

## Current Research

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Special Feature: The role of the national geological surveys.

1. The Importance of Geological Surveys\*by GORDON A. GROSS, Commonwealth Geological Liaison Officer, Africa House, Kingsway, London WC2 6BD:

Events of the past six months have made the general public as well as government executives and politicians increasingly aware of the important part that the earth scientists have to play in planning and developing our way of life. With this growing awareness of our dependence on the earth sciences for exploration, development and management of our mineral and energy resources we observe various levels of appreciation and understanding by the public of the work of geological organizations. It is ironical at times to hear recommendations being made for government activity in resource appraisal and development which suggest the very work that the Geological Surveys were commissioned to do when many were founded more than 150 years ago. Their past achievements are vitally important but the lack of support and interest by the public for these organizations in the past has left much disappointment and frustration for the professional staff involved. The modern role and contribution to be expected from the Geological Surveys does not need to be constantly evaluated and adopted for a developing society.

Geological Surveys are organizations and institutions of geologists and technical specialists sponsored by national governments. Their purpose is to provide a basis of geological knowledge required for devising national policies, for government and industrial planning, and for information services, education and advising the public. They were among the first national scientific bodies to be organized in many countries, and Canada's founded in 1842, India's in 1851, Britain's in 1835 and others of the Commonwealth are among the oldest scientific organizations in the world. Survey geologists in most countries have been in the vanguard of exploration activities. Many of them in the early years were naturalists who reported to their sponsoring government on all aspects of the natural sciences, mineral resources and the possibilities for their development. This first elementary stage of geological reconnaissance has been completed in nearly all parts of the world but systematic, detailed and specialized geology required for resource and environmental appraisal has scarcely begun in many countries.

The necessity for having a basic knowledge of the nature and kind of terrain on which a society is founded is not questioned. Geological knowledge is a fundamental requisite for understanding environmental conditions existing on a particular kind of terrain, the kind and quality of development possible, and an appreciation of terrain in comparison to other or adjacent regions. The Geological Surveys throughout their existence have been concerned with these matters and with providing a competence for dealing with them in national policies and development. The task of the

Geological Surveys becomes increasingly involved and complex as urbanization and industrialization develops.

The Geological Surveys provide a qualified and continuing scientific organization which can work objectively in the interests of the whole country and its society. They have the task of obtaining and evaluating geological and related scientific knowledge and the understanding of it required by a country for defining its mineral resource potential and the restraints or limitations in the development of its natural resources. An objective and well qualified geological staff is required to provide knowledge about the terrain for formulating national policies and defining goals for development. They have an important contribution to make in evaluating implications of development proposals as they affect environment and the use or management of a natural resource heritage.

In Canada the role of the Geological Survey is fundamentally to provide a comprehensive inventory and understanding of the geological framework of the country, interpreted in terms of all national activities that make use of, or are affected by geology. The Geological Survey work is applied in the study of the environment; appraisal of fuel and mineral resources on land, on continental shelves and ocean basins; in the development and research of the geosciences; and in establishing standards, controls and references in the earth sciences; and in providing information services and systems, and scientific support through consultation and collaboration in other scientific and engineering activities.

### 2. The Role of the Geological Survey of India\*:

This office has received from the GSI a list of the functions and responsibilities assigned by Charter to the Geological Survey of India. The following text was originally published in the Gazette of India, August 25, 1973 (Bhadra 3, 1895) Part 1, Section 1, p. 790-791.

1. To prepare geological, geophysical and geochemical maps of the whole country and offshore areas within the territorial right of the country.
2. To explore and assess mineral resources of the country and the offshore areas by geological, geophysical and geochemical and other methods.
3. To conduct all studies pertaining to environmental geology including systematic geotechnical surveys for assisting environmental development and projects.
4. to undertake systematic studies and research in all sub-disciplines of the earth sciences, and methods and techniques of exploration and sensing.
5. To render advice to all government agencies with a national perspective on all matters related to the functions enunciated in this charter.
6. To provide on suitable terms technical services, advice and assistance to the public on matters related to functions enunciated in this charter.
7. To participate in inter and intra-governmental

\* Taken from the C.G.L.O. (74) Newsletter 7.

scientific projects of national interest and to co-ordinate all geological and allied activities for this purpose.

8. To generally liaise with similar organizations abroad including international scientific bodies and sister institutions in the country engaged on problems connected with the earth.

9. To make systematic collections of rocks, minerals and fossils from surface and sub-surface for scientific studies in the country and abroad, and also for the purpose of development of Museums and drill core libraries.

10. To hold as custodian of rare geological material of National and international interest and arrange for protection and preservation of geological interests such as National Geological Monuments and Parks.

11. To train scientific and technical cadres to undertake the programmed activities of the Department and to extend training and logistic assistance to Universities and Institutions for mobilization and training of the country's young scientific potential.

12. To collate, process, store, maintain and disseminate earth science data of all descriptions and from all sources through libraries, information processing units, Data Centres and through documentary and map publications.

13. To mobilize the country's resources of personnel and equipment in the field of geology and to co-ordinate their activities to the best advantage during a national emergency.

14. To undertake such other activities as may become necessary in the light of developments in the fields of earth sciences and related technology.

3. Geological Surveys in the Public Service\* by  
CHARLES H. SMITH, Assistant Deputy Minister, Canada  
Department of Energy, Mines and Resources, Ottawa,  
Canada:

I am honoured to have been invited to join and speak with you on the occasion of the dedication of the John Wesley Powell Federal Building - this remarkable building which is named after an outstanding geologist and explorer, which represents your National Centre for Earth Studies, and which stands for both the historical past and the future challenges facing the United States Geological Survey. The reputation of the USGS extends to all parts of the world, and it is obvious that Major Powell and the other scientists and politicians who were responsible for establishing the Survey in 1879 "planned better than they knew".

The phrase "geological survey" means different things to different people. To some it is the systematic recording of rock types along a picket line in the bush or a steep mountainside - and it excludes geophysical, geochemical, topographical and other related surveys of the earth. To some, the phrase "geological survey" refers to routine work and not research, which is called instead "geological science" or earth science. Modern day specialization has led to a multiplicity of professions, societies and allegiances, which feel more comfortable under such collective phrases as "earth sciences", "earth resources" and "earth surveys". We increasingly use the latter terminology, to the point where people may rightly ask, "What is

this institution - the Geological Survey? Either it is misnamed for the scope of its legitimate activities, or alternatively it is doing things beyond its mandate. By all the sacred principles of program planning and budgeting (PPB) the Geological Survey should cease and desist - cut out these other activities and use the money for geological work in the narrow sense -- or alternatively, why not rename the institution, as perhaps the National Earth Surveys and Research Institution?" It is unfortunately necessary to continually remind the uninitiated that geology means 'the study of the earth'; it is a respected name with a long and honourable history and is not a specialized subdivision of the term "earth sciences". Geology is an integrating science, created directly from man's observation of natural phenomena and his effort to understand them and make use of them, based upon many basic sciences and common sense.

I submit to you that the concept of a Geological Survey in government today is the same as originally conceived by your Powell, and our Logan, the founder of the Geological Survey of Canada. It encompasses the full spectrum of scientific and technical activities to provide data, information and advice on the national landmass and its resources, thus ensuring proper husbandry of the land and proper government of the nation. The original Geological Surveys included not only the full range of earth resource, survey and science activities of their day, but in addition, studies of the flora, fauna, and native peoples - the geologists of the day were indeed broad in interests and practice. Today, in many countries, these earth-oriented activities have become increasingly dispersed through a number of organizations, federal, state or provincial, in universities and industry. Earth science expertise has developed in various parts of government to serve such policy areas as defence, transport, agriculture, environment and energy, to name a few. The institution originally named the national "Geological Survey" is now a lesser component of the total earth survey - science - resource function of government than it was when originally formed. Nevertheless, the need of governments for accurate and timely information on their landmass and its resource base has not diminished, and one of the questions of the day is the role or responsibility of the national Geological Survey in providing that information and advice. My thesis is that governments, and the public, need, more than ever, to know in an integrated way about the landmass and its contained resources, and the conceptual model of the original Geological Surveys offers the best means of acquiring such knowledge as against recent trends of institutionally dispersing the inventory task.

To appreciate a central government's interests and responsibilities in earth studies, it is beneficial to look back to the early evolution of earth surveys, earth sciences, and interest in earth resources, which resulted in positive action by both our governments to formally establish Geological Surveys in the last century; then we might consider briefly the changing policies and thrusts of these organizations over the years; and the scope of their involvement in human affairs and

\* Address on the occasion of the dedication of the John Wesley Powell Federal Building, United States Geological Survey.

the changing needs of the future.

Earth surveys, earth sciences and earth resources have been inextricably entwined in the support of mankind's occupation and use of our planet. One can look far back to the first use of earth resources - flint, chert and other hard stones - for weapons by primitive man. Economic geology may have had its inception with the desire for gemstones and metals by the Egyptians and Greeks. This led to mining activities by the Egyptians as early as 2,000 B.C. The early history of earth surveys, or maps, is not easy to trace, but it is difficult to imagine a time when there were no maps. The ancient Babylonians certainly practised surveying, having made a cadastral survey of their kingdom in 2,800 B.C. Earth sciences followed in historical sequence, as mankind developed both the need and the capability to study and understand the mysteries of the earth - for both intellectual and practical benefit. The great sea voyages of the 16th to 18th centuries sparked research in map-making, geodesy and magnetism. This was the period of Mercator's maps, Copernicus' solar system, Newton's theory of gravitation. If one were to draw a conclusion from the early historical record, it would be that the conduct of earth surveys, interest in the earth sciences, and the development and use of earth resources grew steadily in response to man's occupation of the earth. In critical periods, earth surveys and sciences were of significant importance.

In the last century, at the period of the industrial revolution, man's interest increased remarkably in the search for greater quantities of earth resources. The development of new lands in the Americas not only depended upon the availability of mineral resources, but also on surveys and information of the land surface and its potential use. Geology was turning more and more into an exact science based upon a body of clear principles. Geologists accepted the concepts that rocks had formed by processes similar to those in action today; that in undisturbed strata the upper layers are younger; that fossils change from older to younger beds and can be used for regional or even worldwide correlation. There were strong debates over the sedimentary vs. igneous origin of rocks, and considerable progress was being made in establishing a uniform system of stratigraphic nomenclature. It was this fortunate confluence of intellectual ferment, industrialization and settlement that formed the environment for geology to assume a major role in governmental endeavours.

Governments have traditionally funded earth surveys in order to effectively administer the affairs of a land. Most of the earlier applications had centred around military activities and land settlement. In the early years of the nineteenth century, many states in your country sponsored geological surveys to evaluate the mineral resources and help with the disposal of state lands.

It is a mark of the wisdom and foresight of a generation, or governments, when major governmental structures are established and maintained well in advance of a need or crisis. Such events occurred when national geological surveys such as the United States Geological Survey and the Geological Survey

of Canada were formally established in the last century. I do not suggest there was not a need for these organizations at the time of their formation - rather, that the needs are greater, far greater, today than when Powell and Logan attended to the creation and development of our broadly conceived Geological Surveys.

The directions given by governments to the first directors of these Surveys, many years ago, are as meaningful today as when they were first stated. Clarence King, your first Director, was required to 'examine the geological structure, mineral resources, and products of the national domain, and to classify public lands'. William Logan was called upon to 'make an accurate and complete geological survey and furnish a full and scientific description of its rocks, soils and minerals which shall be accompanied with proper maps, diagrams, and drawings, together with a collection of specimens to illustrate the same'. Of course, in neither case did the governments of the day adequately estimate the cost or time span of such a task. Nevertheless, they pointed in the right direction and laid the foundation for the earth resource knowledge base of our nations today. The Surveys they created have become major instruments of economic and scientific development, with far-reaching effects that have gone beyond our national boundaries.

Governments have grown in size and complexity since the early founding years of their Geological Surveys. They have passed through years of abundance and shortages, wars and depressions. In each case the Geological Surveys have responded to the challenges placed upon them - to provide the nation with information and advice on its landmass and resources. In their formative years, work evolved around the exploration and settlement of the land. The members of the Survey became the foremost authorities on the unsettled regions. Their reports, maps, displays and lectures drew the attention of governments, industry, and the public to the resources and opportunities of the land. Along with their surveys came many scientific discoveries which attracted the attention of the international scientific community. They established a close relationship with the mining industry, providing information and ideas which guided prospectors to the most promising areas, contributing to the opening of major mining regions, and to the development of important mines. At times they were criticized for being too closely involved in the search for, as opposed to research on, ore deposits. At other times they were criticized for being too academic, or working in geographic areas too remote and inaccessible for short-term economic development. However, through this complementary relationship, industry and government have been successful in reaching a high level of mineral development in our lands. The Geological Surveys have also developed their supporting role to governments through the provision of sound information and advice for agriculture, for the military, for space programs, nuclear programs, foreign aid programs, earthquake and hazards prediction, engineering work, energy development, and many more. During both world wars, the Survey staffs were engaged in major strategic mineral

programs and resource appraisals.

Geological Surveys today are being put under increasingly severe pressures, probably greater than have existed in any peacetime period since the time of Powell and Logan. Human occupation over the surface of the earth has grown to such an extent that man is recognized as a significant geological agent. He has touched all parts of the earth's surface, penetrated the depths of the oceans and ventured into space. What he does not touch, he senses remotely. His erosion of nature's bounty is putting into question the adequacy of resources to maintain, for the future, established standards of life; and his alteration of the environment has created concerns about his ability to survive under conditions made almost suddenly different from those under which he has evolved. In the last hundred and fifty years, man's development has not been in the wise light of integrated knowledge but rather along compartmentalized thrusts. A developing technology and population have dictated at each moment or period of time the measure to which the earth's resources are used. A systematic measure of the earth's capabilities has not been the standard of man's discipline towards nature. Such a measure of the earth's capacity to stand modifications in its materials and in the regimen of processes should derive from the type of concerted action for which our Geological Surveys were created. Unfortunately, man's use of the earth has outstripped the rate at which the knowledge of our lands and their resource base has been generated, communicated, and understood by policy-makers and the public. The aim of Powell to "educate the nation" has not yet been achieved in any country.

The public is now becoming increasingly interested and concerned with the results of their Geological Surveys - and let us remember again the direction to Powell and Logan 'to survey the mineral resources'. Now the public and governments are concerned over increased warnings of resource depletion. The Secretary of your Department, Mr. Morton, stated recently that "the United States, and the world as a whole, face a crisis of exhausted natural resources within 25 years unless they act soon to develop the long range planning to prevent it". There have been equally startling statements about man's affect on his environment. Who will provide the public with the basic information respecting resource depletion or degradation of the physical environment? I submit this is the responsibility of the national Geological Surveys.

It might be asked, "Could not this responsibility be undertaken by Industry?" The task of gathering information on the mineral endowment and landmass has been pursued, since Powell and Logan, by industry, state (or provincial) and federal institutions, supported to a lesser extent by university groups. The success of Industry, in particular, has resulted from its ability to develop and exploit resource data in a competitive and confidential manner. A great many data have thus been collected by many groups, but they are not well co-ordinated or synthesized in a national sense. While Industry has synthesized national data for fuels, there have been no comparable national estimates by Industry for the other mineral resources.

The separate roles of Industry and governments in the process of resource inventory over the past hundred years is reminiscent of the situation in the 1870's, when rivalry between the military and civilian surveys brought disorder to government science, reduced public confidence in it, and resulted in the formation of the US Geological Survey to reduce duplication and increase efficiency! Without belittling the tremendous knowledge and expertise developed by Industry, I believe that the public is now seeking its own independent source of advice on the resources and environment of the nation. In our universities and non-profit research organizations there are a number of experienced and interested scientists with viewpoints on the resource base and its adequacy. Their role is extremely important in developing new methodologies and new concepts, and in assisting with the major role of educating the public. They lack, however, access to a sizeable data base which permits factual and timely statements on the national and international resource situation today. Our state and provincial surveys have significant responsibilities and expertise for resource and environmental studies. They have a significant role to play in generating and interpreting earth data and it is essential that these activities be developed and co-ordinated using uniform standards into the national picture.

Can a Geological Survey produce the timely and meaningful analyses required for the resource and environmental policies of the next decade? For Geological Surveys to rise to this increasing responsibility will require focussing talents and efforts in a manner not unlike those of wartime - but the possibilities of disaster warrant such a reaction, even if only to prove the predictions to be unfounded or premature. However, this advisory activity is fraught with many problems. The time is short. The existing data base is inadequate. A pooling of industrial and government data will be required for immediate effectiveness, along with new programs to obtain data from as yet unexplored regions. It is essential to an informed debate that the basic observations of industry and other groups become increasingly accessible in the public realm and new legislation may be required to bear on this problem.

But that is not all. We know that a single drill hole can still turn a 'barren region' into a 'Prudhoe Bay'. We must recognize that the methodology for manipulating resource data and forecasting concentrations in unexplored areas is also inadequate. Much depends upon intuition - or qualitative interpretations. We must look to those experienced in the vagaries of geology to extrapolate, now with the aid of the computer, the possible abundances of metals or fuels in unexplored areas. But how will the quality of their work be tested? It may not be subjected to the test used by industry - drilling - for many years. It may not be subjected to the normal tests of science - the reproducibility of results. Under such circumstances, the whims or judgements of a few specialists can have a major influence on the policies of a nation. In this area of judgement where the facts are not crystal clear, the special interests of scientists can easily influence their

interpretations. Hence a new system of checks and balances will have to be developed within the scientific community to test the work and conclusions of our colleagues. It will be a test of our Geological Surveys that they succeed in mobilizing our limited national expertise from all sectors for this work, and thus show true national leadership, as opposed to becoming merely one of a rising babel on the world scene.

What additional problems will this create for the Geological Survey? There will be problems of credibility, as the forecasts change with the addition of new information. There will be problems of communication in explaining the meaning and variations of resource estimates. There will be problems in confronting professional experts from other sectors, and in debating the technical terminology, data and interpretations in a public forum. However, such debates will have to occur with increasing frequency in the technical community, in order that the people or their elected representatives can make their own decisions.

There will also be problems to ensure that the pressures of this work do not cut excessively into the scientific excellence and quality of other essential Survey programs. Vigilance will be required to ensure there is a continuing buildup of the basic geological data and derived information, which provides a Survey with a springboard for any new thrust, in any direction, arising from the events or concerns of the day.

Before closing, I would like to add a word concerning the importance of international activities. Study and understanding of the earth is not limited by national boundaries. It is essential that governments, through their Survey organizations, work closely together to set the standards and methods for resource estimation. While there is a trend to consider such information to be of a semi-confidential nature, it is extremely important, in my view, that such knowledge be increasingly exchanged to provide a better basis for discussions on the resource problems and opportunities of the world.

The earth sciences and earth surveys are entering a new era of public service. It is up to the earth scientists and our earth science institutions to rise to this challenge and show that the dreams and aspirations of Powell and Logan were not in vain. It is up to the national Geological Surveys to lead the way by co-ordinating the many centres of information now existing across the land and, by building upon their established reputations for excellence and objectivity, to ensure that the public receives the information and sound policies required to meet the new way of life which lies ahead.