the Alaska Mineral Resource Assessment Program (AMRAP). The International Strategic Minerals Inventory (ISMI) program to which Australia contributes, gathers, analyses, and presents information on major deposits of selected strategic mineral commodities and provides an input to MRDS.

Ore Deposits Research

(Geochemistry)

This is the remnant of the Geochemistry Branch who continue their work particularly on chemical aspects of ore deposits. Field and laboratory studies are undertaken of the processes and products of primary and secondary geochemical dispersion of trace and minor elements within and surrounding ore deposits. Studies include research on analytical methods for resource assessment and ore deposit research. Also contributes to the multidisciplinary group study: the role of organic material in the formation and detection of ore deposits.

Commodity Specialists

(Economic Geology)

About 50 commodity geologists, spread throughout the Mineral Resources Branches and the Branch of Resource Analysis keep abreast of major activities and developments in mining, exploration, and technology for about 95 commodities. Those at Menlo Park include:

-- copper - Dennis Cox
-- molybdenum - Ted Theodore
-- platinum group - Norm Page
-- lead-zinc - Joe Briskey.

Oil/Gas/Coal

A small group which carries out modelling and geostatistical research into predicting the extent of undiscovered resources of hydrocarbons.

Resource Analysis Methodology

Core of this group is Don Singer and Dave Menzie at Menlo Park. They are concerned mainly with the mathematical methodology of estimating undiscovered mineral resources. With the continuing emphasis on mineral resource assessments carried out in connection with established programs such as the Conterminous United States Minerals Assessment Program (CUSMAP) and the Alaska Mineral Province Assessment Program (AMRAP), as well as those associated with Bureau of Land Management (BLM) and National Forests programs the group is initiating the development of readily applicable quantitative techniques to increase the facility and rapidity of OMR geoscientists in making resource estimates. They will develop base rates (expected number of deposits by type in well explored terranes per square area) which can be used to estimate the number of undiscovered deposits in less well explored terranes for deposits that may occur in public lands. They will prepare rules (logics) for combining geological, geochemical, geophysical and exploration data in making estimates of numbers of undiscovered deposits. In a word, they will develop data (expected number of deposits by type in well explored terranes) methods (rules for combining base rates and other required geoscience data) and software to assist geologists who are not formally trained in estimating numbers of deposits.

Other Offices Visited

While most of the week was spent within the Office of Mineral Resources, particularly with the Resource Analysis Branch, some time was also spent with

-- Office of International Geology;
-- Office of Scientific Publications;
-- Office of Energy and Marine Geology.

Office of International Geology manages and coordinates the Survey's international assistance in geological studies and scientific exchange programs on behalf of the Department of State and in cooperation with other

agencies and governments, and provides guidance and representation to domestic and international agencies in international earth sciences and resources. Main topic of discussion with Maurice (Ric) J. Terman, Chief of Asian and Pacific Geology, was the forthcoming ESCAP Committee on Natural Resources to be held in Bangkok in October this year.

Office of Scientific Publications is responsible for planning, directing, and supervising the scientific publications program of the Geologic Division including the evaluation of reports for appropriateness, completeness,and method of release; developing new concepts and techniques for preparation and release of scientific information; preparing final copy for the productionof all USGS book publications; maintaining liaison with the Government Printing Office and commercial contractors; and preparation of general interest leaflets and visual information materials. The office manages the USGS library system. Time was taken to discuss with Henry Spall, responsible for publications of the Branch of Resource Analysis, procedures for editing and publication of relevant publications, particularly the trend to have the more prestigious publications printed by electronic type-set printing methods. The Library was also inspected.

Office of Energy and Marine Geology is responsible for assessing the hydrocarbon, energy-mineral, and associated nonmetallic and mineral resource potential of US and its continental shelves. I was particularly interested in the Branch of Coal Resources which collects and analyses geological data about the quantity, quality, and mineability of the Nation's principal coal deposits in order to develop an understanding of the formation, distribution, and economic resource characteristics of coal. It provides regional and national coal resource assessments and maintains a national coal data system. The National Coal Resources Data System (NCRDS) is an interactive computerised storage, retrieval and display system to assess the quantity and quality of the nation's coal resources. It has been developed to provide geological coal resource data currently available, to update those data, and to expand to new types of data.

USGS has initiated a 5-10 year program to acquire point-source data for all coal-bearing regions through its own programs and joint projects with State agencies. Files containing summary areal coal-tonnage estimates

and proximate/ultimate chemical analyses, as well as point-located major, minor and trace-element analyses, and stratigraphic data are available. New resource assessments can be made with point-source data, including drillhole records, field measurements, etc. The system software can calculate coal resource estimates, generate overburden or interburden distribution, and delineate areas of coal with selected parameters.

M. Devereaux (Debbie) Carter is Program Manager of NCRDS.

Synthesis and Discussion

Like the USBM, the USGS is involved in mineral availability assessments, but in the latter case, the thrust is towards the development of mineral deposit models and the development of mineral resource assessment techniques to come up ultimately with numeric assessments and so provide government with the data necessary for realistic planning of resources for the future. While joint reports are issued by the USGS/USBM on mineral potential of land for inclusion in the Wilderness Program, and USGS commodity geologists report annually with the USBM on the identified resources for their particular commodity, the USGS commodity program documents the physical resource and not the economics of extraction and metallurgy which vary with time and which are the responsibility of the USBM.

Development of quantitative assessment of undiscovered mineral resources requires a team effort by the mineral resource geologists, BORA resource analysts, specialists of the Development of Assessment Techniques (DAT) Program, and geologists of the Eastern, Central, Western and Alaskan Mineral Resources Branches.

Mineral resource geologists conduct research and compile resource data to establish and maintain a high level of knowledge of geological controls of deposits and resource supply situation in their assigned commodities. This provides a basic input into the USGS Commodity Program and allows the geologists to provide advice and expert assistance to other USGS mineral resource activities including CUSMAP, AMRAP and the Wilderness Program referred to earlier in this report. Mineral resource geologists delineate known deposit types and identify new geological environments for undiscovered

deposits. Research on deposit types is primarily oriented towards improving assessment techniques rather than on the processes of ore deposition.

Assessment of identified and undiscovered resources generally involves four steps

-- computerised inventory of identified deposits and occurrences;
-- definition of the mineral deposit models for the commodity
-- identification of the domestic and foreign geological terranes in which the deposit types may be found
-- assessment of the identified and undiscovered resources of the commodity.

An inventory of known deposits and occurrences of the commodity is undertaken and computerised to facilitate data recording and updating and to speed up production of outputs such as mineral distribution maps. The basic inventory data entered into CRIB/MRDS include:

-- geological data for deposits and occurrences that can be used to delineate geological terranes in which particular deposit types of the commodities may be expected to occur
-- historic production by tonnage and grade
-- identified resource data by tonnage and grade.

Historic production and identified resource data are combined to develop deposit frequency and tonnage-grade models for well explored terranes which in turn are used to estimate the undiscovered resources of geologically similar but poorly explored or poorly exposed terrains. In summary, then, the mineral resource geologist provides the basic data for identified resources and the geological data for deposits, deposit and tonnage-grade models are constructed, geological terranes in which particular deposit types may occur are delineated and identified and undiscovered resources are estimated numerically.

The summary above perhaps oversimplifies the complexities involved in these procedures. The estimation of undiscovered resources is a difficult and uncertain activity and requires a wide spectrum of special and diversified expertise as exemplified by the approach of the USGS. While the Australian Bureau of Mineral Resources has made considerable progress in the

compilation and publication of details of identified resources, work on quantifying undiscovered mineral resources has been ad hoc and very limited. Minerals deposits databanks being developed by the Minerals Branch will in time provide a computerised inventory of identified deposits but any systematic approach to estimating undiscovered resources will require expertise in the fields of economic geology and statistics/geomathematics as well as formal input by regional geologists and research scientists involved in ore genesis research. Meanwhile, ad hoc teams will need to be formed from available staff to meet urgent demands as they arise for information in specific areas

CANADA

In Canada, involvement in, and control of, the mineral industry at Federal level is the responsibility of the Department of Energy, Mines and Resources (EMR). EMR was established in the mid-1960's as part of a general reorganisation of Canadian government departments.

A detailed organisation chart of EMR is given as Appendix 10.

While each of the ten provinces of Canada has its autonomous Mines Department and Geological Survey, the federal Department of Indian and Northern Affairs (DINA) exercises powers analogous to those of a provincial government for the Yukon Territory and the Northwest Territories.

Within EMR, documentation and analysis of the Canadian mining industry, resource policy and mineral resurce assessment is the responsibility mainly of the Mineral Policy Sector, and the Economic Geology and Mineralogy Division of the Geological Survey of Canada (GSC).

MINERAL POLICY SECTOR

The Mineral Policy Sector encourages and regulates Canadian mineral production and development in conjunction with provincial departments of natural resources and DINA. MPS is dependent on the cooperation of provincial governments, and a Federal-Provincial Committee was established in the mid-1970's where activities in the mineral industry are reviewed and

task forces established to address problem areas in the industry. Other industry groups such as the Mining Association of Canada (MAC) attend committee meetings as observers, and the meetings provide a forum for exchange of views between government and industry.

The Sector is headed by an Assistant Deputy, Minerals, at present R.D. Hutchinson (Bob), who controls three main Branches

-- Minerals and Metals Strategy
-- Economic and Financial Policy Analysis, and
-- Resource Strategy and Information Branch,

as well as the Regional Mining Development Division, Senior Advisers, and financial and administrative groups.

Organisation of the Sector is shown in Appendix 11.

Minerals and Metals Strategy Branch

The Branch is under the directorship of Dr G.E. Wittur (Glen), and is subdivided into four Divisions:

-- International Mineral Relations
-- Nonferrous Commodities
-- Ferrous Commodities
-- Industrial Minerals.

The International Mineral Relations Division deals with the broad international aspects of minerals rather than with individual metals/ minerals. Its commission is to advise Government so as to enhance Canada's role as a mineral exporter. The Branch has a major input in the preparation and drafting of international mineral agreements and study groups but once these are up and running carriage is passed to officers of the Commodity Branches. Each member of the team is allotted particular agreements as his responsibility - e.g. Law of the Sea, UNIDO, UNCTAD, OECD, etc., as well as geographical areas and countries for his surveillance along the lines of the International Minerals Group in USBM.

Professional staff consist of seven or eight high level mineral economists who have had considerable experience in both industry and Government. They are officially classified as Economic Sociologists/ Statisticians (ES), but their academic backgrounds range from economics

through business administration to international law. Most have a technical background as well, although this is not mandatory. There is close liaison with members of the Division and commodity analysts in the Commodity Divisions.

Officers deal directly with opposite numbers in other relevant departments such as External Affairs, Trade, and Regional Industrial Expansion, etc. Research and recommendations on important policy matters are sent up the line through Glen Withur to an Executive Committee consisting of high-level executive officers such as the Assistant Deputy Minister, and the Director of Strategic Planning. The Branch is also called on for input into the Inter-departmental Committee on Mining which meets regularly to bring the Minister up to date on mining matters.

The Division is not responsible for standard publications, but contributes to the **Canadian Minerals Yearbook** and to such regular publications as **The International Minerals Scene**, a semi-annual publication by the Mining Association of Canada. It also produces ad hoc reports in the MR (Mineral Resource) series such as **Chile's Mineral Industry** which provides an overview of the Chilean economy, analyses the structure of the mineral industry, and comments on implications of Chilean mineral development and trade policies on the Canadian mineral industry.

Commodity Divisions. Commodity work is shared by three Divisions

-- Nonferrous (Director, R. Telewiak)
-- Ferrous (C.J. Cajka)
-- Industrial Minerals (J.Y. Tremblay).

As in the USBM, commodity analysts have a technical background in earth science, geology, metallurgy, or mining engineering supplemented by formal training in business, economics, or mineral economics. Unlike their US counterparts, commodity analysts are not involved in the formal collection of mineral statistics; this is the responsibility of the Mineral Census Section in the Resource Strategy and Information Branch; commodity analysts do however have access to confidential company returns. They also assist the Mineral Census Section in the organisation and interpretation of consumption surveys. Mineral analysts are not involved

formally in the compilation of mineral resource data, but their activities do extend into the policy advice area, and they often represent their government at international meetings of organisations such as the International Lead Zinc Study Group, International Tin Council, UN Tungsten Group, International Nickel Discussion Group, etc. There does appear to be a trend for the commodity analysts to move away from the statistical/ interpretative side more to the economic analysis-policy aspects of their mineral specialties.

The Regional Mineral Development Division was until recently within the Minerals and Metals Strategy Branch but now reports direct to the Assistant Deputy Minister. The Division is under the direction of J.E. Reeves (Jack) and consists of ten professionals having a technical and economic background and wide experience in industry. Officers are allotted specific provinces as their responsibility as well as broader areas of responsibility such as land use and environment, Federal-Province mineral agreements, transport and infrastructure.

The Division has two broad thrusts

-- administration of Federal-Province mineral development agreements;
-- surveillance and intelligence of regional developments in the Provinces.

Federal-Province Mineral Development Agreements. Under jurisdiction of the Cabinet Committee on Economic and Regional Development, umbrella agreements (ERDAs) have been concluded which identify priorities and strategies. The agreements aim to strengthen and diversify the mineral industry sector in each province to help industry to respond to both structural change in international markets and effects of economic cycles. Implementation of the objectives of the agreement involve three main functions

-- geoscientific activities designed to provide new and more detailed information on selected areas considered to have favourable mineral potential - this usually involves input by GSC,
-- application of mining and mineral technology to new developments on existing operations to help producers improve productivity and enhance conpetitiveness - support provided by CANMET;

-- studies such as market assessments and economic feasibility studies, to identify new development opportunities.

Province Regional Developments. Members of the Division maintain close contact with their counterparts in provincial mines departments. While these interests are on a more macro-scale than that of the commodity analysts, joint visits by members of the two groups are occasionally arranged. The Regional Mineral Development Division is responsible for the preparation of the regional review section of the **Canadian Minerals Yearbook.**

Economics & Financial Policy Analysis Branch

This Branch headed by Director-General K.J. Brewer (Keith) is composed of four Divisions

-- Tax Policy Analysis
-- Financial and Corporate Analysis
-- Economic Policy Analysis
-- Statistics and Modelling.

Tax Policy Analysis. The Division closely monitors taxation in Canada and produces econometric models to predict possible effects on Canadian mineral development resulting from changes in taxation law. The group is very conscious of the competitive position of the Canadian mining industry, vis a vis world producers/exporters, and a discreet section headed by Roberta Albert specialises in studies of various international taxation systems and their effects on the domestic mining industry.

Financial and Corporate Analysis, Director, R.K. Jones, deals mainly with financial aspects of company performance. Staff has access to company balance sheet returns as collected under the Mining Census, and which contain detailed data of operating costs. The group has developed an extensive computerised system for determining company DCFROR and is in close contact with the MAS group of USBM at Denver regarding production costs of operating mines and of possible future operations from major deposits.

Economic Policy Analysis. Director, D. Hull (Dale). This Division concentrates on mineral policy analysis, feasibility studies of mineral projects, international mineral competitiveness particularly in trade, and coordinates the Research Agreement Program of the Minerals Policy Sector.

Statistics and Modelling Division. Headed by Lise Hubert, this Division provides computer support and statistical research for the whole Branch. Computer facilities are based on a Cyber mainframe and several personal computers used by individual economic analysts. Work of the Branch is highly computerised particularly in determining company performance and discounted cash flows, and in the economic/econometric modelling of other phases of the Branch activity. The Statistics and Modelling Division is very self-sufficient from key-board operations through programming, modelling and trouble shooting when called on to solve problems encountered with the micro-computers. Data retrieval and manipulation extend to CANSIM, Chase Econometrics, SRI, Conference Board of Canada, Financial Post and the International Mineral Demand Model to mention some of the national and international computer systems with which the S&M Division is linked. The S&M Division also provides support to the Branch by maintaining a mineral economics reference room, retrieving statistics and economic data not computerised, and preparing data tables and graphics.

While many members of the Analysis Branch have a formal degree in earth science, this is not considered to be essential. They are mainly economists and public administrators - the officers of the Financial and Corporate Analysis Division have formal training in accountancy.

Their publications centre about framework papers, the latest to be produced (February 1985) being **The Canadian Minerals and Metals Sector: a Framework for Discussion and Consultation.** The overall intent of the paper was to identify the industry's problems and opportunities. It was distributed to companies in the minerals industry, financial institutions, labour unions, and provincial governments, and addressed the five themes considered to guide the federal approach to minerals and the economy as a whole: viz,

-- fiscal responsibility
-- restoration of investor and consumer confidence
-- support of innovation and entrepreneurship

-- improvement in domestic and international trade
-- emphasis on economic partnership in the roles and responsibilities of all concerned

Resource Strategy & Information Branch

Director General, Robert J. Shank, heads up four Divisions

-- Information Systems and Statistical Survey Activity
-- National Mineral Inventory
-- Resource Policy
-- Human Affairs

Information Systems & Statistical Survey Activity. Director, John Brennan. Is responsible for the Annual Mining Census, Monthly Production survey, Mineral Consumption Survey, and Technical Records Centre.

Annual Census of Mines, Quarries and Sand Pits is distributed by this group in collaboration with the mining departments of the provincial governments and Statistics Canada. The Census covers production data on mines, quarries, etc., as well as on inventories, fuel and material inputs, employment and structural data. Returns are worked up by EMR, Provincial Statistics and Statistics Canada, and are available to these groups for their particular use. EMR uses the statistics mainly for publication in the **Canadian Minerals Yearbook.** Statistics on smelters and refineries in Canada are collected by Statistics Canada in its Census of Manufactures. EMR plans to take up responsibility for collection of smelter and refinery production. In addition to the comprehensive Mining Census, the Statistical Group publishes preliminary annual production statistics early in the year in the **Canadian Mineral Survey** and in the February edition of the **Canadian Mining Journal.** These are based on production figures estimated by companies in response to a questionnaire forwarded by the EMR group towards the end of the relevant year. The Information Systems Division is also responsible for the collection of mineral consumption data which is obtained by means of a questionnaire distributed annually to end-use consumers.

National Mineral Inventory (NMI), Director, A.G. Sozanski (Andy), compiles and maintains records of nonfuel mineral deposits and occurrences in Canada. NMI consists of an open-file system of nearly 20 000 deposit records

presenting information in a standard format and covering the following information

-- name and location of deposit
-- owner or operator
-- description of deposit
-- associated minerals or products
-- history of exploration and development
-- history of production
-- references

The card file is indexed into the MINSYS computer database, which facilitates retrieval of all or part of the card file in packages, by any region or key characteristics. Xeroxed copies of NMI cards are available for 25 cents/sheet. Computer custom print-outs are available at nominal cost, and the complete database can be obtained on magnetic tape.

Resource Policy Division, Director J. Zwantendyk (Jan) monitors mineral resource adequacy and long-term supply of minerals for Canada through exploration, Canadian mine supply, world resources (ISMI), ocean mining, and imported mineral supply, and researches such areas as new industrial materials (mineral or otherwise) which might augment or substitute for minerals in the future. Of particular interest in this area was

-- the monitoring program, and
-- the exploration analysis program

Through the monitoring program, national analysis is directed toward timely identification of troublesome developments in flows from resources to reserves to mineral supply. A basic tool of the monitoring procedure is the "monitoring curve". A monitoring curve for a commodity is derived from an analysis that considers each mine currently producing the commodity, as well as every new mine or standby mine that is committed to come on-stream and produce the commodity. Construction of such curves requires, for each mine/concentrator the following information

-- metal(s) produced
-- tonnage and grade of current reported ore reserves
-- current and planned annual ore production and processing capability
-- current concentrator recovery

Using this information, and allowing for smelter/refinery losses, a monitoring curve for each metal is developed annually and represents the year-by-year future production of the metal from Canadian mines as a whole arrived at by projection from every mine's ore reserves and ore production rate as reported in the year of projection. Development of the monitoring curves requires production and reserve data on individual mining properties which are acquired by three questionnaires - a survey of mine production and ore reserves, an annual survey of mills/concentrators, and a survey of mineral deposits committed to production during the relevant year. Information acquired from the questionnaires is supplemented by mineral intelligence obtained from mine visits by teams of EMR and provincial mining engineers who also discuss with mine personnel classification and calculation of reserves. The focus in this analysis is on supply from resources in the ground, not from scrap material. The latter may be included at a later date. This work results in publications such as MR201 **Canadian Reserves as of 1 January 1983** which details tonnages and grades of economically mineable ore of copper, nickel, lead, zinc, molybdenum, silver and gold for each producing mine and deposit committed for production in Canada, and MR200 **Canadian Mines: Perspective from 1983** which covers reserves, production capability, exploration and development details for copper, zinc, lead, nickel, molybdenum, silver, gold, iron and asbestos.

In order to improve consistency, clarity, and timeliness of mineral exploration statistics and to better interprovincial coordination, EMR, provincial mine departments, and companies are cooperating in the distribution, completion and analysis of evaluation questionnaires to replace those previously the responsibility of Statistics Canada. The Exploration and Development Survey is carried out on a Province basis and collects comprehensive data for individual minerals regarding general exploration, on-property exploration (properties producing or committed to production) as well as on-property mine development.

Data are summarised and made available as

A. Provincial Distribution by Types of Work
B. Distribution of Activity by Types of Companies (foreign companies, Canadian federal and provincial government agencies, etc.)
C. Distribution of Expenditures by Commodities sought (base, precious, ferrous, uranium, miscellaneous, non-metals, coal and other)
D. Distribution of Surface Drilling by Commodities sought.

Other Groups Interviewed

Management Processes Division Main interest was in the Publication Section which is responsible inter alia for the publication of the **Canadian Minerals Yearbook** the main regular publication of the Mineral Policy Sector.

The Publication Section, headed by Ed. Thompson is staffed by

-- four editors
-- a publication processing officer
-- two draftsmen
-- a publication distribution officer.

Strong action was taken this year to have publication of the **Canadian Minerals Yearbook** more timely and the effort has been most effective.

-- two year's text and tables have been combined - i.e. 1983-1984;
-- MS prepared by authors is word-processed, edited (two editors) and returned to author for corrections - his only opportunity to make alterations;
-- corrected version is sent to printer as camera-ready copy;
-- page proof is returned to editor (blue copy) for checking of format - not text, etc., and not to author;
-- printed as separate English and French publications;
-- original tender is drawn up by Publications Section and passed to Department of Supply and Services (DSS) for outside tendering;
-- in 1985 Ed Thompson took word-processed MS to printer in Winnipeg in early April (1985), received back Page Proof which was returned to printer next day, daily contact with printer by 'phone, publication (English and French copies) trucked back to Ottawa early May - a total time of six weeks;
-- MS had to be in editor's hands (from Branches) by end of March 1985;
-- domestic statistics were for Jan-Sept 1984 - world production statsistics were for 1983.

CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY (CANMET)

CANMET's head office in Booth Street, Ottawa, was visited on 23 May and discussions held with Dr W.G. Jeffery, the Director-General. CANMET is within the **Research and Technology Sector** of EMR and is the principal federal agency for research and development in mining, minerals, metals and fossil fuel technologies.

The mission of CANMET is to enhance the role and contribution of minerals and energy to the Canadian economy by means of mission-oriented research and development which

-- provide information to the Minister for making resource policies;
-- serve government social objectives for health and safety and the environment;
-- are supportive to R&D performed by industry in order to improve the economic performance and productivity of industry.

To fulfill its mandate CANMET carries out basic and applied research, development, demonstration and transfer of new technology to industry. Close links are maintained with industry and other research organisations to ensure that all projects are undertaken in response to, and in anticipation of, real needs and problems. The National Advisory Committee on Mining and Metallurgical Research (NACMMR) has an important advisory role in CANMET's program. On the minerals side, emphasis is placed on developing techniques for mining deep and less accessible orebodies as well as on finding ways to recover minerals from problem ores. CANMET also carries out mineralogical, geochemical and associated studies to identify and assess the extent, quality, and potential for economic recovery of Canada's mineral resources.

CANMET staff consists of 800 scientists, engineers, technicians and support staff engaged on energy research, mineral sciences, physical metallurgy, mining research and coal research. About one quarter of the annual budget ($70-80M) is directed to contracts for R&D projects conducted on behalf of CANMET by industry and universities.

Synthesis and Discussion

Canada, like Australia, is very conscious of its mineral exports, mineral resources, competitive position in production, and depletion of known resources in meeting both domestic and particularly export demand. Canadian provinces, under the British North American Act of 1867 have ownership of their mineral resources, and all provinces, including those that joined the Confederation after 1867 have sovereign mineral rights including granting of prospecting, exploration and production rights as well as levying of direct taxes on mineral producers. In Canada,

therefore, provinces exercise great authority over their mineral resources and provinces play a major role in the formation of mineral policy. It also means that the study of mineral policy and collection and use of mineral statistics in Canada involves the policies of 11 governments; the 10 provincial governments, and the federal government which has jurisdiction over mineral matters in the Northwest Territories and the Yukon Territory.

Within the Federal Government sphere of influence the work of the Mineral Policy Sector (within the Department of Energy, Mines and Resources) falls into well defined areas - mineral intelligence and interpretation, mineral inventory and monitoring of future supply, regional development, economic analysis and forecasting. The strength and success of MPS derives from government support in establishing policies and strategies to ensure that the minerals and metals sector contributes with maximum effect to the Canadian economy. Government efforts are directed towards this end and concentrated mainly within a single government organisation (EMR) and more specifically, within MPS.

MPS is attempting to introduce long-term planning into the domestic mineral industry and goals and objectives are being set for certain sections of the industry. Such efforts are aided by the fact that relevant officers are provided with regular policy direction from a single source - Cabinet, and that they have direct, regular access to the Minister of State (Mines).

Within MPS, expertise on known mineral resources and future mineral supply including exploration analysis is concentrated in the Resource Strategy and Information Branch (National Mineral Inventory and Resource Policy Division); the Economic Financial Policy Analysis Branch deals with the economic analysis of the mineral industry at both a national and company level; the Regional Mineral Development Division administers the Federal/Provinces regional development objectives; and the Minerals and Metals Strategy Branch is responsible for mineral commodity studies at a national level and on an international mineral basis. Collaboration between divisions and branchs within the Sector, as well as cooperation at a higher level between Federal/Provincial/Industry officers, is a feature of the system.

The work of mineral commodity specialists, locally designated as commodity analysts, and who are concentrated within the Minerals and Metals Strategy Division, is directed more towards the industrial/commercial end of the mineral industry spectrum; the commodity analysts are very conscious of, and au fait with, policy implications of their work and often are included in Canadian delegations to intergovernmental mineral meetings.

In the area of mineral statistics, commodity analysts would appear to have the best of all worlds; they have access to timely detailed data on production, shipments, stocks, smelting and refining, and consumption without being directly involved in the distribution of questionnaires or with the extraction and compilation of statistics from the returns; they can also rely on the cooperation of provincial mines departments and of industry because of the Federal-Provincial Committee on Mineral Statistics which provides a forum for the exchange of ideas between governments and industry on problems arising in mineral statistical collections and analysis.

However, there do appear to be one or two weaknesses in the system. In general, commodity analysts in MPS do not regard commodity specialisation as a long-term career and tend to extend their professional interests beyond the confines of particular commodities. Accordingly, they do not acquire the same in-depth knowledge and coverage of specific minerals as say, the commodity specialists in the USBM. In particular, because they are not involved in the collection, analysis and publication of mineral resource data they have no deep interest in, or feel any responsibility for, the exploration/discovery/ resources end of the commodity spectrum and their work is therefore confined to a somewhat narrow coverage of the commodity being studied.

While timeliness in the publication of the **Canadian Minerals Yearbook** is most impressive it is achieved at the expense of comprehensive statistics - e.g. 9 month's statistics for domestic production, all of which have to be revised in the following year, and country production statistics are a full year behind that being reviewed. The emphasis on timeliness also results in a somewhat stereotyped version of the **Yearbook** which is word-processed and little changed from year to year except for statistics and the Chapter summaries, and which lacks the pleasing impact of type-set print. These pros and cons will need to be considered in improving the timeliness of Mineral Branch publications, particularly that of the **Australian Mineral Industry Annual Review (AMIAR).**

I suggest that the MPS experience can be of benefit to the Minerals Branch of BMR in developing

-- discussions between BMR, ABS, State Departments of Mines, and Industry with a view to improving timing and coverage of Australian mineral statistics;
-- mineral exploration analysis;
-- monitoring curves of mineral supply and in supply/demand projections, generally.

Of course, some progress in these areas has already been made.

GEOLOGICAL SURVEY OF CANADA (GSC)

The GSC is a major agency within the Earth Sciences Sector of the Minerals and Earth Science Program. GSC ensures that comprehensive knowledge, technology and expertise pertaining to the geology of the Canadian landmass and offshore areas are available. The subject matters include mineral and energy resources and conditions affecting land and seabed use for exploitation of mineral and energy resources, effective land use, estimation of Canada's resource base and policy formulation.

GSC has eight Divisions (of which three are regional centres) and the branch headquarters (Appendix 12).

My main interest lay in

-- Economic Geology and Mineralogy Division
-- Resource Geophysics and Geochemistry Division
-- Geological Information Division

<u>Economic Geology and Mineralogy Division</u>

The Division has four main responsibilities

-- to maintain a national information base on the nature, distribution and geological characteristics of Canada's non-hydrocarbon mineral resources
-- to conduct research into the mechanisms of formation of mineral deposits

-- to interpret the relationships of mineral deposits to the geological characteristics of Canada's principal geographic and geological regions
-- to provide guidelines and models for use by the Canadian exploration industry and input to government policies.

The Division was expanded in April 1984 to accommodate the merger of the Analytical Chemistry and Mineralogy Sections of Central Laboratories and Technical Services Division. The Division, under the directorship of Dr D.C. Findlay (Chris), is now composed of two major subdivisions - Economic Geology, and Mineralogy and Chemistry (Appendix 13). The Economic Geology Sub-Division comprises six Sections

-- Regional Mineral Resource Assessment
-- Mineral Deposits Geology
-- Regional Metallogenic Studies
-- Mathematical Applications in Geology
-- Mineral Resource Information Services
-- Laboratory and Scientific Support.

However, the administrative section boundaries tend to be ignored in interdisciplinary responses to both internal and external projects and demands.

The Regional Mineral Resource Assessment Section includes the former Uranium Resource Evaluation Section, and conducts investigations of uranium deposit types and is responsible for regular appraisals (now on a biennial basis) of Canadian uranium and thorium resources additional to reserves (EAR) for EMR-URAG (Thorium Resources Assessment Group) requirements. The Section also carries out multicommodity (deposit type) assessments as input to the interdepartmental (EMR-DINA-DOE) Northern Mineral and Energy Resource Assessment (MERA) process for evaluation of proposed national parks, ecological reserves and northern land use planning regions.

The Section is headed by Vladamir Ruzicka and consists of five research scientists including Dr R.T. Bell and Dr C.W. Jefferson and two physical scientists. It appears to have been built around the remnant of

the Uranium Resource Evaluation Section with the addition of two newly-recruited research scientists - viz. Drs Scoates and Jefferson. The uranium resource evaluation component is now supplied by two research scientists and ranges from inferred extensions of reserves in identified deposits to hypothetical and speculative resources of less-explored areas. The biennial assessment is conducted in cooperation with industry, the provinces, the Department of Indian Affairs and Northern Development, CANMET, and the uranium and Nuclear Energy Branch of EMR. The reports are submitted to the Uranium Resource Appraisal Group and used as an input to the management of Canada's uranium and nuclear energy policy. Vladamir Ruzicka is responsible for Canadian uranium supply input into the NEA/IAEA Redbook.

The mineral resource assessments of northern areas involve qualitative ratings of resource potential for mineral commodities in selected areas based on probabilities of their occurrence. Members of the Section participate in integrated metallogenic studies of specific geological ore-bearing environments where they have special expertise.

The Mineral Deposits Geology Section collects and synthesises data on Canadian mineral deposit types, other than uranium, and develops genetic models for major deposit types and tests and researches these models. The Section was mainly responsible for the recent publication of **Canadian Mineral Deposit Types: A Geological Synopsis** which recognises groups of deposits where geological features are sufficiently similar to suggest a common genesis. The summaries of deposit types list contained commodities and names of example deposits, outlines economic significance, typical size and grade of orebodies, geological setting, host rocks, associated rocks, form and distribution of mineralisation, minerals present, age, genetic models, and guides to exploration.

The Section is staffed by 8-10 Research Scientists. Emphasis is on deposit-type specialisation rather than specialisation in specific mineral commodities, but researchers such as Don Sangster (Pb-Zn) and Gordon Gross (Fe,Mn) both of whom are now in the Special Projects Group, retain their interest in specific minerals.

The Regional Metallogenic Studies Section researches the distribution types of mineral deposits in terms of their relationships to geological

histories of distinctive domains within major tectonic units throughout Canada. As such much of their work is closely allied to that of the two sections described above and have in common the

-- refinement of conceptual models for use in exploration, and
-- evaluation of mineral resource potential in designated areas.

The Section headed by S.M. Roscoe is made up of five research scientists and one physical scientist. Dr A.R. Miller is a member of the team. Al. Miller has just returned from a one-year scientific exchange visit with BMR to investigate deposits in the Pine Creek uranium field and in Western Australia and Tasmania for comparative studies with regional metallogenic parameters in the Keewatin District of the Northwest Territories.

The main responsibility of the Mineral Resource Information Services Section is the maintenance and operation of the CANadian Mineral Occurrence INDEX (CANMINDEX). CANMINDEX in general meets the requirement of the Economic Geology Division for a national computer-processable mineral deposits file. Document files and related scientific materials are retained mainly by individual project scientists in the Division. CANMINDEX provides a single standardised computer processable file for certain elementary data for all Canadian mineral deposits and occurrences. The basic contents of the file are

-- identification: name, alternate name, accession number
-- location: geographic location
-- geological data: commodities present and their development status, geological deposit type; and brief geological characterisation of deposit
-- lithography: selected bibliography of documents and maps describing the occurrence or the local geology
-- remarks: special aspects of the occurrence
-- cross-references: include accession numbers from up to four other files containing information on the occurrence.

Several principal sources are consulted and data are extracted, interpreted, summarised or reduced to code as necessary. These data are recorded on a single document prior to entry into the computer file. Main data sources are

-- National Mineral Inventory (NMI) - a card file developed within the Resource Strategy & Information Branch of the Mineral Policy Sector and described earlier in this report
-- Geological Survey Commodity Files. These are manual files maintained by commodity geologists at GSC
-- Publications of GSC and corresponding provincial agencies
-- Scientific and Trade Journals
-- Open-file reports by federal and provincial agencies
-- Assessment records on mining and exploration properties filed by industry in accordance with provincial and federal regulations
-- Existing computer files within GSC, provincial agencies and universities.

The Mineral Resource Information Services Group (five physical scientists) as well as acting as the compiler and curator of CANMINDEX provides programming services for other project files of the Division and maintains divisional library and reference services.

Mathematical Applications in Geology Section This Section (also known as the Geomathematics Section) headed by Dr F.P. Agterberg (Fritz) attempts to

-- develop and apply probablistic methods of mineral resource estimation for land-use planning applications
-- provide statistical expertise and services to projects throughout GSC
-- develop statistical exploration methods for use by the mineral industry.

These objectives are met by maintaining a long-range research program on mathematics and statistics applied to solve geological problems. Geostatistical techniques and systems of computer programs are prepared for use in projects normally carried out in collaboration with other GSC staff. The Section provides an invaluable fount of statistical expertise for research scientists in GSC which manifests itself in such areas as

-- frequency distribution modelling
-- multivariate statistics applied to geological data
-- geostatistical contouring techniques such as 'kriging'
-- statistical analysis of directional features

-- quantitative stratigraphic correlation techniques
-- computer simulation of geological processes.

The Section is staffed with five research scientists with an earth science/mathematical background although one, Dr C.F. Chung, is a straight mathematician.

Geological Information Division

The Division under Dr R.G. Blackadar (Bob) operates through six sections

-- Scientific Editing and Publication
-- Library
-- Data Systems Group
-- Cartography
-- Technical Photography
-- Publications Distribution

The Division is therefore responsible for ensuring that the results of the Branch - i.e. GSC - scientific programs are made available in a timely and effective way; maintaining the Library of the Geological Survey as the principal earth science library in Canada; managing the National GEOSCAN Centre which coordinates the activities of a Federal-Provincial bibliographic data base as it relates to bibliographic federal and provincial input of Canada-related geoscience literature; providing comprehensive drafting and cartographic services; providing a Branch public information service; and maintaining expertise and providing service in technical photography.

Editing and publication are along the lines of that practised in BMR. Dr Blackadar maintains that he has been able to reduce overall cost/page of publications by a total switch to word-processing procedures for text preparation, and by more efficient processing procedures - most material is sent to the printer as camera-ready copy.

The Data Systems Group is a small, select group (only three professionals) headed by Dr Phyllis Charlesworth. The group was established in 1974 and transferred to the Geological Information Division

in 1979. It provides specialist services to other divisions within GSC and advises senior management on computer use. It operates under the general umbrella of the Departmental (EMR) ADP, a centralised computer establishment in Ottawa.

Resource Geophysics and Geochemistry Division

The Division, under the directorship of Dr A.G. Darnley (Arthur) provides geophysical and geochemical information on a national systematic basis to assist in the discovery, evaluation and exploitation of Canada's mineral resources, and to improve the understanding of subsurface geology. This is achieved by undertaking R&D relating to existing and new methods of mineral exploration technology, data interpretation and presentation; by establishing systematic measurement and reporting standards for exploration geophysics and geochemistry; and by collecting, compiling and interpreting geophysical and geochemical data from national and regional surveys. The Division serves as a national centre for R&D into geophysical and geochemical methods relating to metalliferous exploration, regional, economic, environmental and engineering geology.

The geophysical activities of the Division revolve mainly about regional aeromagnetic surveys aimed at a complete coverage of the Canadian Shield; gradiometry surveys; detailed airborne radiometric surveys associated with programs under Federal-Provincial Agreements; downhole logging particularly with the GSC Induced Polarisation probe; and shallow reflection seismic work.

Operations of the Geochemistry Sub-Division were discussed with R.G. Garrett (Bob), Head of the Exploration Research Section. Much of the work of the Sub-Division is directed towards regional geochemical surveying and in geochemical surveys directed to resource assessment work in connection with Federal-Provincial Mineral Development Agreements. Geochemistry has proved to be a useful tool for the Regional Mineral Resource Assessment Section for mineral resource assessments of northern areas involving qualitative ratings of resource potential. Work of the sub-division is highly computerised and researchers in the sub-division have access to geostatistical expertise in the Mathematical Applications in Geology Section.

One of the interesting research projects undertaken by the Exploration Research Section is that of abundance model resource appraisal. The abundance method is used in similar fashion to deposit modelling. However, instead of comparing areas on a detailed geological scale, the comparison is made on the much larger scale of gross geological terrane. Similar terranes are identified, the model built and the area of known resources used to extrapolate resources inferred in the less known area. A more detailed account of th method appears in **Mathematical Geology**, Vol.10, No.5. **An Abundance Model Resource Appraisal for Some Canadian Commodities** by Robert G. Garrett.

Synthesis and Discussion

The groups with whom discussions were held within GSC - viz: Economic Geology and Mineralogy Division, Resource Geophysics and Geochemistry Division, and the Geological Information Division - are responsible mainly for investigation of mineral deposits and regional mineral resource evaluation and disseminatin of information on this work in a timely and effective manner. Continuing investigation of mineral deposits is achieved through field and laboratory studies with particular emphasis on major metal commodities such as copper, nickel, lead-zinc, gold, silver, iron, molybdenum and uranium, together with investigations of other commodities such as tin, tungsten, chromium, platinum group and rare-earth metals as strategic and economic priorities require. Investigations involve the application of specialised research techniques such as isotope studies, computer simulations, and mathematical and statistical correlation methods as aids to the interpretation of ore-forming mechanisms, and the development and application of methods, including geophysical, geochemical and mathematical methods to evaluate the potential of various geological regions to contain undiscovered mineral resources.

Responsibilities also include the development and maintenance of national information files, both manual and computerised, on Canadian mineral deposits and mineral deposit types. Tonnages and grade data for these deposits and others that are used in geological research are usually retrieved from published reserves and cumulative production figures in order to represent the size of the original deposit. The information entity - i.e. a naturally occurring geological deposit is therefore not

necessarily consistent with the mining property entity as produced by the Mineral Policy Sector in say, the National Mineral Inventory (NMI).

It should be noted that researchers in the Economic Geology and Geochemistry Division do not collect reserve/resource information or maintain information files as an agency mission. However, the GSC uses grade and tonnage information on mineral deposits for studies on mineral deposit modelling and regional mineral resource evaluation. CANMINDEX has been developed as an index level file on Canadian mineral occurrences with links to specialised files containing more geological information and which are used in GSC for research projects. Accumulation of information is use-oriented; files started for project work are entered in CANMINDEX, but files are not started with the main objective of enlarging CANMINDEX. In a regional mineral resource evaluation project - e.g. Project Appalachia, reserve/resource data are collated and combined with regional geology, metallogeny, geochemical and geomathematical concepts, and involves compilation of individual mineral files of a number of deposit types.

As part of the national database, the Division of Economic Geology and Mineralogy maintains and curates the Economic Geology Research Collections, an extensive collection of ore and host rocks samples representing a wide variety of Canadian mineral deposits and localities, as well as reference material from foreign deposits.

CONCLUSIONS AND RECOMMENDATIONS

In the United States, government is very conscious of strategic/critical minerals and emphasis of its mineral industry goals is on long-term supply and availability from domestic, and particularly, foreign sources. This emphasis (some would call it a fixation) carries through to relevant policy areas in both the USBM and the USGS, and is reflected in relatively generous funding for such projects as Minerals Availability System (MAS), Conterminous United States Mineral Availability Program (CUSMAP), and the Wilderness Lands Program.

In the USBM, the objective of obtaining basic data on minerals (both domestic and foreign) and interpreting it is met by the detailed work of

commodity specialists (both domestic data and international minerals groups); economic analysis and projection of the data is the responsibility of the Mineral Data Analysis Office. USGS is also heavily involved in mineral availability/assessment projects which take the form of development of mineral deposit models; development of mineral resource assessment techniques; joint reports of USGS/USBM on mineral potential of land for inclusion in the Wilderness Program; and USGS systematic geological mapping and research in connection with CUSMAP. These programs ensure that sufficient mineral resource potential information is available to land planners and to Congress on which to make informed decisions. USBM interests are directed more towards identified resources, the economics of developing and mining these resources, and future supply/demand balance. USGS thrust is directed more towards geological aspects of potential resources and their extent.

In Canada, as in Australia, the mineral industry is very much export oriented, despite the large mineral market south of its border. As a result, Canada is very conscious of its competitive position as a producer/exporter/processor of minerals and availability of its mineral resources to meet both domestic and particularly export demand. Also the minerals industry in Canada is a much larger contributor to the national economy than is the case in US. Nevertheless, the approach to mineral resource assessment and availability is broadly the same in both countries - data collection, interpretation and economic analysis, inventory of known resources and assessment of mineral potential. In both countries long-term implications of non-renewable resource depletion have caused re-examination of mineral endowments and national policies on minerals. This has required Federal bodies to publish expanded information on mineral resource availability and has resulted in an improved geological knowledge base to meet requests for information by policymakers; consciousness in communicating mineral data to policymakers in a comprehensible form; increased analysis of mineral related data; and concern over the capacity of Federal agencies to predict trends and potential crises, and to identify policy issues.

On balance, Canada appears to be more proactive in its attitudes to these issues at a Federal Government level and more effective in long-term planning. To some extent this reflects the constitutional framework that

encourages provincial interest in policy-oriented research cooperation resulting from the Federal-Provincial Committee on Mineral Statistics, and the general cooperation between EMR, Provincial Departments of Mines and Geological Surveys, and the mining industry; and at the Federal Government level aggregation of responsibilities for particular policy areas. On the other hand, the US by weight of numbers, if for no other reason, has an enviable record of achievement in mineral resource assessment, mainly the result of long-term projects such as CUSMAP and the Wilderness Lands Program.

The experience of the two countries in coping with geoscience/mineral industry/resource assessment challenges, and their strengths and weaknesses in these areas, can be used profitably by BMR to improve its efficiency and effectiveness particularly in the organisation of the Minerals Branch in the following areas.

Mineral Industry Statistics. Both the US and Canada have continuing difficulty in obtaining basic statistics on the mineral industry as comprehensive and as quickly as they would wish. I do not think it feasible for us to follow the US line and have commodity specialists and statistical assistants responsible for the distribution, collection and compilation of mineral census questionnaires. Nor does it seem practical within our organisational structure to follow the Canadian system where the Mining Census group within the Mineral Policy Sector cooperates with Departments of Mines in the provinces, and Statistics Canada to achieve the same end. However, I suggest that we initiate discussions between BMR, ABS and State Departments of Mines with a view to achieving more direct contact between BMR and Mines Departments on mineral statistics matters and more direct involvement of our commodity specialists in the statistical collection process.

Publications. In common with Australia, the standard publication of the mineral industry in US and Canada is the **Mineral Yearbook** cf, **Australian Mineral Industry Annual Review (AMIAR)**. Timely availability of statistics, meeting of deadlines for preparation of manuscript, availability and responsibility of editors, method and quality of printing to meet deadlines, direct and indirect contact with the printer are recurring themes in any discussion on the subject. In both USA and Canada positive steps are being

taken to speed up publication of their respective Yearbooks, and I recommend that procedures recently adopted by the Mineral Policy Sector of the Canadian Department of Energy, Mines and Resources be considered in discussions on future trends of Mineral Branch publications particularly in connection with the AMIAR and Quarterly Reviews.

Mineral Commodity Studies. Commodity studies remain the basis of documentation and analysis of the mineral industry, and commodity specialists in the USBM and commodity analysts in the Canadian EMR have functions similar to those of our commodity specialists in the Minerals Branch. However, it is unrealistic, with our staff numbers, to expect a coverage of the Australian mineral industry comparable to that of Canada or the US. The Minerals and Metals Strategic Branch of the Mineral Policy Sector which monitors the Canadian mineral industry is staffed with 20 commodity analysts excluding those in the International Minerals Relations Division; commodity specialists of the Mineral Information Directorate of USBM number about 60 excluding those in the International Minerals Division. On the other hand, I would not wish to see our commodity specialists not involved in the assessment of identified mineral resources (as is the case in Canada), not divorced from policy implications of their work (as is the case in USBM). I therefore recommend that commodity specialists in the Minerals Branch of BMR

- -- continue to monitor the Australian mineral industry as of now with perhaps more in-depth study on production, consumption and use of scrap metal
- -- continue to monitor the level of, and classify, the identified resources of their commodities
- -- maintain a two-way flow of intelligence between BMR and the mineral policy officers in the Coal and Minerals Division of the Department of Resources and Energy, and in other Commonwealth and State departments and agencies
- -- receive increased support on the technical/economic analysis of mineral exploration and special facets of the mineral industry by the recruitment of experts in those fields.

Economic Analysis of the Mineral Industry. While commodity studies are recognised as the basis for documentation and day-to-day analysis of the mineral industry, both Canada and US have developed a more sophisticated

economic approach to the long-term problems of the industry in a national context. In the USBM expertise is centred in the Mineral Data Analysis directorate of Dr Hermann Enzer and covers economic analysis, policy analysis and technical analysis. In the Canadian EMR such analysis is distributed between Keith Brewer's Economic and Financial Policy Analysis Branch and Bob Shanks' Resource Strategy and Information Branch. These groups provide fundamental contributions to in-depth analysis of the mineral industry in their respective countries and are largely responsible for economic advice included in the long-term policymaking process. These particular functions are now being developed in the Central Office of our Department. However, there is also a requirement for professionals with geoscientific/economic background and experience in the mineral industry to provide in-depth technical/economic studies of special facets of the industry including such projects as the rates and costs of exploration and discovery of ore in Australia along the lines of those undertaken by Don Cranstone in the Canadian Resource Policy division. I recommend that we continue our attempts to recruit suitably qualified and experienced staff for the Assessment Research Section of the Mineral Commodities Branch to fill this gap in our comprehensive coverage of the mineral industry.

Mineral Resource Assessment. In most developed countries there is growing awareness of the need to establish not only the extent of economic demonstrated resources and other subeconomic identified resources, but also the potential for undiscovered mineral resources. The extent of the nation's 'mineral endowment' is now regarded as essential for resource management, decisions on competing land use, and general resourcepolicy formulation. In the US and Canada assessment of the nation's mineral resources has been allotted a high priority and in the public sector of earth science research considerable effort is being directed towards qualifying and quantifying the extent of the nation's undiscovered mineral resources - by the Office of Mineral Resources in USGS, and in the Economic Geology Division in GSC.

In BMR considerable progress has been made in classifying and quantifying identified mineral resources; the results of this work are tabulated and published annually. Perhaps there is scope to formalise the activity along the lines of the National Mineral Inventory and the Mineral Resources and supply publications as produced by the Resource Strategy and

Information Branch of the Mineral Policy Sector of EMR. However, although BMR is already involved in the estimation of undiscovered petroleum and uranium resources, no parallel research has been mounted for other minerals. While the scale of effort directed to this area in the US and Canada is well beyond the resources of BMR, it is suggested that expertise already available within BMR be augmented with additional expertise on mineral deposit geology and geostatistics and that an ad hoc team be made available to react to requests for information on mineral potential of specific areas particularly where questions on competing land use need to be resolved.

APPENDIX 1.

ITINERARY - J. WARD

A.P.S. SENIOR EXECUTIVE FELLOWSHIP (9 APRIL-23 JUNE), 1985

USA

Washington, DC (10/4-3/5

- Office of Mineral Information
  - Division of Nonferrous metals
  - Division of Industrial Metals
  - Division of Ferrous Metals
  - Division of International Minerals
- Office of Mineral Data Analysis
  - Special Projects Group
  - Division of Atate Activities
  - Division of Mineral Land Management
  - Minerals Policy & Analysis
  - Division of Minerala Availability
  - Division of Minerals Information Systems
  - Division of Technical Information
- Senior Adviser to Director
- Congressional Liaison

DEPARTMENT OF STATE

- Industrial & Strategic Materials Division

DEPARTMENT OF THE INTERIOR

- Bureau of Land Management
- Minerals Management Service

Reston, Va (6/5-10.5

USGS (Geologic Division)

- Office of Mineral Resources
  - Branch of Resource Analysis
  - Branch of Eastern Mineral Resources
  - Branch of Coal Resources
- Office of Chief Geologist
- Office of Scientific Publications

CANADA

Ottawa, Ontario (13/5-3/6) — Department of Energy, Mines & Resources

- Mineral Policy Sector
  - Minerals and Metals Strategy Branch
  - Economic & Financial Policy Analysis Branch
  - Resource Strategy & Information Branch
- Canada Centre for Mineral and Energy Technology (CANMET)
- Geological survey of Canada
  - Economic Geology and Mineralogy Division
  - Resource Geophysics and Geochemistry Division
  - Geological Information Division

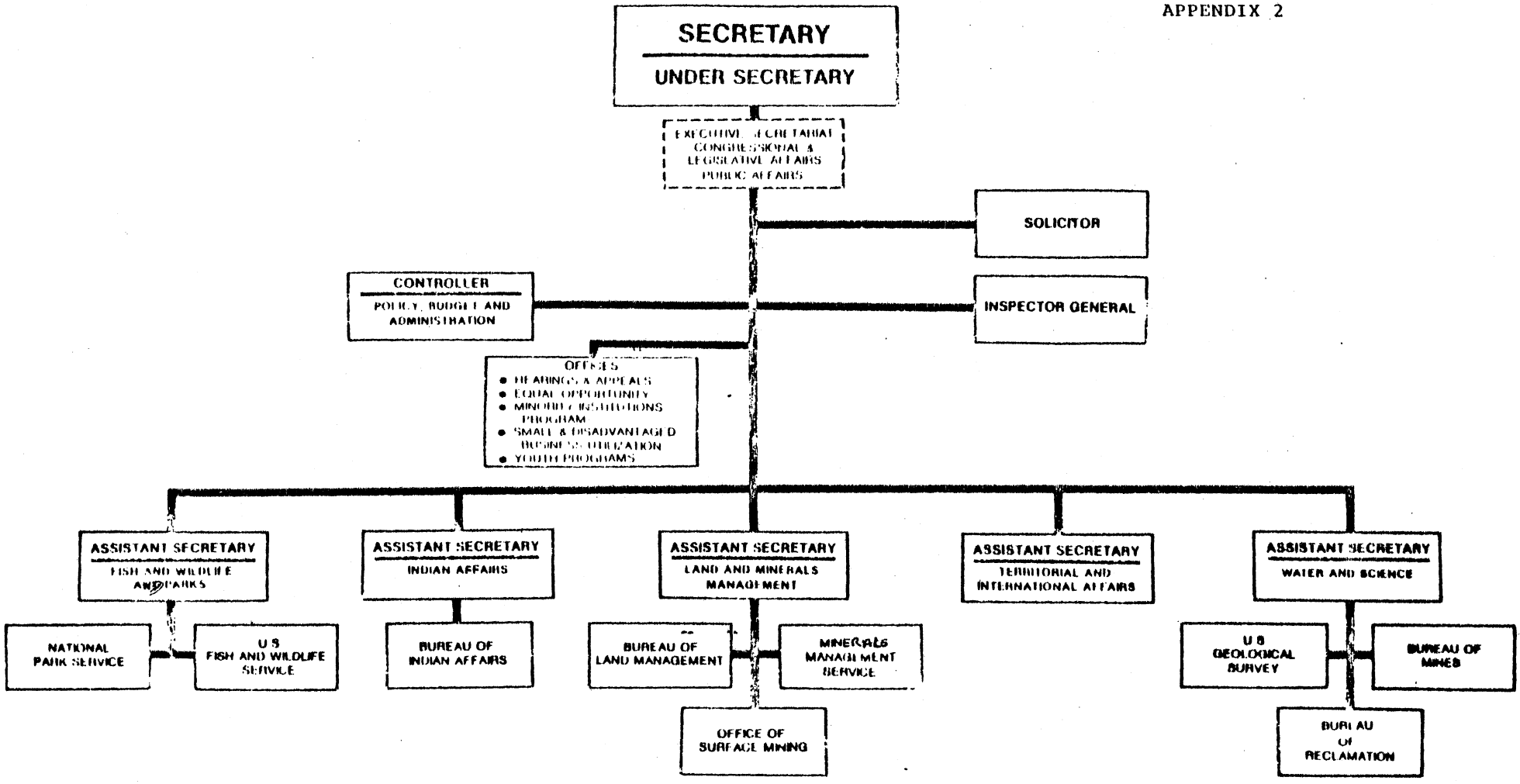
USA

Denver, Colorado (5/6-14/6)

- Mineral Availability Field Office
  - Engineering Feasibility & Economic Evaluation Section
  - System Support Group
- Office of Mineral Resources
  - Central Mineral Resources Branch
  - Exploration Geochemistry Branch
  - Branch of Resource Analysis

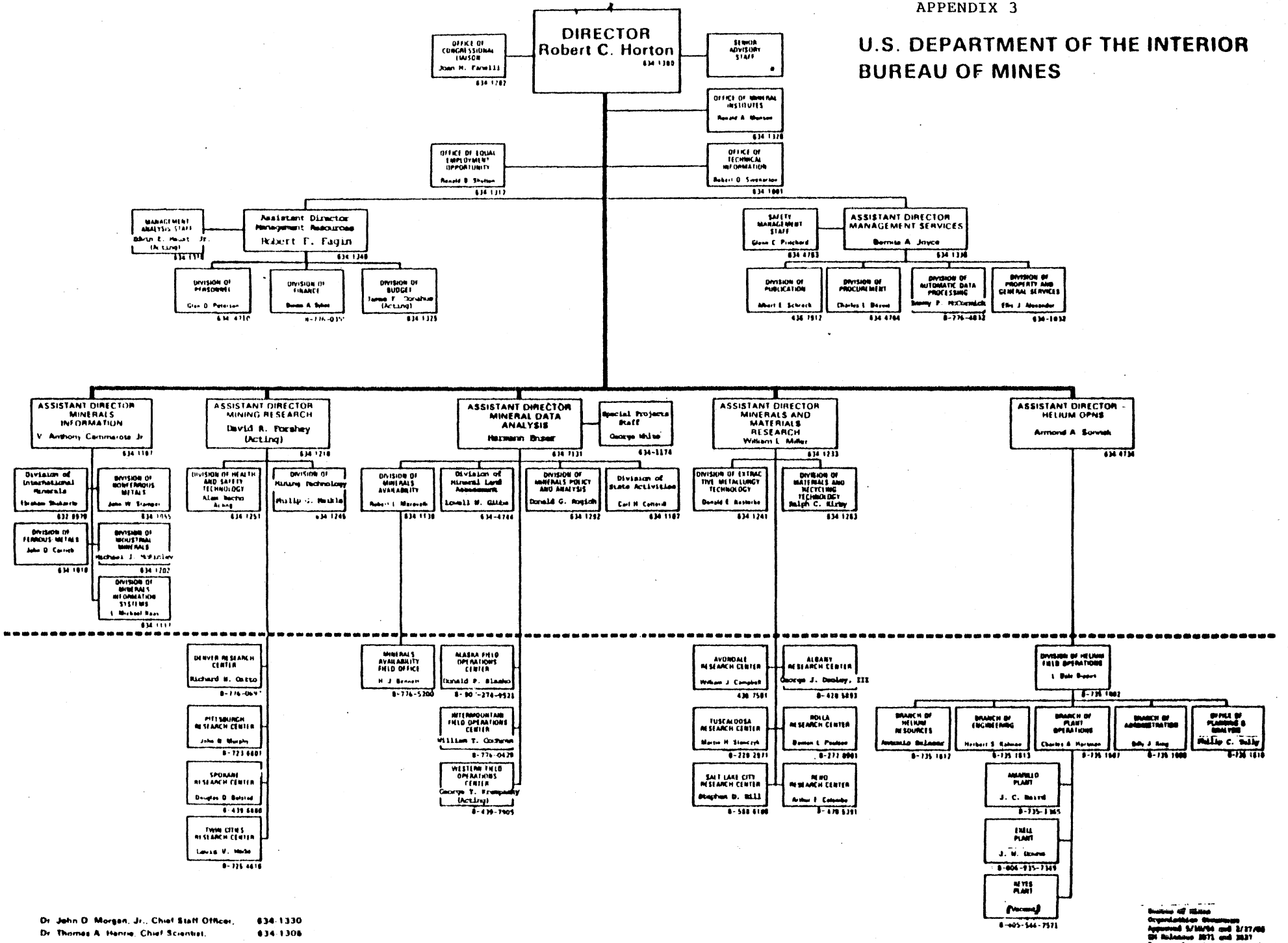
Menlo Park, Ca (17/6-21/6)

- Office of Mineral Resources
  - Branch of Resource Analysis
  - Western Mineral Resources Branch



GENERAL ORGANIZATION
U.S. DEPARTMENT OF THE INTERIOR
MAY 1984

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF MINES



Dr. John D. Morgan, Jr., Chief Staff Officer, 634-1330
Dr. Thomas A. Henrie, Chief Scientist, 634-1308
Gordon N. Miner, Chief Mining Engineer 634-1303

Bureau of Mines
Organization Structure
Approved 5/18/94 and 3/27/96
BM Release 3871 and 3837
Personnel assignments as of 3/27/96

APPENDIX 4

February 8, 1985

BUREAU OF MINES
2401 E Street, NW
(202) 634 + EXT.
DIRECTORY OF SPECIALISTS

John D. Corrick, Chief, Division of Ferrous Metals, (F), Ext. 1010, Rm. 667
H. V. Makar, Chief, Branch of Iron and Steel, Ext. 1014, Rm. 662
S. F. Sibley, Chief, Branch of Refractory Metals, Ext. 1020, Rm. 660
S. Guerrino, Chief, Branch of Ferrous Metals Data, Ext. 1017, Rm. 672
John W. Stamper, Chief, Division of Nonferrous Metals, (NF), Ext. 1055, Rm. 703
W. Butterman, Chief, Branch of Copper and Precious Metals, Ext. 1072, Rm. 725
H. Kurtz, Chief, Branch of Light and Base Metals, Ext. 1085, Rm. 755
B. Carrico, Chief, Branch of Nonferrous Metals Data, Ext. 1101, Rm. 716
Michael J. McKinley, Chief, Division of Industrial Minerals, (IM), Ext. 1202, Rm. 870
R. Singleton, Chief, Branch of Construction Materials, Ext. 1180, Rm. 805
S. Absalom, Chief, Branch of Chemical Materials, Ext. 1190, Rm. 851
B. Gunn, Chief, Branch of Industrial Minerals Data, Ext. 4770, Rm. 865

Commodity	Specialist	Division	Ext.	Room
Abrasive Materials	J. Fletcher Smoak	IM	1206	883
Aluminum (Al)	Frank X. McCawley	NF	1080	757
Antimony (Sb)	*Patricia Plunkert	NF	1083	767
Arsenic (As)	Dan L. Edelstein	NF	1053	711
Asbestos	Robert A. Clifton	IM	1206	880
Asphalt Natural	Wilton Johnson	IM	1184	876
Barium (Ba)	Sarkis G. Ampian	IM	1180	878
Bauxite	Luke Baumgardner	NF	1081	759
Beryllium (Be)	Deborah A. Kramer	NF	1083	760
Bismuth (Bi)	*James F. Carlin	NF	1073	763A
Boron (B)	Phyllis A. Lyday	IM	1177	847
Bromine (Br)	Phyllis A. Lyday	IM	1177	847
Cadmium (Cd)	Patricia Plunkert	NF	1083	767
Calcium (Ca) & Ca Comps	Lawrence Pelham	IM	1177	853
Cement	Wilton Johnson	IM	1184	876
Cesium (Cs)	William T. Adams	NF	1082	717B
Chromium (Cr)	John Papp	F	1028	675
Clays	Sarkis G. Ampian	IM	1180	878
Cobalt (Co)	William S. Kirk	F	1028	675
Columbium (Cb)	Larry Cunningham	F	1024	657
Copper (Cu)	Janice L. Jolly	NF	1071	712
Corundum-Emery	J. Fletcher Smoak	IM	1206	883

* Acting

Commodity	Specialist	Division	Ext.	Room
Diamond, Industrial	J. Fletcher Smoak	IM	1206	883
Diatomite	Arthur C. Meisinger	IM	1184	872
Explosives	Charles L. Davis	IM	1190	839
Feldspar	Michael J. Potter	IM	1180	881
Ferroalloys	Ray Brown	F	1015	665
Fluorspar	Lawrence Pelham	IM	1177	853
Fused Alumina	J. Fletcher Smoak	IM	1206	883
Gallium (Ga)	Deborah A. Kramer	NF	1083	760
Garnet	J. Fletcher Smoak	IM	1206	883
Gemstones	Jean W. Pressler	IM	1206	871
Germanium (Ge)	Patricia Plunkert	NF	1083	767
Gold (Au)	John M. Lucas	NF	1070	709
Graphite	Harold A. Taylor	IM	1180	882
Greensand	James P. Searls	IM	1190	845
Gypsum	Jean W. Pressler	IM	1206	871
Hafnium (Hf)	William T. Adams	NF	1082	717B
Helium (He)	**Phillip C. Tully	AC.806	376-2604	939
Indium (In)	*James F. Carlin	NF	1073	763A
Iodine (I)	Phyllis A. Lyday	IM	1177	847
Iron Ore	Fredrick L. Klinger	F	1023	653
Iron Oxide Pigments	William I. Spinrad, Jr.	F	1019	671
Iron & Steel	Frederick J. Schottman	F	1022	658
Iron & Steel Scrap	Franklin D. Cooper	F	1022	656
Iron & Steel Slag	Donald P. Mickelsen	F	1023	651
Kyanite-Mullite	Michael J. Potter	IM	1180	881
Lead (Pb)	William D. Woodbury	NF	1083	765
Lime	Jean W. Pressler	IM	1206	871
Lithium (Li)	John Ferrell	IM	1177	855
Magnesium (Mg) & MG Comps	Deborah A. Kramer	NF	1083	760
Manganese (Mn)	Thomas S. Jones	F	7091	663
Mercury (Hg)	Linda Carrico	NF	1082	717
Mica	Lawrence L. Davis	IM	1184	879
Molybdenum (Mo)	John Blossom	F	1021	661
Nickel (Ni)	Peter G. Chamberlain	F	1025	654
Nitrogen (N)	Charles L. Davis	IM	1190	839
Peat	Charles L. Davis	IM	1190	839
Perlite	Arthur C. Meisinger	IM	1184	872
Phosphate Rock	William F. Stowasser	IM	1190	841

**Division of Helium Field Operations
1100 South Fillmore
Amarillo, Texas 79101

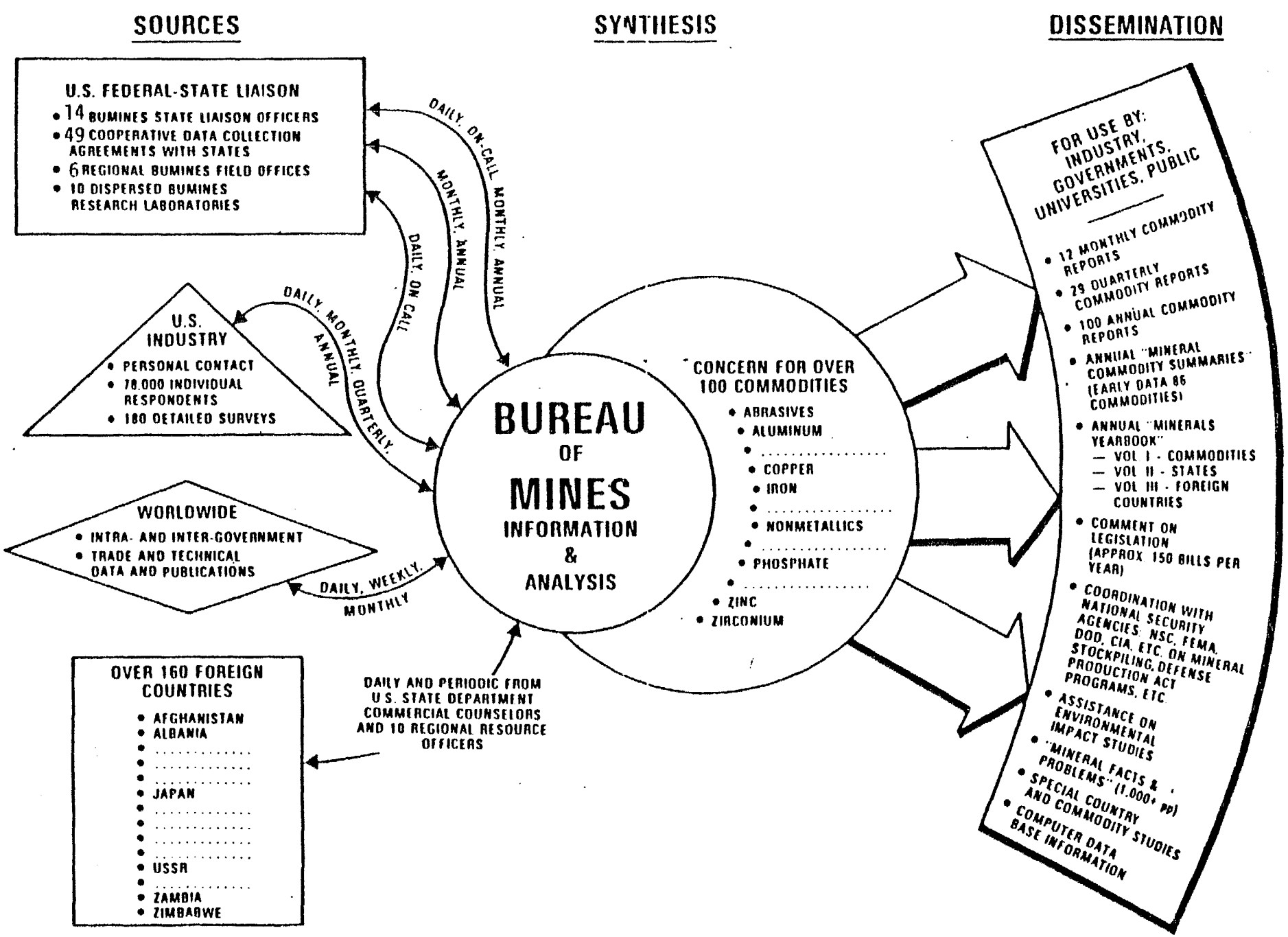
*Acting

Commodity	Specialist	Division	Ext.	Room
Platinum (Pt) Group Metals	J. Roger Loebenstein	NF	1058	707
Potash	James P. Searls	IM	1190	845
Pumice	Arthur C. Meisinger	IM	1184	872
Quartz Crystal	John Ferrell	IM	1177	855
Rare Earths	James B. Hedrick	NF	1082	717A
Resource Sepcialist	Neldon L. Jenson	NF	1063	763
Rhenium (Re)	John Blossom	F	1021	661
Rubidium (Rb)	William T. Adams	NF	1082	717B
Salt	*David Morse	IM	1177	843
Sand & Gravel	Lawrence L. Davis	IM	1184	879
Sand, industrial	Valentin V. Tepordei	IM	1185	874
Selenium (Se)	Dan L. Edelstein	NF	1053	711
Silicon (Si)	Gerald E. Murphy	F	1024	647
Silicon Carbide (Abrasive)	J. Fletcher Smoak	IM	1206	883
Silver (Ag)	Robert Reese	NF	1054	713
Sodium Compounds	*James P. Searls	IM	1177	845
Staurolite	Harold A. Taylor	IM	1180	882
Stone, crushed	Valentin V. Tepordei	IM	1185	874
Stone, dimension	Harold A. Taylor	IM	1180	882
Strontium (Sr)	John Ferrell	IM	1177	855
Sulfur (S)	David Morse	IM	1190	843
Talc	Robert A. Clifton	IM	1206	880
Tantalum (Ta)	Larry Cunningham	F	1024	657
Tellurium (Te)	Dan L. Edelstein	NF	1053	711
Thallium (Tl)	*Patricia Plunkert	NF	1083	767
Thorium (Th)	James B. Hedrick	NF	1082	717A
Tin (Sn)	James F. Carlin	NF	1073	763A
Titanium (Ti)	Langtry E. Lynd	NF	1073	761
Tripoli	J. Fletcher Smoak	IM	1206	883
Tungsten (W)	Philip T. Stafford	F	1029	659
Vanadium (V)	Peter H. Kuck	F	1021	666
Vermiculite	Arthur C. Meisinger	IM	1184	872
Wollastonite	Michael J. Potter	IM	1180	881
Yttrium (Y)	James B. Hedrick	NF	1082	717A
Zeolite	Robert A. Clifton	IM	1206	880
Zinc (Zn)	James Jolly	NF	1063	755B
Zirconium (Zr)	William Adams	NF	1082	717B

*Acting

WORLD-WIDE MINERAL INFORMATION

APPENDIX 5



BUREAU OF MINES MINERALS INFORMATION PUBLICATIONS

The minerals data that have been collected, validated, processed, and stored in Bureau of Mines data bases are utilized to produce several series of publications. These publications address the information needs of a wide variety of users of Bureau information.

According to a 1980 study, the principal classes of users of Bureau of Mines minerals information publications the dominant professions represented and the percentage of Bureau readership are:

Classes of Users		Professions	
Mining and Exploration	20%	Scientist/Engineer	22%
Government Agencies	12%	Company Officer	18%
Other manufacturing	12%	Market Specialist	14%
Metal Processing	8%	Librarian	12%
Universities and Colleges	8%	Economist	9%

The "Minerals Yearbook" is an annual three-volume publication that summarizes the economic and technologic developments of the mineral industries. Statistics on production, trade, consumption, and other pertinent economic variables are included. The mineral industries are covered by commodities (Volume I) and by geographic area (U.S. States and Island possessions in Volume II and foreign countries and area in Volume III).

"Mineral Facts and Problems" is a one-volume reference book containing worldwide production information and demand forecasts for all nonfuel minerals. It is published every 5 years. Each commodity chapter covers the structure of the industry, uses of the commodity, reserves and resources, technology, supply-demand relationships, byproducts and coproducts, strategic considerations, economic and operating factors, and forecasts. Each chapter also compares U.S. and world reserves with cumulative demand to appraise the adequacy of world mineral supplies.

The "Mineral Industry Surveys" series includes brief monthly, quarterly, and annual reports that contain timely statistical and economic data on nonfuel mineral commodities. They are designed to keep Government agencies, the minerals industries, and the business community regularly informed of trends in production, distribution, inventories, and consumption of nonfuel minerals.

"Mineral Commodity Summaries" is an annual overview of mineral data. It furnishes the earliest published estimates of resources, reserves, production, imports, exports, use, recycling, substitution, environmental considerations and related subjects. Published in January, it covers approximately 90 mineral commodities for the previous calendar year.

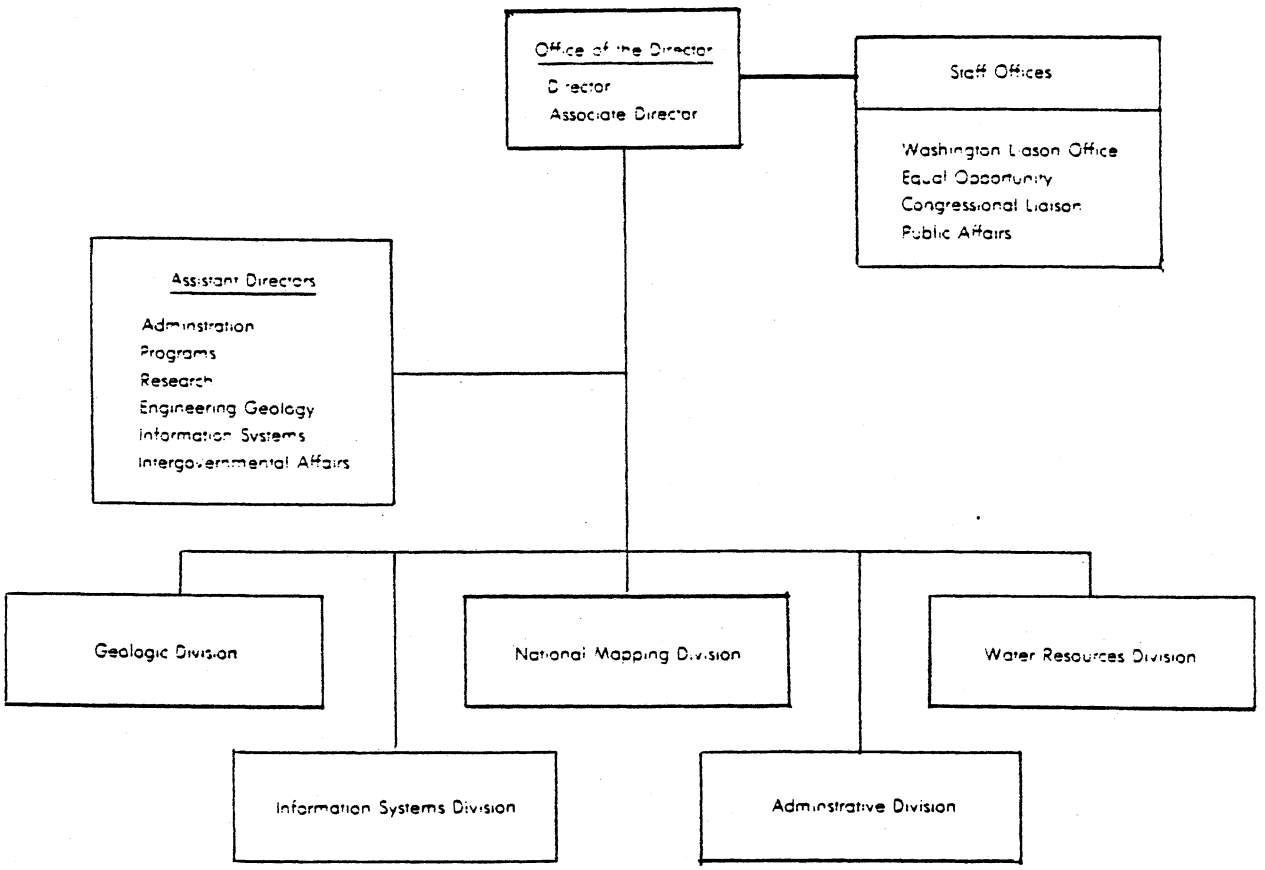
The "Mineral Commodity Profile" series presents the latest data on important strategic minerals including background material on industry structure, technology, reserves, timely economic data, and forecasts of future supply-demand relationships. These commodity-specific publications serve as updates to "Mineral Facts and Problems" and are issued in the middle years of the "Mineral Facts and Problems" five-year cycle.

The "Mineral Perspectives" series reports on the mineral resources, industries, and related infrastructure of those foreign sources (individual countries or regions on the world) that assume major importance to our nation's mineral needs.

"Minerals and Materials/A bimonthly Survey" provides timely information on selected commodities. Data and analyses are presented that are germane to policy issues of current interest. Brief narratives are supplemented by statistical graphs and tables. An economic analysis of the status of the mineral industry and articles focusing on major mineral issues are presented in each issue.

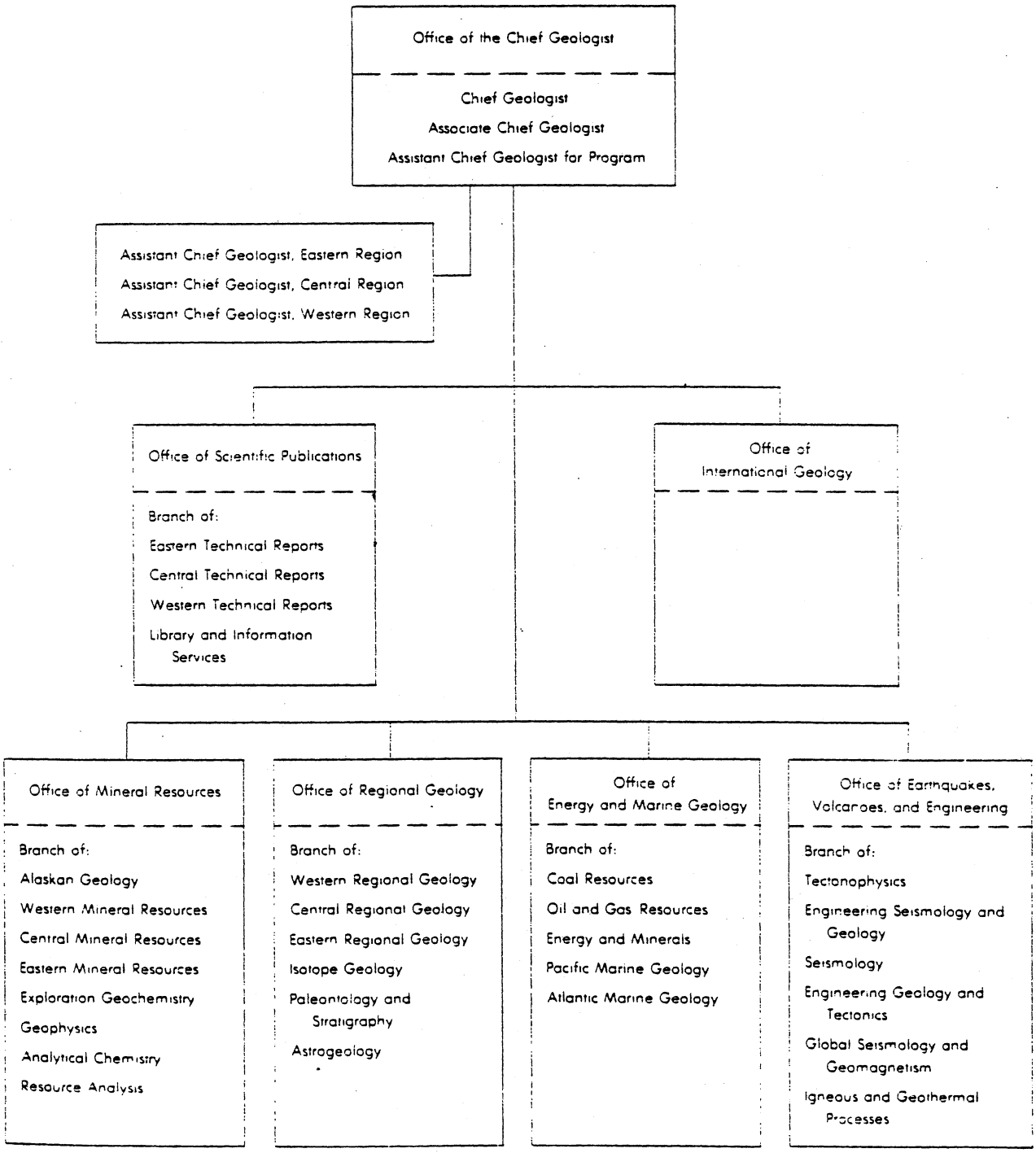
APPENDIX 7

ORGANIZATION OF THE GEOLOGICAL SURVEY



APPENDIX 8

ORGANIZATION OF THE GEOLOGIC DIVISION



APPENDIX 8a

ORGANIZATION OF THE GEOLOGIC DIVISION - MARCH 1985

Office of the Chief Geologist

Chief Geologist - Robert M. Hamilton
Associate Chief Geologist - William Cannon (acting)
Assistant Chief Geologist for Program - Benjamin A. Morgan
Deputy Chief Geologist for Scientific Personnel - Penelope M. Hanshaw
Policy and Budget Officer - Norman E. Gundersen
Administrative Officer - Elwood H. Like
Information Systems Coordinator - J. Nicholas Van Driel

Assistant Chief Geologist, Eastern Region - Bruce R. Doe
Assistant Chief Geologist, Central Region - Harry A. Tourtelot
Assistant Chief Geologist, Western Region - Carroll Ann Hodges

Office of Earthquakes, Volcanoes, and Engineering

Chief - John R. Filson
Deputy Chief for Research Applications - Walter W. Hays
Deputy Chief for Plans and Programs - Darrell G. Herd
Deputy Chief for Research - David P. Russ
Deputy Chief for Volcanic Hazards and Geothermal (sic) - Donald W. Klick
Deputy for External Research - Elaine R. Padovani
Administrative Officer - William E. Phelps

Chief, Branch of Tectonophysics - Wayne R. Thatcher
Chief, Branch of Engineering Seismology and Geology - Thomas C. Hanks
Chief, Branch of Seismology - William L. Ellsworth
Chief, Branch of Engineering Geology and Tectonics - Albert M. Rogers
Chief, Branch of Global Seismology and Geomagnetism - Robert P. Masse
Chief, Branch of Igneous and Geothermal Processes - L. J. Patrick Muffler

Office of Energy and Marine Geology

Chief - Terry W. Offield
Associate Chief - Gary W. Hill
Assistant Chief - Robert L. Rioux
Assistant Chief for Programs - Paul G. Teleki
Deputy Chief for Coal Programs - Stanley P. Schweinfurth
Deputy Chief for Marine Programs/Government Liaison - Robert W. Rowland
Deputy Chief for Oil and Gas Programs - John B. Roen
Staff Geologist, Offshore Mining - Michael J. Cruickshank
Staff Geologist, Contracts & Grants - Valentine E. Zadnik
Administrative Officer - Joseph S. Pillara

Chief, Branch of Coal Resources - (vacant)
Chief, Branch of Oil and Gas Resources - Dudley D. Rice
Chief, Branch of Energy Minerals - Thomas D. Fouch
Chief, Branch of Pacific Marine Geology - David G. Howell
Chief, Branch of Atlantic Marine Geology - William P. Dillon

Office of International Geology

Chief - A. Thomas Ovenshine
Associate Chief - William R. Greenwood
Deputy Chief, Latin American Geology - Richard D. Krushensky
Deputy Chief, Middle Eastern Geology - Anthony P. Stanin
Deputy Chief, Asian and Pacific Geology - Maurice J. Terman
Special Assistant for Program Coordination - Lee L. Benton
Administrative Officer - Helen P. Willingham
International Training and Visiting Scientist Section - Olga H. Marinenko

Office of Mineral Resources

Chief - Glenn H. Allcott
Associate Chief - Gary R. Winkler
Deputy Chief for Wilderness Programs - (vacant)
Deputy Chief for Development of Assessment Techniques Programs - Charles G. Cunningham
Deputy Chief for CUSMAP Program - Gary C. Curtin
Deputy Chief for Strategic and Critical Minerals Program - (vacant) John N. Dalton, Jr.
Deputy Chief for Geophysics - Gary L. Raines
Staff Geologist for BLM Programs - Susan M. Marcus
Administrative Officer - Douglas K. Fridrich

Chief, Branch of Alaskan Geology - Thomas P. Miller
Chief, Branch of Western Mineral Resources - Edwin H. McKee
Chief, Branch of Central Mineral Resources - Charles H. Thorman
Chief, Branch of Eastern Mineral Resources - Bruce R. Lipin
Chief, Branch of Exploration Geochemistry - Byron E. Berger
Chief, Branch of Geophysics - Frank Frischknecht
Chief, Branch of Analytical Chemistry - Philip A. Baedecker
Chief, Branch of Resource Analysis - Lawrence J. Drew

Office of Regional Geology

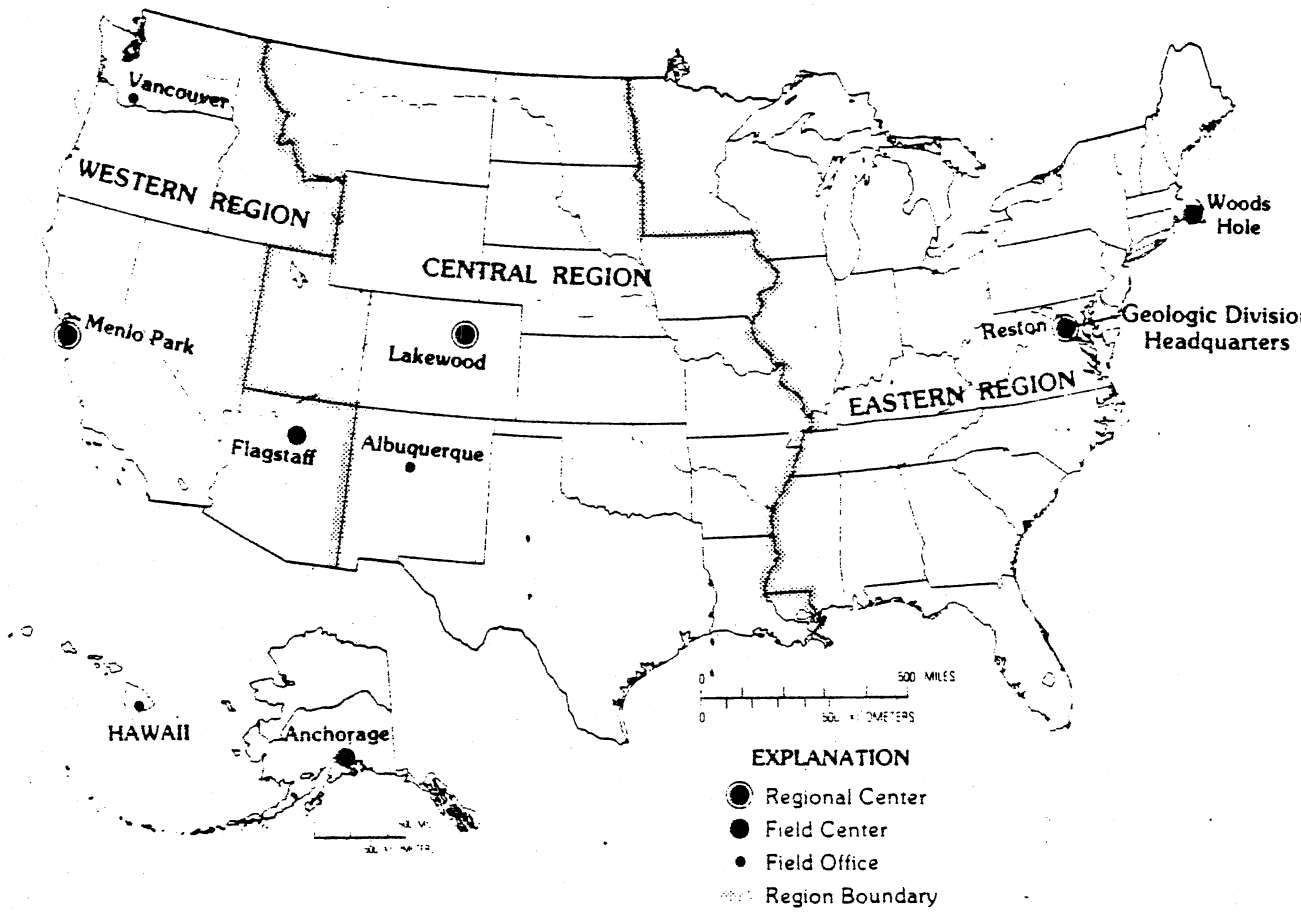
Chief - Eugene H. Roseboom
Associate Chief - (vacant)
Deputy Chief for Radwaste Program - Newell J. Trask
Deputy Chief for Climate Program - Richard Z. Poore
Deputy Chief for Reactor Hazards and Geologic Framework Programs - Fred K. Miller
Deputy Chief for Program Development - Juergen Reinhardt
Administrative Officer - Scott E. Tilley

Chief, Branch of Western Regional Geology - Robert O. Castle
Chief, Branch of Central Regional Geology - Kenneth A. Sargent
Chief, Branch of Eastern Regional Geology - Gregory S. Gohn
Chief, Branch of Isotope Geology - Robert E. Zartman
Chief, Branch of Paleontology and Stratigraphy - Richard Z. Poore
Chief, Branch of Astrogeology - Gerald G. Schaber

Office of Scientific Publications

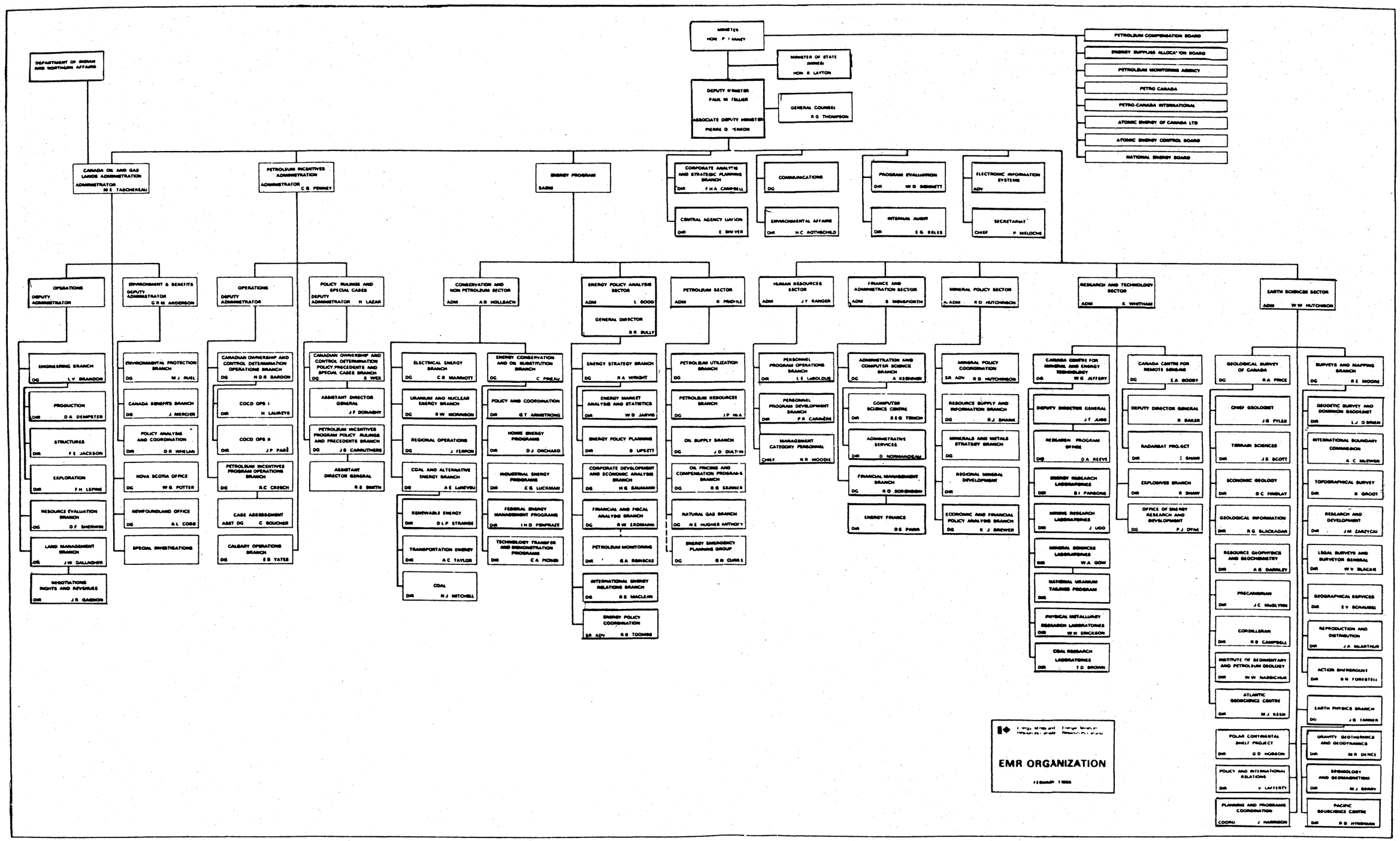
Chief - John M. Aaron
Associate Chief - Henry R. Spall
Deputy Chief for Publications Management - Tree Smith
Staff Geologist - Clifford M. Nelson
Staff Scientist - John R. Keith
Administrative Officer - Gladys A. Anderson

Chief, Branch of Eastern Technical Reports - James E. Fassett
Chief, Branch of Central Technical Reports - David Schleicher
Chief, Branch of Western Technical Reports - Lawrence F. Rooney
Chief, Branch of Library and Information Services - George H. Goodwin



Locations and regional boundaries of major Geologic Division offices.

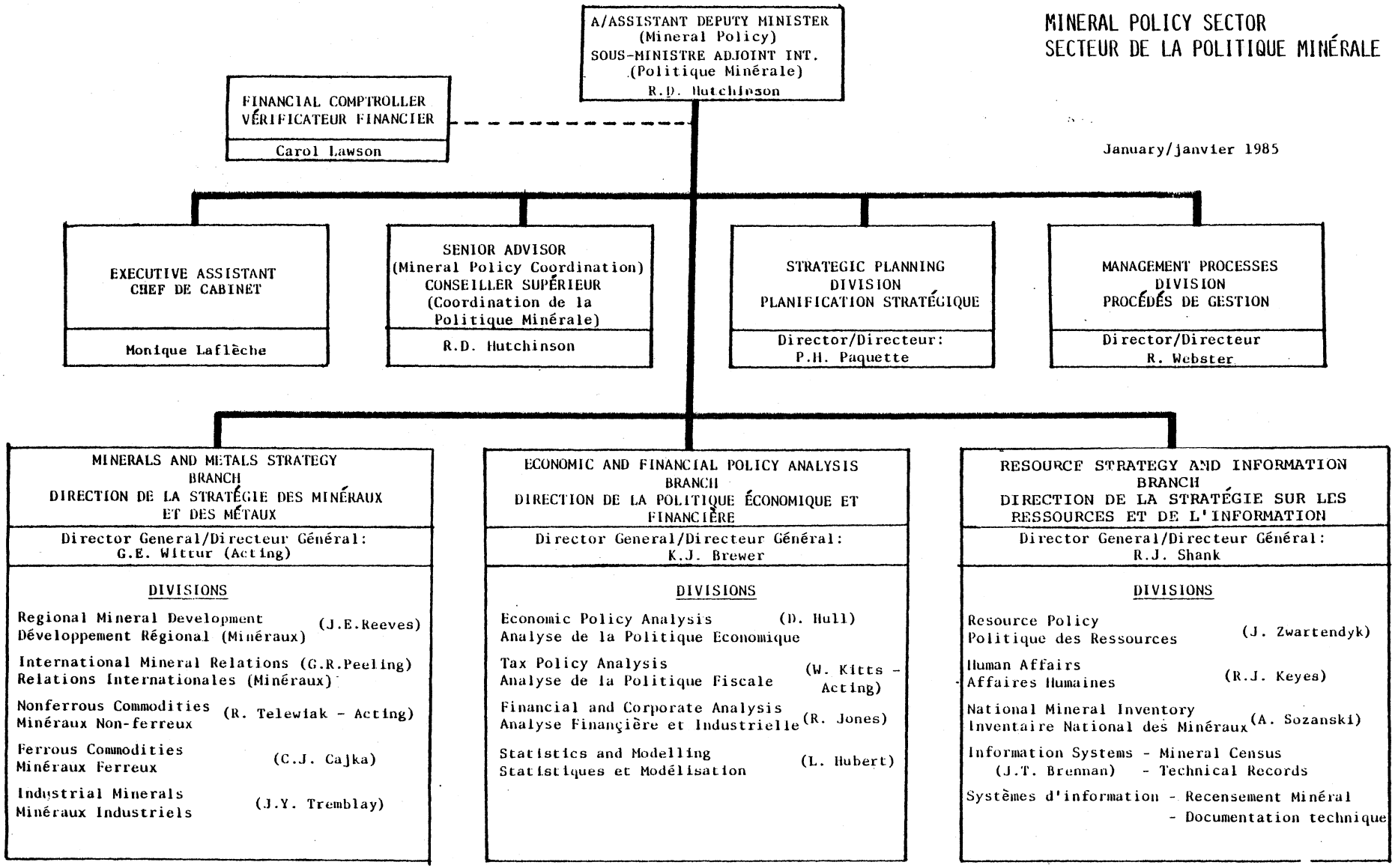
APPENDIX 10


DEPARTMENT OF ENERGY MINES AND RESOURCES
MINISTER
HON P J AMEY
MINISTER OF STATE (MINES)
HON R LAYTON
DEPUTY MINISTER
PAUL M FELLER
ASSOCIATE DEPUTY MINISTER
PIERRE O TÉMION
GENERAL COUNSEL
R G THOMPSON
PETROLEUM COMPENSATION BOARD
ENERGY SUPPLIES ALLOCATION BOARD
PETROLEUM MONITORING AGENCY
PETRO CANADA
PETRO-CANADA INTERNATIONAL
ATOMIC ENERGY OF CANADA LTD
ATOMIC ENERGY CONTROL BOARD
NATIONAL ENERGY BOARD
CANADA OIL AND GAS LANDS ADMINISTRATION
ADMINISTRATOR
M E TASCHEREAU
PETROLEUM INCENTIVES ADMINISTRATION
ADMINISTRATOR
C B PENNEY
ENERGY PROGRAM
BARRIS
CORPORATE ANALYSIS AND STRATEGIC PLANNING BRANCH
DIR F H A CAMPBELL
COMMUNICATIONS
DG
PROGRAM EVALUATION
DIR W D BENNETT
ELECTRONIC INFORMATION SYSTEMS
ADV
CENTRAL AGENCY LIAISON
DIR E SHUVER
ENVIRONMENTAL AFFAIRS
DIR H C ROTHSCHILD
INTERNAL AUDIT
DIR E G EALES
SECRETARIAT
CHIEF P MELOCHE
OPERATIONS
DEPUTY ADMINISTRATOR
ENVIRONMENT & BENEFITS
DEPUTY ADMINISTRATOR
G R M ANDERSON
OPERATIONS
DEPUTY ADMINISTRATOR
POLICY RULINGS AND SPECIAL CASES
DEPUTY ADMINISTRATOR H LAZAR
CONSERVATION AND NON PETROLEUM SECTOR
ADM A R HOLLBACH
ENERGY POLICY ANALYSIS SECTOR
ADM L GOOD
GENERAL DIRECTOR
R R SULLY
PETROLEUM SECTOR
ADM R PRIDDLE
HUMAN RESOURCES SECTOR
ADM J Y RANGER
FINANCE AND ADMINISTRATION SECTOR
ADM S MINSHORTH
MINERAL POLICY SECTOR
A/ADM R D HUTCHINSON
RESEARCH AND TECHNOLOGY SECTOR
ADM S. WHITHAM
EARTH SCIENCES SECTOR
ADM W W HUTCHISON
ENGINEERING BRANCH
DG L V BRANDON
PRODUCTION
DIR D A DEMPSTER
STRUCTURES
DIR F E JACKSON
EXPLORATION
DIR F H LEPINE
RESOURCE EVALUATION BRANCH
DIR D F SHERWIN
LAND MANAGEMENT BRANCH
DIR J W GALLAGHER
NEGOTIATIONS RIGHTS AND REVERSIBLES
DIR J R GABRIOR
ENVIRONMENTAL PROTECTION BRANCH
DG M J RUEL
CANADA BENEFITS BRANCH
DG J MERCIER
POLICY ANALYSIS AND COORDINATION
DIR D R WHELAN
NOVA SCOTIA OFFICE
DG W G POTTER
NEWFOUNDLAND OFFICE
DG A L COSS
SPECIAL INVESTIGATIONS
CANADIAN OWNERSHIP AND CONTROL DETERMINATION OPERATIONS BRANCH
DG H D R SARDON
COCD OPS I
DIR H LAUREYS
COCD OPS II
DIR J P PARÉ
PETROLEUM INCENTIVES PROGRAM OPERATIONS BRANCH
DG R C CRESCH
CASE ASSESSMENT
ASST DG C BOUCHER
CALGARY OPERATIONS BRANCH
DG E B YATES
CANADIAN OWNERSHIP AND CONTROL DETERMINATION POLICY PRECEDENTS AND SPECIAL CASES BRANCH
DG S WEX
ASSISTANT DIRECTOR GENERAL
J F DONAGHY
PETROLEUM INCENTIVES PROGRAM POLICY RULINGS AND PRECEDENTS BRANCH
DG J S CAMMUTHERS
ASSISTANT DIRECTOR GENERAL
R S SMITH
ELECTRICAL ENERGY BRANCH
DG C B MARRIOTT
URANIUM AND NUCLEAR ENERGY BRANCH
DG R W MORRISON
REGIONAL OPERATIONS
DG J FERRON
COAL AND ALTERNATIVE ENERGY BRANCH
DG A E LAMEVSU
RENEWABLE ENERGY
DIR D L P STRANGE
TRANSPORTATION ENERGY
DIR A C TAYLOR
COAL
DIR N J MITCHELL
ENERGY CONSERVATION AND OIL SUBSTITUTION BRANCH
DG C PINEAU
POLICY AND COORDINATION
DIR G T ARMSTRONG
NORTHERN ENERGY PROGRAMS
DIR D J ORCHARD
INDUSTRIAL ENERGY PROGRAMS
DIR C G LUCKMAN
FEDERAL ENERGY MANAGEMENT PROGRAMS
DIR I H D PENFRAZE
TECHNOLOGY TRANSFER AND DEMONSTRATION PROGRAMS
DIR C A PICNER
ENERGY STRATEGY BRANCH
DG R A WRIGHT
ENERGY MARKET ANALYSIS AND STATISTICS
DIR W D JARVIS
ENERGY POLICY PLANNING
DIR B UPSETT
CORPORATE DEVELOPMENT AND ECONOMIC ANALYSIS BRANCH
DG H G BAUMANN
FINANCIAL AND FISCAL ANALYSIS BRANCH
DG R W ERDMANN
PETROLEUM MONITORING
DIR G A REINSCH
INTERNATIONAL ENERGY RELATIONS BRANCH
DG A S MACLEAN
ENERGY POLICY COORDINATION
SR ADV R G TOOMBS
PETROLEUM UTILIZATION BRANCH
DG
PETROLEUM RESOURCES BRANCH
DG J P NOA
OIL SUPPLY BRANCH
DG J D QUILTON
OIL PRICING AND COMPENSATION PROGRAMS BRANCH
DG R G SUMNER
NATURAL GAS BRANCH
DG N E HUGHES ANTHONY
ENERGY EMERGENCY PLANNING GROUP
DG G N CURRIE
PERSONNEL PROGRAM OPERATIONS BRANCH
DIR L E LABOLDUS
PERSONNEL PROGRAM DEVELOPMENT BRANCH
DIR P R CARR-EM
MANAGEMENT CATEGORY PERSONNEL
CHIEF N R MOORE
ADMINISTRATION AND COMPUTER SCIENCE BRANCH
DG A REBINNER
COMPUTER SCIENCE CENTRE
DIR E E G TEICH
ADMINISTRATIVE SERVICES
DIR D NORMANDEAU
FINANCIAL MANAGEMENT BRANCH
DG R O SORENSEN
ENERGY FINANCE
DIR D S PARR
MINERAL POLICY COORDINATION
SR ADV R D HUTCHINSON
RESOURCE SUPPLY AND INFORMATION BRANCH
DG R J SHARE
MINERALS AND METALS STRATEGY BRANCH
DG
REGIONAL MINERAL DEVELOPMENT
DIR
ECONOMIC AND FINANCIAL POLICY ANALYSIS BRANCH
DG E J BREWER
CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY
DG W G JEFFERY
DEPUTY DIRECTOR GENERAL
J T JUBB
RESEARCH PROGRAM OFFICE
DIR D A REEVE
ENERGY RESEARCH LABORATORIES
DIR B I PARSONS
MINING RESEARCH LABORATORIES
DIR J UDD
MINERAL SCIENCES LABORATORIES
DIR W A GOW
NATIONAL URANIUM TAILINGS PROGRAM
DIR
PHYSICAL METALLURGY RESEARCH LABORATORIES
DIR W H ERICKSON
COAL RESEARCH LABORATORIES
DIR T D BROWN
CANADA CENTRE FOR REMOTE SENSING
DG E A GOOBY
DEPUTY DIRECTOR GENERAL
R BAKER
RADARSAT PROJECT
DIR I SHAW
EXPLOSIVES BRANCH
DIR R SHAW
OFFICE OF ENERGY RESEARCH AND DEVELOPMENT
DG P J DYNE
GEOLOGICAL SURVEY OF CANADA
DG R A PRICE
CHIEF GEOLOGIST
J G FYLES
TERRAIN SCIENCES
DIR J S SCOTT
ECONOMIC GEOLOGY
DIR D C FINDLAY
GEOLOGICAL INFORMATION
DIR R G BLACKADAR
RESOURCE GEOPHYSICS AND GEOCHEMISTRY
DIR A G DARNLEY
PRECAMBRIAN
DIR J C McGLYNN
CORDILLERAN
DIR R B CAMPBELL
INSTITUTE OF SEDIMENTARY AND PETROLEUM GEOLOGY
DIR W W RAMBOCHAM
ATLANTIC GEOSCIENCE CENTRE
DIR M J KEEN
POLAR CONTINENTAL SHELF PROJECT
DIR G D HOBSON
POLICY AND INTERNATIONAL RELATIONS
DIR V LAFFERTY
PLANNING AND PROGRAMS COORDINATION
COORD J HARRISON
SURVEYS AND MAPPING BRANCH
DG R E MOORE
GEODETIC SURVEY AND DOMINION GEODESIST
DIR L J O'BRIEN
INTERNATIONAL BOUNDARY COMMISSION
A C McEWEN
TOPOGRAPHICAL SURVEY
DIR R GROOT
RESEARCH AND DEVELOPMENT
DIR J M ZARZYCKI
LEGAL SURVEYS AND SURVEYOR GENERAL
DIR W V BLAGAIR
GEOGRAPHICAL SERVICES
DIR E V SCHAUBEL
REPRODUCTION AND DISTRIBUTION
DIR J A McARTHUR
ACTION ENVIRONNEMENT
DIR G N FORSTALL
EARTH PHYSICS BRANCH
DG J S TARNER
GRAVITY GEOTHERMICS AND GEODYNAMICS
DIR M A DENIS
SEISMOLOGY AND GEOMAGNETISM
DIR M J BERRY
PACIFIC GEOSCIENCE CENTRE
DIR R D HYNDMAN
EMR ORGANIZATION

APPENDIX 11

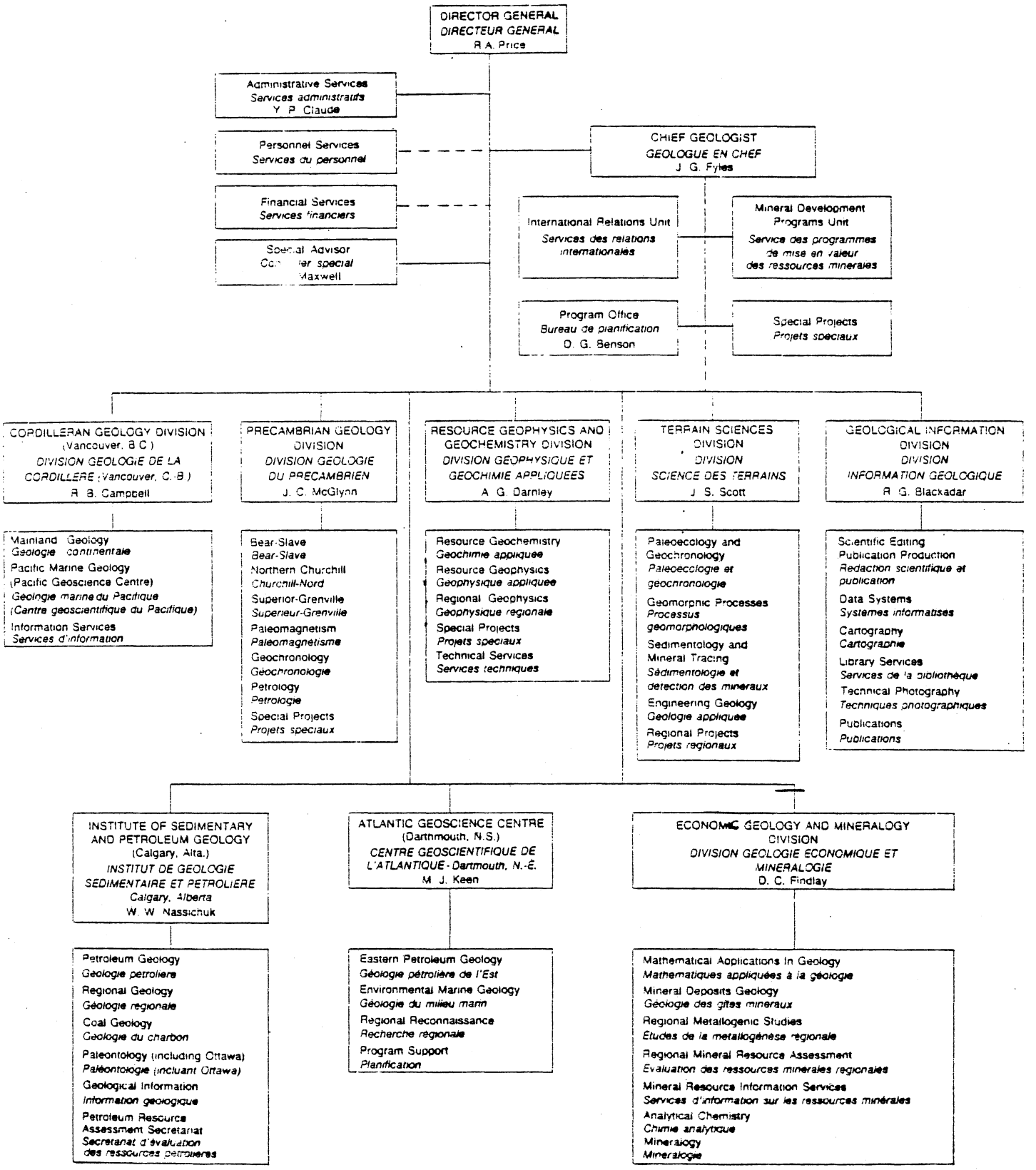
MINERAL POLICY SECTOR
SECTEUR DE LA POLITIQUE MINÉRALE

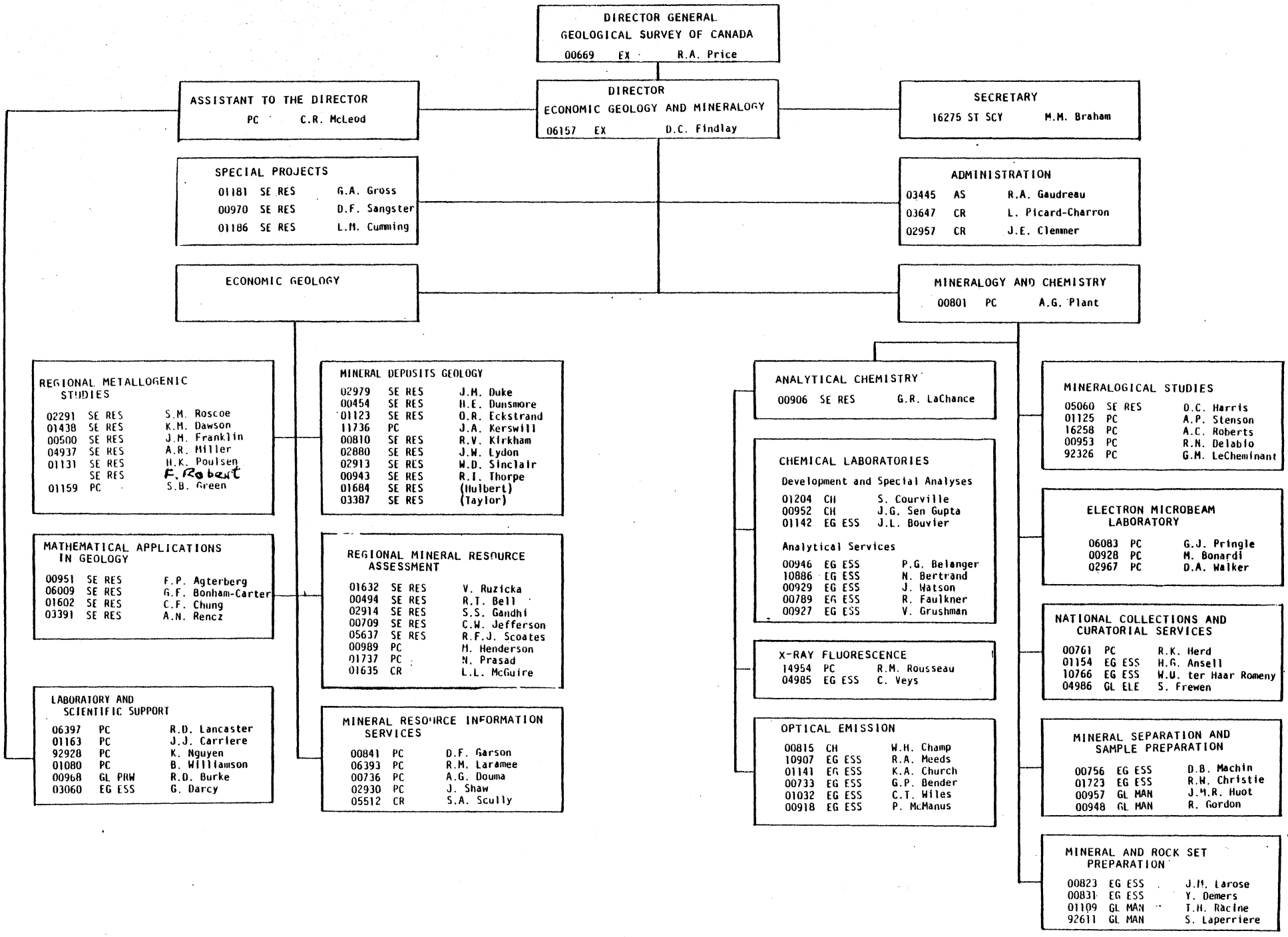
January/janvier 1985



GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA

APPENDIX 12




DIRECTOR GENERAL
GEOLOGICAL SURVEY OF CANADA
00669 EX R.A. Price
ASSISTANT TO THE DIRECTOR
PC C.R. McLeod
DIRECTOR
ECONOMIC GEOLOGY AND MINERALOGY
06157 EX D.C. Findlay
SECRETARY
16275 ST SCY M.M. Braham
SPECIAL PROJECTS
01181 SE RES G.A. Gross
00970 SE RES D.F. Sangster
01186 SE RES L.M. Cumming
ADMINISTRATION
03445 AS R.A. Gaudreau
03647 CR L. Picard-Charron
02957 CR J.E. Clemmer
ECONOMIC GEOLOGY
MINERALOGY AND CHEMISTRY
00801 PC A.G. Plant
REGIONAL METALLOGENIC STUDIES
02291 SE RES S.M. Roscoe
01438 SE RES K.M. Dawson
00500 SE RES J.M. Franklin
04937 SE RES A.R. Miller
01131 SE RES H.K. Poulsen
SE RES F. Robert
01159 PC S.B. Green
MINERAL DEPOSITS GEOLOGY
02979 SE RES J.M. Duke
00454 SE RES H.E. Dunsmore
01123 SE RES O.R. Eckstrand
11736 PC J.A. Kerswill
00810 SE RES R.V. Kirkham
02880 SE RES J.W. Lydon
02913 SE RES W.D. Sinclair
00943 SE RES R.I. Thorpe
01684 SE RES (Hulbert)
03387 SE RES (Taylor)
MATHEMATICAL APPLICATIONS IN GEOLOGY
00951 SE RES F.P. Agterberg
06009 SE RES G.F. Bonham-Carter
01602 SE RES C.F. Chung
03391 SE RES A.N. Rencz
REGIONAL MINERAL RESOURCE ASSESSMENT
01632 SE RES V. Ruzicka
00494 SE RES R.T. Bell
02914 SE RES S.S. Gandhi
00709 SE RES C.W. Jefferson
05637 SE RES R.F.J. Scoates
00989 PC M. Henderson
01737 PC N. Prasad
01635 CR L.L. McGuire
LABORATORY AND SCIENTIFIC SUPPORT
06397 PC R.D. Lancaster
01163 PC J.J. Carriere
92928 PC K. Nguyen
01080 PC B. Williamson
00968 GL PRW R.D. Burke
03060 EG ESS G. Darcy
MINERAL RESOURCE INFORMATION SERVICES
00841 PC D.F. Garson
06393 PC R.M. Laramee
00736 PC A.G. Douma
02930 PC J. Shaw
05512 CR S.A. Scully
ANALYTICAL CHEMISTRY
00906 SE RES G.R. LaChance
CHEMICAL LABORATORIES
Development and Special Analyses
01204 CH S. Courville
00952 CH J.G. Sen Gupta
01142 EG ESS J.L. Bouvier
Analytical Services
00946 EG ESS P.G. Belanger
10886 EG ESS N. Bertrand
00929 EG ESS J. Watson
00789 EG ESS R. Faulkner
00927 EG ESS V. Grushman
X-RAY FLUORESCENCE
14954 PC R.M. Rousseau
04985 EG ESS C. Veys
OPTICAL EMISSION
00815 CH W.H. Champ
10907 EG ESS R.A. Meeds
01141 EG ESS K.A. Church
00733 EG ESS G.P. Bender
01032 EG ESS C.T. Wiles
00918 EG ESS P. McManus
MINERALOGICAL STUDIES
05060 SE RES D.C. Harris
01125 PC A.P. Stenson
16258 PC A.C. Roberts
00953 PC R.N. Delabio
92326 PC G.M. LeChemfinant
ELECTRON MICROBEAM LABORATORY
06083 PC G.J. Pringle
00928 PC M. Bonardi
02967 PC D.A. Walker
NATIONAL COLLECTIONS AND CURATORIAL SERVICES
00761 PC R.K. Herd
01154 EG ESS H.G. Ansell
10766 EG ESS W.U. ter Haar Romeny
04986 GL ELE S. Frewen
MINERAL SEPARATION AND SAMPLE PREPARATION
00756 EG ESS D.B. Machin
01723 EG ESS R.W. Christie
00957 GL MAN J.M.R. Huot
00948 GL MAN R. Gordon
MINERAL AND ROCK SET PREPARATION
00823 EG ESS J.M. Larose
00831 EG ESS Y. Demers
01109 GL MAN T.H. Racine
92611 GL MAN S. Laperriere