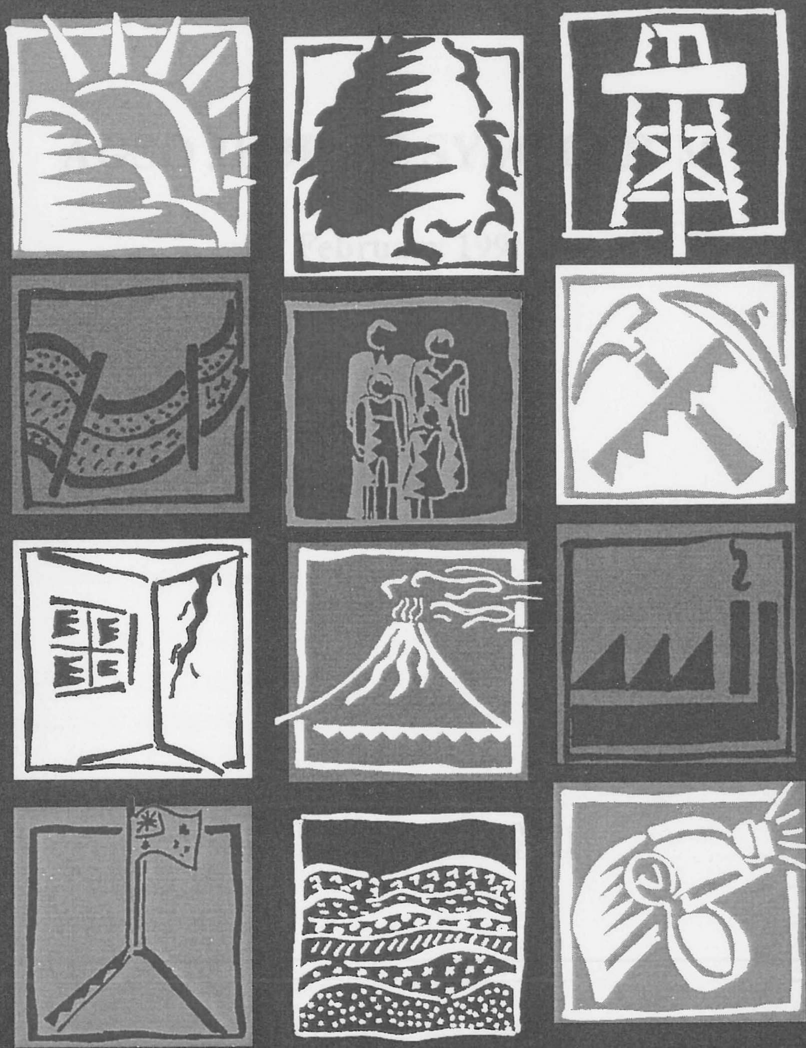
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

AGSO JUBILEE SYMPOSIUM

Canberra 21 February 1996



ABSTRACTS

AGSO RECORD 1996/1

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DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
Executive Director: Neil Williams

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Raymond A. Price

Raymond A. Price is a Professor of Geological Sciences at Queen's University in Canada, and a registered Professional Engineer in the Province of Ontario. He graduated from the University of Manitoba in 1955 with a B.Sc. (Hons.) in Geology, and in 1958 received a Ph.D. in Geology from Princeton University.

From 1958 to 1968 he was a member of the Petroleum Geology Section of the Geological Survey of Canada and was engaged in geological mapping and structural and tectonic studies in the Cordillera of western Canada.

He then moved to Queen's University, where he was Head of the Department of Geological Sciences from 1972 to 1977, and a Killam Fellow from 1978 to 1980. Between 1981 and 1988 Professor Price was the Director-General of the Geological Survey of Canada and an Assistant Deputy Minister in the Department of Energy, Mines and Technical Resources in Ottawa. He was President of the International Lithosphere Program from 1980 to 1985, and President of the Geological Society of America in1989–90.

Professor Price is a Fellow of the Royal Society of Canada, a Foreign Associate of the US National Academy of Sciences, and an Honorary Foreign Fellow of the European Union of Geosciences. He received the R.J.W. Douglas Medal from the Canadian Society of Petroleum Geologists in 1984, the Sir William Logan Medal of the Geological Association of Canada in 1985, the Leopold von Buch medal from the Deutsche Geologische Gesellschaft in 1988, and the Major Edward Coke Medal from the Geological Society of London in 1989, and he was made an Officer in L'Ordre des Palmes Académique of France in 1988. He was awarded the degree D.Sc. (honoris causa) by Carleton University in Ottawa and the Memorial University of Newfoundland.

Professor Price's research interests include global change in the geosphere and biosphere, and the role of science in public policy, as well as tectonics and structural geology. He is a Member of the Board of Directors of the Canadian Global Change Program, a Member of the Commission on Geosciences, Environment and Resources of the U.S. National Research Council, and the Chairman of the Board of the Sudbury Neutrino Institute. He recently chaired the Canadian Environmental Assessment Agency Scientific Review Group that evaluated the scientific and engineering aspects of Atomic Energy of Canada Limited's proposed concept for the disposal of Canada's Nuclear Fuel Waste.

NATIONAL GEOLOGICAL SURVEYS: THEIR PRESENT AND FUTURE ROLE IN A CHANGING WORLD

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Change is the watchword at the threshold of the 21st century. Consider the implications of the unprecedented rate of growth and size of the human population; the unexpected abrupt end of the cold war and the emergence of new democracies in Europe, Asia, the Americas, and Africa; a growing emphasis worldwide on competition in a non-interventionist free market economy; the globalization of the economy; the amazing growth in information technologies and the internet; the rapid growth in the economies and the affluence of many "poor" nations; growing and alarming environmental degradation associated with the large-scale use of natural resources; and the looming prospect of global changes in the geosphere and biosphere that threaten our human habitat and the genetic diversity of the biosphere. National geological surveys along with most of the rest of our global society are struggling to meet the challenge of the rapid pace of change in our social, political, economic, technological and natural environment.

The challenge and response vary greatly from one national geological survey to another. One year after it was destined to be abolished as part of the Republican Contract with America, aimed at eliminating non-essential government spending, to achieve a balanced budget and reduced taxes, the U.S. Geological Survey has managed to survive, in part, with new strategic goals focused on natural hazards, water resources, availability of geographic data, and environmental issues. The Australian Geological Survey Organization also recently went through a major review, but it emerged with a new mission focused on economic growth and encouraging economically and environmentally sustainable management of mineral, energy, soil, and water resources. These differences should not obscure the common raison d'être of national geological surveys, which has not changed significantly since the British Geological Survey was formed about 160 years ago, and probably will not change significantly in the near future; nor should they obscure the similarities in the strategic responses to change.

To plan strategically for success (or even survival) in our rapidly changing, competitive environment an organization should be able to give itself clear, logical answers to some basic questions:

- what is our business? (Why do we/should we exist?)
- who are our clients? (Who pays for our services and products? and why do they pay?) and
- what is our competition? (Where else does our client's money go?).

National geological surveys are in the geoscience information business. They exist to ensure that the geoscience information requirements of the nation, as defined and redefined from time to time by the government, are met. Although they work for the nation, their de facto clients are the government that decides what they will do, and how much they will spend doing it. Their competition comes from other demands that are made upon the same government—to provide other services and products, and to reduce taxes (and the national debt!).

Geoscience information is required by governments for the development and implementation of public policies on mineral, energy and water resources; the management of risk due to natural hazards; the protection of human health and the natural environment; national security and sovereignty; and science and culture. It may come from many sources, but in so far as the required information and advice cannot be provided more effectively, efficiently, and economically by non-governmental sources, it must be assembled and/or generated by the government. National geological surveys do this by conducting field research and related laboratory research, compiling information available from state or provincial agencies, universities, industry and various other sources, and by using all of this to maintain a national geoscience knowledge base from which the required information and advice can be extracted as required. The national geoscience knowledge base is an important national resource that becomes depleted with the advancement of science, if not continually updated. Geoscience information, unlike many other kinds of scientific information, has both local and universal significance. It pertains to a specific place in a specific country, as well as to the global corpus of scientific knowledge. It is part of the knowledge base on the country. When made available to reduce natural hazard risks or to encourage resource exploration and exploitation , geoscience information becomes an instrument for the implementation of public policy. The specific character of the geoscience information and expertise provided by a national geological survey depends upon the special circumstances and needs of the nation, and upon how those needs and their relative priority are perceived by the national government. The requirements of Japan obviously are different from those of both the United Kingdom and of Australia because of fundamental differences in the relative importance of mineral resource endowment, natural hazard risks, and environmental issues. In a world of change, national geological surveys can find new opportunities as well as challenges.

Trevor Powell

Trevor Powell is currently Deputy Executive Director with the Australian Geological Survey Organisation. He has particular responsibility for overall scientific strategic planning for the organisation. Prior to assuming his present position, he was Associate Director, Minerals and Environment Group. He was Chief of the Onshore Sedimentary and Petroleum Geology and later Chief Marine and Petroleum Geology Program in the period 1989–92. He joined AGSO (then BMR) in 1983 as Senior Principal Research Scientist, following 10 years with the Geological Survey Canada, from which he left as Head of the Petroleum Geology Program. His research interests have been mainly in organic and petroleum geochemistry, paleogeography, sediment-hosted mineral deposits, petroleum resource assessment and environmental geochemistry.

STRATEGIC INFLUENCES ON THE FUTURE ROLE OF AGSO

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As the Australian Geological Survey Organisation enters its 50th year the societal need for geoscientific information has expanded beyond the traditional role associated with national development of the minerals and petroleum industries. Whilst provision of pre-competitive information to facilitate resource exploration remains important, geoscientific information and resource assessment of these commodities are increasingly being used as inputs to decision making on land use in a complex and frequently contentious political environment.

The need to correct environmental degradation will be the most serious challenge to society in the 21st century, and timely reliable geoscientific information related to environmental issues will be essential. In Australia, groundwater and land degradation are of particular importance. Increasingly, management of land and water resources is moving towards adaptive management at the community level. For this to succeed, technical and scientific information and advice needs to be provided at a variety of government and community levels.

Rapid urban growth around Australia's coastal fringe and increased consciousness of land use issues and pollution have contributed to a growing need for geoscientific information to address the development of national infrastructure, waste disposal, supply of construction materials and the geochemical environment. As urbanisation progresses, the risk of damage to infrastructure from natural hazards also increases. Urbanisation of the coast line has resulted in pressure from pollution, over harvesting of resources, loss of habitat, and enhanced resource usage to support development. Any meaningful management of these issues requires fundamental knowledge of the underlying geoscience and associated processes and baseline conditions.

The declaration of the United Nations Convention on the Law of the Sea, and its subsequent ratification by Australia in 1994, places a particular need for geoscientific information to establish Australia's claim for extending its offshore jurisdiction. The Convention also places an onus on countries to actively manage their jurisdiction. In many ways our geoscientific knowledge of this vast area, 40% larger than Australia's land mass, is similar to that of the land area a century ago and will require a large scale systematic mapping program targeted at marine resources and the requirements for management of the environment.

The new clients for geoscientific information are the stakeholders in the emerging management paradigm of ecologically sustainable development. Their information needs relate to policy and management outcomes.

Data acquisition and analysis in the field will continue to be important, but they will need to be integrated with data from many disparate sources, in digital form. The demand will be to master geoscientific information management and use modern information technology to capture and analyse all relevant information in a meaningful way and supplement it in a strategic manner to meet customers' needs. Even in the traditional client areas of petroleum amd mineral exploration, information needs have changed with the increased pace and commercial edge given given to business by an increasingly competitive market, both nationally and internationally, and the long-term trend to lower commodity prices. Customisation of outputs to meet the diverse needs of clients will be required, whilst traditional forms of publication will diminish in relative importance.

Within government, policy frameworks relating to the aspects of the delivery of government service delivery are increasingly impacting on public science. These include:

- the separation of policy development from program delivery ;
- the identification of the public and private benefit in the provision of service and the establishment of a framework for cost sharing;
- the devolution of resource management to the community to increase focus on needs in the provision of services;
- the corporatisation/commercialisation of program delivery to obtain the benefits of competition and stakeholder involvement;
- a focus on evaluation of outcomes and performance in program delivery of agencies rather than on inputs and role and functions.

Ultimately it is the government who authorises the expenditure of public funds on the work of the geological survey. The challenge is to maintain alignment both with the objectives of government and the requirements of the external client and make the geological survey a critical factor in the business achievement of both.

Wally Johnson

Wally Johnson is a Chief Research Scientist with the Australian Geological Survey Organisation. He joined AGSO (then BMR) in 1968 as a volcanologist and has specialised in volcanic-rock geochemistry and petrology, the tectonic controls of magma genesis, the geology of island-arc volcanoes, and volcanic hazards. He has worked extensively in Papua New Guinea, in particular, in close association with the Rabaul Volcanological Observatory. Wally is currently collaborating with the Australian Agency for International Development (AusAID) in developing a major Australian Government support project for the volcanological service in Papua New Guinea, following the disastrous 1994 volcanic eruption at Rabaul. He is Secretary General of the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI).

GEOSCIENCE OF NATURAL HAZARDS: INCREASING RISK IN A DEVELOPING WORLD

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Geoscience and relevant hazards information

The geoscience of natural hazards is emerging as a key component of the modern geological survey. There are three main reasons for this: (1) communities are becoming increasingly vulnerable to the impact of natural hazards, (2) the general public and other clients identify directly both with the threat of hazards and with effective ways of mitigating them, and (3) geological surveys have the capacity to handle the large amounts of spatial and attribute data and the analytical techniques needed to tackle such issues as community vulnerability to geological hazards. The challenge for geological surveys is to add to their traditional role of collectors of geohazard data by designing the most relevant information packages and by improving the flow of this information for practical use at the community level. This challenge is set in the clear context of the 1990s, which the United Nations has declared the International Decade for Natural Disaster Reduction (IDNDR).

World pressures and global public-safety issues

Key public-safety and vulnerability concerns relate to the following socio-economic issues: global population growth and the accompanying drift of people to urban areas; the prospect of a much larger number of megacities (populations greater than 8 million in each) in the 21st century; increased investment in these and other cities; whether megacities contain internal instabilities of self-destruction; increasing stress on the reinsurance industry; the strongly established links between world poverty and vulnerability to hazards; and the greater vulnerability of communities in developing countries. The principles of ecologically sustainable development (ESD) are championed by powerful developed countries, yet the third element missing from (1) development *versus* (2) environmental-degradation discussions is the role of (3) natural hazards in restricting development and in destroying the natural environment. This is the concept of the 'Development Triangle'.

Community vulnerability and the role of geological surveys

Disaster reduction in the context of geological surveys, IDNDR, and an increasingly vulnerable world is primarily about disaster preparedness (as opposed to disaster relief and recovery). Vulnerability can be defined as the degree of susceptibility and resilience of the community and environment to hazards, and the key role for geological surveys is helping communities show how vulnerable they are and what they can do about it. However, this role cannot be achieved by geological surveys alone and strong alliances must be achieved with, for example, social scientists, town planners, and facility and emergency managers in urban communities. This is because the *nature of a community*—in terms of, for example, the safety of its buildings, evacuation strategies, demographic characteristics, wealth levels, levels of insurance, the sources of decision-making power, social cohesion, and social networks—determines its vulnerability to natural hazards, rather than just the ferocity of the natural hazards themselves. There is, indeed, no such thing as a '*natural* disaster' in the strict sense, because disasters take place only where a community is not prepared for, and not resilient to, hazards. This is the context in which geological surveys, by providing the most relevant information, can have their greatest impact.

AGSO and geohazards

Closer and more direct links with the community are starting to characterise the Geohazards Program in AGSO. The results of recent seismic-microzonation surveys in Homebush (Olympics 2000 site, Sydney) and Launceston are being provided digitally for use at the city and community level in Geographic Information Systems (GIS). Plans are under way to begin a major project entitled *Geohazard vulnerability of urban communities*, the aims of which will include improved assessments of geological hazards as well as contributing to risk-deduction processes (e.g. the development of building codes and emergency-management plans). The project 'vision' is significant reduction in the vulnerability of Australian urban communities to the effects of geological hazards.

David Berman

David Berman has a professional background in scientific database design and information technology management in Australian and overseas government. He has an M.Sc. from ANU in biochemical genetics, and a Graduate Diploma in Computing (CCAE/University of Canberra). Within AGSO, he has responsibility for Information Services. This group of about 85 people provides corporate IT and scientific information-related services, including library and cartographic services, as well as national geoscience database coordination and development. David chairs the Government Geoscience Database Policy Advisory Committee, and is Program Manager for the government's new initiative to create an Australian National Geoscience Information System (@ngis), using the technology of the Internet.

GEOSCIENCE AND THE INFORMATION REVOLUTION: BITS AND BYTES NOT BOOKS

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Until the early 1960s, the general framework for scientific information management and communication was predominantly paper-based. Techniques of classification, indexing, preservation and providing access were developed, based largely on the relatively low rate of production of information, the physical characteristics of paper media, the accompanying technology of printing, and the economics of distribution.

The focus on the paper medium (book, journal, map, photo) as the archetypical information source is now disappearing fast. This has come about because of parallel evolution and convergence in:

- the technology of information (computers, software, telecommunications and networks, data capture);
- the increasing rate of primary data capture (3D seismic, air/space remote-sensed);
- the digital representation of content—integration or juxtaposition of information types (multimedia);
- new paradigms in the classification of information (metadata, geo-referencing, generalisation);
- new methods of access (networked, distributed, on-demand, multi-user, World Wide Web).

A modern geological survey such as AGSO has an obligation to apply the most effective techniques to its information management requirements. These means are increasingly technologically enabled. They bypass the traditional serial mode of information production and distribution, resulting in universal access to current information and associated supporting data. In general, there has been a shift from static physical media to a richer, dynamic digital model. A number of the key technological developments are discussed and illustrated: hypermedia—GIS, databases built on multimedia data, voice, vision; and Internet—browsers, crawlers, VRML.

New organisation and service models
A new digital publication paradigm is now emerging. This still meets editorial and content standards, but is more timely, more accessible, and linkable to related or supporting information. Once information and the software tools for its manipulation are accessible at any location, from any location, then old concepts of centralised databanks lose their meaning. Information veracity, quality assurance and fitness for purpose—custodial issues—become important. Physically holding copies of vast quantities of base information can look uneconomic. Mining the information bases, simultaneously, of a number of data providers (eg geological surveys, companies) who provide a cost-effective information management function might be more attractive.

AGSO has prime carriage of developing a new model for national geoscience information access, and is setting up the *Australian National Geoscience Information System* (or @ngis) to achieve this. A prototype @ngis system, linking users and providers is demonstrated to illustrate some of these concepts. In particular, an on-line demonstration is being given of the use of the Internet to locate and explore environmental geoscience information relating to the Murray–Darling Basin through a geographic information system (GIS). As well, access to geoscience education materials is demonstrated, as is facilitating community awareness and knowledge of nuclear explosions through online historic and current database records and images.

Challenges
A number of new technical, managerial and organisational challenges arise in dealing with the information revolution, as the rate of information accumulation is increasing, and the rate of change of the supporting technology is increasing. However, the potential for loss of the information base is paradoxically higher if it is left on outdated media or dependent on defunct hardware or software, or is not backed up, or is corrupted.

Management is faced with developing strategies for a holistic approach to information management, its delivery, and the associated technology. Organisational structures and operating modes must be fluid and adaptable. Social factors become the key determinants of uptake and acceptance. New policy issues in the areas of custodianship, copyright and the pricing of information must be faced.

In summary, the old model of the physical holdings of libraries as the knowledge repository is changing. The digital information revolution will serve the needs of geoscience well, and help convey its message better.

S.M. Richards

S.M. (Max) Richards is a geologist, with B.Sc (H1) and Ph.D (New England); he is a Fellow of the Australasian Institute of Mining and Metallurgy and the author of several papers on mining and exploration.

He is a non-executive director of Aberfoyle Limited (Chairman) and Bligh Oil and Minerals N.L.; and a member of the CSIRO Board and the Cooperative Research Centre Committee.

In 1993, he chaired the review committee of the Australian Geological Survey Organisation.

PETROLEUM AND MINERAL EXPLORATION: GOVERNMENTAL GEOSCIENCE AND AUSTRALIA'S COMPETITIVE POSITION

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Petroleum and mining companies of all sizes, in order to achieve, maintain and improve their competitive positions think and act globally. Many prospective countries have been made attractive to explorers in recent times, and want strong petroleum and mining industries. Subject to politics and economics, company decisions are driven by better chances of success, larger targets, lower cost of exploration, and faster transformation of discovery into production.

The great bulk of exploration expenditure is made by the larger companies, which through amalgamation and growth, are becoming fewer and larger. On the assumption that Australia needs and wants its strong petroleum and mining industries to continue, it must attract a significant proportion of this expenditure, in addition to maintaining vigorous activity from small to medium size explorers. Australia's mineral prospectivity is high, established by the record of discoveries and large areas of Precambrian rocks, still underexplored; the problem is more to do with ease of detectability. In petroleum, Australia's prospectivity is unknown, the density of drilling being too low to enable a reliable judgement. The essential task of Governmental Geoscience is to create positive perceptions about exploration attractiveness and feasibility, especially when the rates of expenditure and discovery are falling.

To do so is not an exercise in propaganda. An understanding of exploration risk is essential. The degree of risk, from the geoscience perspective, is determined by the knowledge of the essential ingredients of ore-deposit styles, their mappability and the effectiveness of direct and indirect search techniques. In the public good sense, Governmental Geoscience needs to respond to the risk assessment for any particular region by presenting any or all of new information, new ideas, and new and improved search technologies. In the last 10 years Governmental Geoscience has pursued a course which involves increasing collaboration between Commonwealth and State agencies, with Universities and with industry. AGSO and State Geological Surveys, either directly or through the National Geoscience Mapping Accord, have provided a considerable amount of new aeromagnetic mapping and seismic surveys, and have begun to produce maps in which many layers of information can be integrated. An understanding of "mineral systems" is beginning to influence the collection of information and its presentation. Similarly, strong support is evident for study of "petroleum systems" with particular emphasis on Australian circumstances and Australian exploration objectives. There has been some progress in the establishment of information systems that will make new and prior open file Government and industry data readily available to all users, be they policy makers, researchers or explorers; and in areas where information is sparse, especially offshore, use of the constantly improving "Rig Seismic" facilities and the swath mapping technique is sufficiently imaginative to influence perceptions of exploration attractiveness.

Industry assessment of its competitive position must include the time and cost of acceptable environmental management, and AGSO's increasing involvement in acquiring baseline geoscientific information, particularly on soil and water, will be welcome.

Governmental Geoscience agencies, Universities and industry have collaborated for over 30years in precompetitive research joint ventures, brokered principally by AMIRA. In recent times, supported by additional Commonuealth funding, collaboration is occurring through Key Centres for Teaching and Research, and Cooperative Research Centres, intent of producing new search concepts and technologies. Outstanding work has been done in remote sensing, image processing, regolith geochemistry, airborne electromagnetics, volcanic stratigraphy, and the understanding of volcanic processes, and in the control of gold mineralisation.

It is evident that Government expenditure outlays which do successfully improve perceptions of prospectivity stimulate industry exploration expenditure worth many times the original outlay. With this recognition, Governmental Geoscience is devoting an increasing proportion of its resources to stimulation of industry interest, and the combination of mechanisms has the capability of being highly effective in improving perceptions of Australia's attractiveness to explorers.

Lynton Jaques

Lynton Jaques is currently Chief of the Division of Regional Geology and Minerals at the Australian Geological Survey Organisation. This Division undertakes multidisciplinary geoscientific mapping and research of mineral provinces throughout Australia, in collaboration with the State Geological Surveys, under the National Geoscientific Mapping Accord. He also has responsibility for several mapping integrated projects overseas, notably Argentina.

Lynton Jaques gained his BSc(Hons) from the University of Western Australia in 1971. During 1972–1975 he was involved in regional geological mapping in Papua New Guinea. After returning to Australia, he gained his PhD from the University of Tasmania in 1980, and then was involved in regional mapping for BMR in the Mount Isa mineral province. From 1982 he lead a collaborative research project on the nature and origin of Western Australian diamond deposits. Before being appointed to his present position in 1991, he undertook consulting work for BMR in the Middle East in geological and geophysical mapping. His current interests are in mineral systems mapping and analysis, and the application of spatial analysis systems to mineral potential mapping.

MAPPING TO SUPPORT MINERAL EXPLORATION IN THE 21ST CENTURY

A.L. Jaques
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A modern geoscientific knowledge base developed through systematic mapping is a major component of sustainable development strategies, underpinning appraisal of mineral resource potential and exploration. The exploration and discovery of Australia's onshore mineral and petroleum resources for the past 3 decades have been sustained by the national geological and geophysical databases, principally the national 1:250 000 geological map series and reconnaissance airborne geophysical surveys, undertaken by AGSO, its predecessor the BMR, and State/Territory Geological Surveys. This period saw discovery of more than 100 new mineral deposits, several of world class, which have established Australia as a major mineral producer.

The most critical decision in mineral exploration is area selection. The National Geoscience Mapping Accord (NGMA) between AGSO and the State and Northern Territory Geological Surveys is providing a new generation of geoscientific maps, data sets and interpretive reports of strategically important areas through multidisciplinary studies using modern technology to support resource exploration into the next century. Underpinning "second generation" mapping of mineral provinces are high resolution airborne magnetic and gamma-ray spectrometric data, now an integral part of modern geoscientific mapping and mineral exploration. Such surveys provide rapid, cost-effective systematic definition of structure and lithology in diverse geological provinces and terrains. Magnetic (and gravity) data have proved crucial in determining basement geology and structure, and continuity of basement under cover. Gamma-ray spectrometric provide a geochemical (K, Th, U) map of lithology and alteration in areas of subcrop, and of regolith materials and regolith activity in highly weathered, regolith-dominated terrains. Mapping the nature and distribution of regolith units is essential for successful geophysical and geochemical exploration. Other important mapping technologies are multi-spectral satellite imagery, GPS navigation; deep seismic reflection surveys to define crustal structure; precise geochronology to establish time relationships of key geological units and events; multi-element geochemistry for lithological characterisation and definition of background values and anomalous regions; structured databases (RDBMS) databases for effective storage, management and manipulation of data; digital cartography for rapid map output; and Geographic Information Systems (GIS) for the integration and analysis of multiple spatial datasets.

Future mineral discoveries in Australia are likely to be made under cover where potential remains high (e.g., Olympic Dam, Cannington, Century, Bronzewing). Exploration for buried deposits especially in structurally complex metamorphic terrains, beneath conductive and/or transported overburden, requires a multidisciplinary approach employing high level conceptual thinking and effective integration and analysis of multi-dimensional spatial datasets. Most mineral deposits are spatially small parts (<3 km^2) of mineralising systems resulting from interaction of geological factors occurring at district and province scales. Mapping programs need extend beyond traditional lithological/lithostratigraphic mapping to identify and map the essential elements of mineral systems for key commodities at the regional and district scale since these provide a larger target than the ore deposit. Essential elements include regional alteration, structural relationships, volcanic facies, oxidation state, metamorphic grade, and the distribution of highly oxidised and reduced mineral species (including organic matter), and involve spaceborne, airborne, ground and laboratory methods. For example, airborne magnetics can map hydrothermal fluid-flow and redox fronts, airborne and field spectrometers identify micas, clays and other alteration mineral species, and oxygen isotopes map the extent of regional hydrothermal alteration. Using a conceptual mineral systems approach such data can be integrated and analysed in Spatial Information Systems to develop thematic maps presenting new play concepts and outlining prospective areas at the regional and district scale. Expert systems are being developed to integrate and analyse the large volume of new high quality digital regional geological, geophysical and geochemical data generated by the current enhanced national mapping efforts. Further efforts are required to calibrate the remotely sensed and potential field data to maximise effective modelling and interpretation.

The modern geoscientific framework established by the current generation of geoscientific mapping, coupled with modern spatial information systems, is resulting in a more comprehensive understanding of the geology of Australia and its mineral and petroleum resource potential. This is leading to more efficient and effective exploration, and reduced exploration risk, thereby making Australia a competitive site for exploration investment into the 21st century in the face of increasing global competition.

Tom Loutit

Tom Loutit is co-Chief of the Marine, Petroleum and Sedimentary Resources Division in the Australian Geological Survey Organisation (AGSO). He joined AGSO in 1992 after 11 years with Exxon Production Research Company in Houston, Texas. Tom's early training was in stratigraphy and geological oceanography at the University of Otago (B.Sc. Hons, 1975), New Zealand, and the University of Rhode Island (Ph.D. 1981), USA, respectively. During the early part of his career at Exxon, he was one of the developers of sequence stratigraphy and sequence biostratigraphy. After six years with the sequence stratigraphy group he moved to the areas of source rock prediction (2 years), thermal history and migration (1 year) and basin analysis (2 years). During the last few years at Exxon, he spent a considerable time developing information systems for basin analysis and petroleum systems analysis. The past three years at AGSO have been spent developing and managing a number of mineral and petroleum-related basin analysis projects within the Continental Margins and National Geoscience Mapping Accord Programs.

SYSTEMATIC APPROACH TO BASIN RESOURCE EVALUATION (SABRE)

Tom S. Loutit
Australian Geological Survey Organisation, GPO Box 378, Canberra, ACT 2601

In its simplest form, basin analysis provides the time–space framework within which observations relating to the character, timing and distribution of fluid systems are made. Different fluid systems require different exploration methods, but there are a number of steps common to the evaluation of any palaeo or present fluid system. SABRE is an attempt to systematically document the critical or minimum number of steps required to evaluate the resource potential of a range of fluid systems in sedimentary basins. The method quickly highlights the datasets required for basin resource evaluation in all areas and the order in which they should be evaluated. For example, a national basement or crustal elements map is an essential component of basin analysis, and the Australian Crustal Elements map was commissioned in 1994 to meet this need. In addition, an important part of the systematic approach is to recognise where there are differences between the analytical methods employed by different groups and to focus research on these differences.

The approach is based on "traditional" petroleum basin analysis techniques. Basin analysis involves five major steps aimed at providing a tectonostratigraphic time-series framework within which to define petroleum and mineral fluid systems as a precursor to prospect definition and evaluation. The advantage of concentrating on the discrete components of fluid systems is to systematically focus research on to the key questions required to understand the geological processes that produce an economic mineral deposit or hydrocarbon accumulation. The approach is to define the "source" of metals, brines and hydrocarbons, the timing of generation or movement of the fluids, the "migration" pathways of the fluids, the location and timing of "trap" formation and finally the distribution and quality of the "seal" and "reservoir". In the case of a mineral system, the "source" may be intra- or extrabasinal; the "trap" will involve complex fluid–rock interactions, in contrast to the relatively simple volumetric trap for hydrocarbons; the "reservoir" is also more a function of the fluid–rock interactions; and the "seal" is probably more important in constraining migration paths that metal-rich fluids may take rather than a seal rock over a volumetric trap.

One of the main objectives of basin analysis is to define the structural and stratigraphic framework at the time of fluid movement so that the migration pathways and sites of potential "traps" can be predicted. The first step is to document the timing of tectonic events and elements that may influence the development of the basin under investigation. The second step is to establish a first-pass structural and stratigraphic framework that defines the sediment accommodation space during each phase of development of the basin. The geometry, characteristics and distribution of the sediment fill are defined during the third step. The fourth step involves the prediction of the distribution, character and timing of "play elements" within each basin phase, to define areas of higher economic potential in the basin. The fifth step is to define "plays" from combinations of play elements and evaluate the potential of each play to high grade areas of possible higher prospectivity.

Methods used to evaluate resource potential in basins have been documented by the Continental Margins Program and National Geoscience Mapping Accord projects during the past two years. An information system designed to ensure the smooth flow of data and information toward key products is now under development.

Garry Lowder

Dr Lowder is Director-General of the New South Wales Department of Mineral Resources. Before taking up this position in March 1993 he spent more than 25 years in the Australian and international resources industry, filling various roles, both in mining companies and as a consultant. For 10 years he held senior positions with Pancontinental Mining Ltd, initially in exploration management and, later, in a much broader context as Group General Manager—Corporate Development, where he was responsible for exploration and acquisition activities, as well as marketing, human resources, information systems, and strategic planning. Earlier, he spent several years with the major United States copper company, Kennecott, and consulted in both the geological and management areas.

Dr Lowder is a graduate of the University of Sydney, the University of California at Berkeley and the Advanced Management Program at the Harvard Business School.

STATES AND COMMONWEALTH—A PARTNERSHIP IN GEOSCIENCE MAPPING

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This article focusses on systematic (or series) regional geological mapping. A historical background gives an account, State by State, of regional mapping and liaison with AGSO. Historical changes in the working environment influencing the way geologists go about their work are reviewed, along with the complexity of the techniques currently available.

The development of the National Geoscience Mapping Accord (NGMA) is regarded as a success story in cooperation between States and Commonwealth, and the similar success of the Broken Hill Exploration Initiative (BHEI) is presented. Factors contributing to the success of these ventures are: sharing costs of expensive studies; sharing infrastructure and equipment; optimising diversity of skills; sharing of knowledge.

Recommended areas for future cooperation are continued geological mapping as one of the prime stimuli to exploration, development of regolith studies, deeper crustal studies using deep seismic techniques, continuation of the refinement of timing of geological events, and the application of computer techniques to map production and the development of GIS systems.

Neil Williams

Since March 1995, Dr Williams has been the Executive Director of the Australian Geological Survey Organisation. Before this, he was the foundation Executive Director of the Department of Primary Industries and Energy's other scientific research bureau, the Bureau of Resource Sciences.

Dr Williams holds an undergraduate degree in geology from the Australian National University and a PhD from Yale University, in the United States. After gaining his PhD, Dr Williams returned to the Australian National University for five years as a research fellow in the Research School of Earth Sciences. He then joined MIM's (Mt Isa Mines) exploration arm, Carpentaria Exploration Company Pty Ltd, as a senior research geologist. During his 10 years with MIM, he held various positions, including that of Chief Geologist. He returned to Canberra in January 1991 to take up the position of Associate Director in the then Bureau of Mineral Resources, Geology and Geophysics (BMR) and remained in that position until the formation of the Bureau of Resource Sciences in October 1992.

AGSO/BMR - 50 YEARS OF CHANGING NEEDS - WHAT NOW?

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"The best way to suppose what may come, is to remember the past"
George Savile, Marquis of Halifax (1633-1695)

As we celebrate AGSO/BMR's Jubilee and remember the past, what may we suppose about the next 50 years for Australia's national geological survey? Rick Wilkinson's recently published history of AGSO/BMR, *Rocks to Riches,* gives us some important clues about the future.

By international standards, AGSO/BMR is a relatively young national geological survey. While talk of a national survey goes back to the early days of the Australian Federation, it took the global crisis of World War II to show the necessity of a national survey to complement the work of the State Surveys. After the War, a national priority was the reconstruction of the country and its economy. The quest for sources of strategic minerals and petroleum resources during the War had focussed attention on the potential mineral wealth of Australia and, particularly, on our inability to assess and develop this potential because of a lack of basic information about Australia's geology. BMR was established to overcome this shortcoming, and Australia's present position as one of the world's leading mineral producers owes much to the vision of those who were responsible for BMR's formation.

Today, 50 years later, the world faces a very different global crisis—this time the threat of a global ecological catastrophe caused by exponential human population growth and our increasing demand for natural resources. Our present consumption rates of minerals, fossil fuels and biological and water resources are leading to environmental degradation and to growing concern about the viability of society as we know it.

In Australia, as elsewhere, Governments' policies are becoming increasingly focussed on the concept of ecologically sustainable development (ESD) as a means of averting a global ecological catastrophe. As this focus has sharpened, Australia is once again realising that a lack of basic information is limiting the achievement of a national priority, namely the sound management of our natural resources within an ESD framework.

There is an often underestimated geological component to the various natural systems upon which we rely for our natural resources and the challenge for AGSO now is to put the "geo" into ESD through the elucidation of this geological component and the impact the human race has on it. All relevant geological processes must be understood, including the rates at which they occur and the distances over which they operate.

For minerals and petroleum, where rates of formation of economic deposits and accumulations are slow relative to our exploitation of them, particular attention will need to be paid to the factors controlling their size and distribution, so that we can more realistically assess potential and improve the efficiency and effectiveness of exploration.

For soil and water resources, an improved understanding of the interaction between natural systems and human activities is vital if we are to overcome land degradation problems such as dry-land salinity and soil loss, which are threatening the biosphere and, in turn, our rural industries, our urban environments and our natural heritage.

Possibly, the area of greatest ignorance regarding natural resources is Australia's 16.1 million square kilometres of Ocean Territory. Here our knowledge of natural resource systems is comparable to what our knowledge of terrestrial natural resource systems was in the early 1880s, and marine geoscientific surveys have a particularly important role to play in overcoming this deficiency.