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Author Biography:

J.M. (Murray) Duke is a graduate of McGill University (B.Sc. 1968, M.Sc. 1971) and the University of Connecticut (Ph.D. 1974). He joined the Geological Survey of Canada in 1976, following postdoctoral studies at the University of Toronto. As a research scientist at the Survey, he focused on the economic geology of mafic and ultramafic rocks, publishing about 40 papers on nickel-copper sulphide, platinum group element, chromite and asbestos deposits. Murray became Director of the GSC's Mineral Resources Division in 1988, Director-General of the Minerals and Regional Geoscience Branch in 1995, and Director General of the Central and Northern Canada Branch in 2005. He was also active in the broader geoscience community, serving as an associate editor of the journal Economic Geology, and as Secretary, Vice President, and President of the Mineralogical Association of Canada. The MAC awarded him the Leonard G. Berry Medal in 1996. Since retirement from the public service in 2006, he has undertaken projects for federal, provincial and territorial government departments as well as the private sector in the areas of strategic planning, program impact assessment, and the public policy rationale for public geoscience.

REFLECTIONS ON THE GSC 1988 TO 2006

MURRAY DUKE

CONTENTS

PROLOGUE

I began my thirty-year career in the Geological Survey of Canada in June 1976 as a research scientist in the Mineral Deposits Geology Section of the Regional and Economic Geology Division. During the first eight years or so, I was afforded the luxury of devoting most of my time to research on the geology of nickel and chromite deposits. Survey management also supported my involvement in the Mineralogical Association of Canada as Secretary, a position that I held for seven years. These were scientifically exciting times, especially latterly, when I was part of a research group known colloquially as the "Ultramafia", which included colleagues Roger Eckstrand, Jon Scoates, Larry Hulbert, and Brian Williamson.

Like most Survey scientists, I had previously had little interest in a career in management, preferring instead to keep my eye on a different prize - the pinnacle of the Research Scientist category.[1] My perspective began to change in 1981, when I was sent on a research managers' course as a last minute replacement for my colleague Jim Franklin. This experience opened my eyes to the broader context of government and, in particular, the role of science in public policy. I began to take on management responsibilities, first as Head, Mineral Deposits Geology Section (1983-86) and later as Head, Mineral Deposits Subdivision (1986-1987), within the newly formed Mineral Resources Division.

Mineral Resources Division (MRD) was established following the amalgamation GSC and Earth Physics Branch in 1986. MRD was a combination of the Economic Geology and Mineralogy Division and Resource Geophysics and Geochemistry Division (although some elements of the latter had been transferred to Terrain Sciences and Geophysics Divisions). The second phase of the GSC-EPB re-organization was the creation of four branches.[2] D.C. Findlay became Director-General of the new Continental Geoscience and Mineral Resources Branch, and I succeeded him as Director, MRD.

This narrative covers my years as Director of Mineral Resources Division (1988-1995) and subsequently as Director General of Minerals and Regional Geoscience Branch (1995-2005) and Central and Northern Canada Branch (2005-2006). The first part of my account overlaps that of D.C. Findlay, who described events from 1970 to 1995.[3] I believe that we generally agree on the facts, but I trust that my perspective will provide some additional insights.

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[1]The senior ranks of the public service included relatively few scientists. This reflected the fact that for all intents and purposes, a scientist had to choose between a career path in research and one in management. One reason for this was that accomplishments as a manager counted little towards promotion as a Research Scientist and did not offset the scientific productivity forgone during a stint in management.

[2] A.G. Plant has outlined the changes in the GSC organizational structure over the years in separate contribution to the GSC History Series (in draft).

[3] Findlay, D.C. *Notes on some events and activities at the Geological Survey of Canada, 1970-1995.* Friends of GSC History, Series A - Historical Contributions no. GSCHIS-A014, 2010; 42 pages.

My account is divided into three sections that I have called *Reinventing the GSC (1988-1995)*, *Picking-up the Pieces (1995-2000)*, and *The Virtual GSC (2001-2006*). Although these correspond to the tenures of the three Assistant Deputy Ministers responsible for the GSC during these years (Ken Babcock, Marc Denis Everell, and Irwin Itzkovitch), it is not my intent to focus on personalities. There is no doubt that the leadership styles and preoccupations of these individuals had a significant impact on life in the GSC and would make an interesting story in its own right. However, my premise is that the evolution of the GSC during these years was influenced more by the policy environment in which it operated than by the personalities of its leaders. In my narrative, I will attempt to identify some of the government policies that had the greatest consequences for the Survey.

The topics that I have chosen to highlight are a mixed bag, including some that had a major impact on the GSC, such as the government's Program Review in the mid-1990s, as well as inconsequential but interesting events, such as the abortive attempt to rename Mt. Logan in honour of the late Prime Minister Trudeau. At the outset, I had planned to include an overview of the GSC's contributions to science during these years, but quickly came to the conclusion that that was too daunting a task for one individual. In any case, the scientific priorities and highlights have been described in published planning documents and annual reports.

Finally, I would like to offer a *caveat*. What follows is by no means a history of the GSC: the content is neither comprehensive nor balanced. Rather, it provides a personal perspective on selected events in which I was often an active participant and, as such, undoubtedly reflects some personal bias. My colleagues both inside and outside the GSC might well see things differently.

Acknowledgements

I am grateful to Chris Findlay and Gina Lecheminant for their reviews of the manuscript, as well as to Bob Garrett and Alfonso Rivera for their comments on the sections dealing with Metals in the Environment and Groundwater Programs, respectively.

REINVENTING THE GSC (1988-1995)

Mont Ste-Marie and the Sandbox Speech -The New Public Management – The Ten Percent Solution – A New Strategic Plan and the Beginnings of Program Management – Revenue Generation, Joint Projects, and the Industrial Partners Program - Probing the Third and Fourth Dimensions - The 150th Anniversary – Strategic Reallocation – New Department, New Government, But No New MDAs - Hitting the Wall: Government-wide Program Review

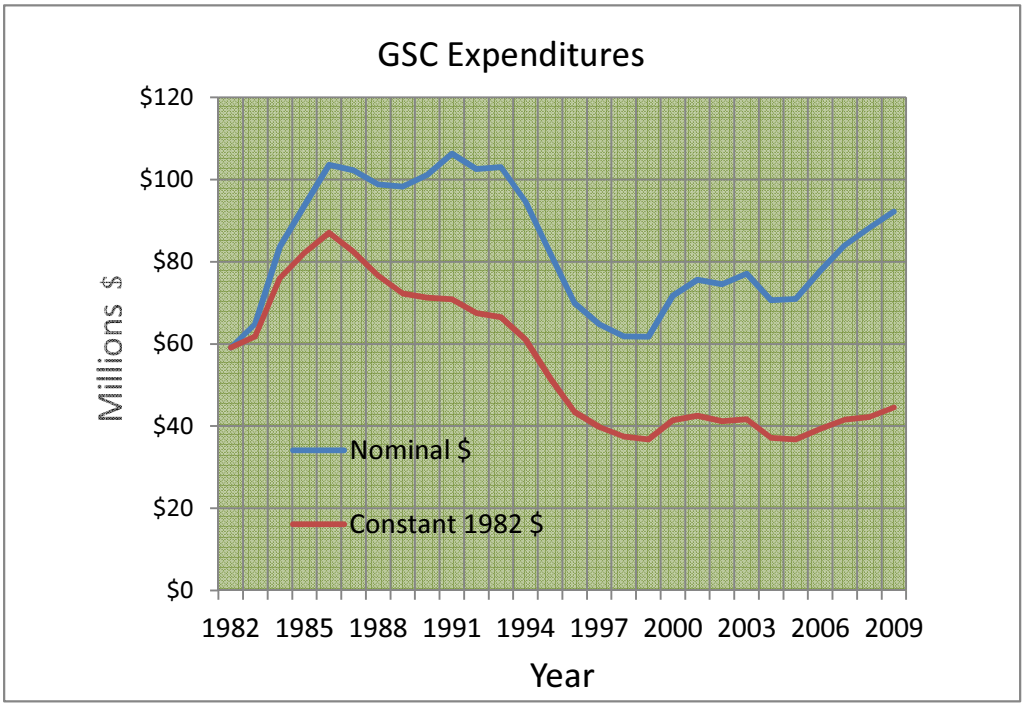
MONT STE-MARIE AND THE SANDBOX SPEECH

The point of departure for my narrative is the GSC Planning Conference convened in Mont Ste-Marie in November 1987. Although I had recently won the competition for Director MRD, the result had not been announced and I was not supposed to let my scientific colleagues know that I was about to "go over to the dark side". In the event, before taking up my new position, I underwent four months of full time French language instruction at the government training centre in a converted high school on Carson Road in the east end of Ottawa. In the meantime, it was announced that Assistant Deputy Minister R.A. Price would be leaving the Survey for a position at Queen's University and that E.A. (Ken) Babcock, formerly Vice President of the Alberta Research Council, would assume the ADM position in September 1988. My first attempt at the French test was not successful and I began my new job on acting basis in the summer of 1988, not long before Ken Babcock assumed his position.

Two things stand out in my recollection of Mont Ste-Marie. The first was a presentation by policy advisor John Harrison highlighting the burgeoning government debt and the grim outlook for future program funding. To put this in context, GSC expenditures had reached their highest level ever in 1987. Funding had increased significantly in the early 1980s due to Mineral Development Agreements (MDA) and the Frontier Geoscience Program (FGP), among other "sunset" initiatives. Although funding did not begin to decline immediately, the lack of inflation adjustment resulted in a substantial reduction in spending power (Figure 1a). In 1992, the government signalled significant budget reductions, and then in 1994, the newly elected Liberals launched its massive government-wide Program Review. It took until 2000 to staunch the bleeding and by 2009, expenditures had returned to the 1987 peak in nominal terms (dollars-of-the-day), but about half in constant dollars.[4]

I have also compared the trend in expenditures of the GSC and provincial/territorial surveys (Fig. 1b). There are two salient points. First, total expenditures by all governments on geological surveys in 2009 were only about 60 percent the level of the mid-1980s in constant dollar terms. Second, GSC's share had declined from about two-thirds to parity.

[4] The expenditures in Fig.1 have not been adjusted for the transfer of some corporate functions from GSC to the amalgamated Earth Sciences Sector in 1996, which at the time amounted to $11.5 million. If these were added back in, the 1987 and 2009 nominal dollar totals would be similar.



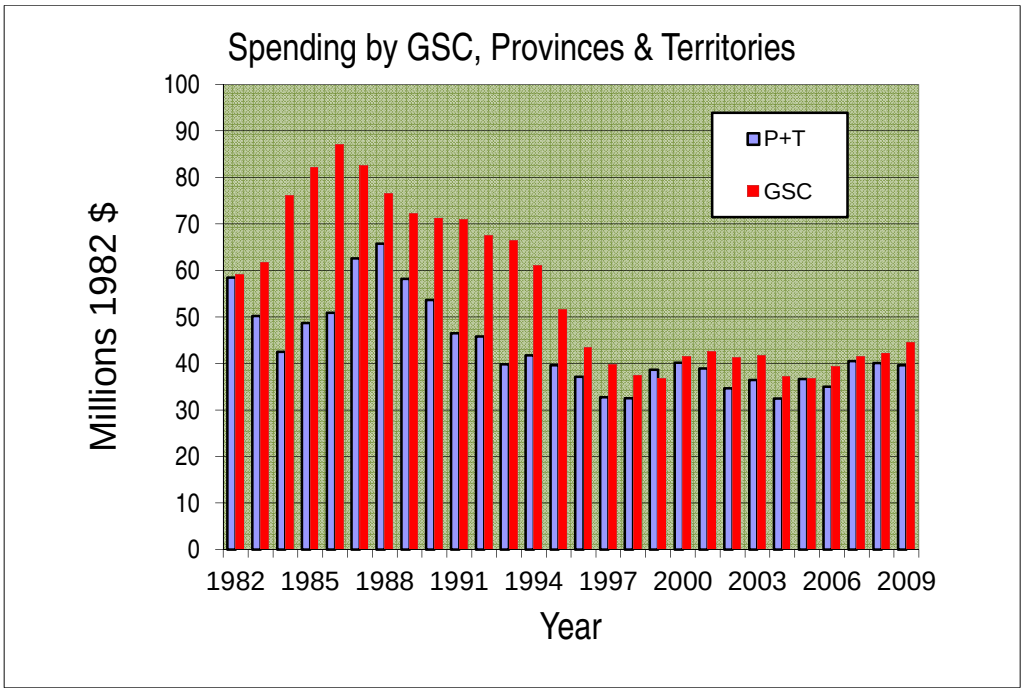


Figure 1: (a) GSC expenditures 1982-2009 in nominal and constant 1982 dollars. (b) Total spending by GSC, provincial and territorial surveys in constant 1982 dollars. [5]

[5] After Duke, J.M. (2010) *Government Geoscience in Support of Mineral Exploration: Public Policy Rationale and Impact.* Prospectors and Developers Association of Canada. 64 pp. GSC totals include Earth Physics Branch but exclude the Polar Continental Shelf Project. Totals before and after

My second vivid memory of Mont Ste-Marie was a presentation of Associate Deputy Minister Pierre Perron, in which he likened GSC scientists to "children playing in their sandbox". I took this to mean that from his perspective, these scientists were interested only in their own research and cared little about societal needs and government priorities. His speech had the effect of an enormous bucket of cold water thrown on the participants, who had spent the two preceding days engaged in anything but sandbox play. Although Perron's remarks were stunningly tone deaf, they nevertheless betrayed a perception of the Survey that persisted in certain quarters for several years. Deputy Minister Bruce Howe, for example, was fond of referring to GSC as "the Jesuits". Some other senior department officials put it less poetically, describing GSC as "a university without classrooms". In retrospect, I think that these perceptions were indicative of a redefinition of the role of government science that would play out over the next decade.

The federal government had recently identified industrial innovation and technology diffusion as key elements of its science policy.

> *Since the late 1980s, the government has seen the major important direction for S&T as increasing competitiveness. This trend has resulted in a larger share of grants and government research being aimed at developmental rather than basic research; more partnerships between government laboratories, universities and private businesses; and a general refocusing of government R&D efforts towards competitiveness.* [6]

The change in emphasis also appeared to downplay if not actually militate against government's role in building a national information base for the public good.[7]

The larger context of this debate was what would become known among students of public administration as the "New Public Management".[8] NPM emerged in Margaret Thatcher's Britain in the early 1980s and quickly spread to many other jurisdictions. Johnson has reviewed the principles of NPM and its evolution in the Mulroney, Chretien and Martin governments.[9] Because the tenets of NPM strongly influenced the evolution of GSC during the late eighties and nineties, a short summary of its characteristics is in order.

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amalgamation of GSC and Geomatics in 1996 are not strictly comparable due to centralization of some corporate services (see also footnote 4).

[6] Brassard, Daniel (1996): Science and Technology: The New Federal Policy. Library of Parliament, Parliamentary Research Branch Background Paper BP-414E. 23 pp.

[7] Price, R.A., Campbell, F. and Smith, E. *EMR's Public Good Mission*. Internal memorandum for Strategic Planning Session. 29 July 1988.

[8] Hood, C. (1989) Public Administration and Public Policy: Intellectual Challenges for the 1990s. *Australian Journal of Public Administration*, v.48, pp. 346-358.

[9] Johnson, David (2006) *Thinking Government: Public Sector Management in Canada*. University of Toronto Press, 668 pp.

THE NEW PUBLIC MANAGEMENT

The New Public Management (NPM) was a response to a number of trends. One was a loss of confidence in government, especially at the conservative end of the political spectrum. In 1979, Margaret Thatcher had been elected in the United Kingdom with a mandate to reduce government's role in the economy and promote market solutions. Ronald Reagan, in his first inaugural address in 1981, famously said "*In this present crisis, government is not the solution to our problem; government is the problem*". Rapidly escalating public debt was another driver: regardless of political perspective, it had become imperative to reduce the cost if not the size of government. Finally, there was the belief that adoption of private sector business practices and increased exposure to market forces would make governments more efficient. In the United States, the book *Reinventing Government* became a popular best seller (and inspired the title of this first part of my narrative).[10] This movement coincided with the rise of what political philosopher Michael Sandel has called "market triumphalism" – the notion that markets are "the primary means of achieving the public good".[11]

Three characteristics of NPM that are particularly relevant in the present context are managerialism, market-orientation, and alternative service delivery. *Managerialism* is defined as the application of commercial business management practices to government or public service organizations. These included the adoption of mission statements, strategic planning, business plans, quantitative performance measures, Quality Management initiatives, and so on. *Market-orientation* refers both to measures that make public services subject to market forces and to government's role in facilitating markets. One manifestation of the former was the new priority accorded revenue generation and cost recovery. *Alternative service delivery* involves different means to deliver public services and runs the gamut from privatization and public-private partnerships, to crown corporations and special agencies within government, to contracting-out.

Each of these became a priority of the federal government and, therefore, of Energy Mines and Resources. They are inherent, for example, in EMR's three department-wide goals in the early 1990s - Program Performance, Collaborations and Efficiency of Program Delivery, and Revenue Generation.[12] The last of these had a particular impact on the GSC, which I describe in more detail below.

The Department's most significant movement in the direction of Alternative Service Delivery was a proposal to convert its three scientific sectors into Special Operating

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[10] Osborne, David and Gaebler, Ted (1992): Reinventing Government – How the Entrepreneurial Spirit is Transforming the Public Sector. Addison Wesley. Reading, Mass. 436 p.

[11] Sandel, Michael J. (2012) *What Money Can't Buy: The Moral Limits of Markets*. Farrar, Straus and Giroux. New York. 272 pp.

[12] *EMR Annual Management Report 1991-92*

Agencies (SOA).[13] Indeed, the 1993 Federal Budget announced that GSC's sister sector - Surveys, Mapping and Remote Sensing (later Geomatics Canada) - would be transformed into an SOA as a pilot project. In September 1993, GSC and Minerals and Energy Technology Sector (CANMET) formally submitted a joint proposal to the Deputy Minister seeking SOA status by April of the following year. In October, the Deputy directed that this proposal be put on hold pending the outcome of the SMRS pilot and, given that a federal election was to take place on October 25th, the views of a new Minister. The election resulted in a change of government and, to my knowledge, the question of SOA status for GSC was not formally raised again.[14] The SMRS pilot was delayed and finally put to rest about three years later. One argument for the *status quo* was that the department's revised IMAA[15] agreement with the Treasury Board provided sufficient revenue retention and financial flexibility. Perhaps an even more important factor, in my opinion, was that following Program Review, the perception of the role of government began to focus again on the public good mission. I will return to this below.

Many elements of NPM survived and are now standard practice. Others proved less durable. One principle that enjoyed but a short life was the notion of decentralizing decision-making, reducing the layers of management, "letting the managers manage", and empowering frontline employees. PS 2000, a government-wide initiative launched in 1989 to accomplish these goals, collapsed within two years owing to resistance from central agencies as well as political concerns.[16] One provision of PS 2000 was that each department should develop a "mission statement" and an accompanying set of values and service-oriented goals. In EMR, this took the form of the Mission Project, which involved a large number of staff at various levels. The resultant mission statement and values were for a while prominently displayed on colourful (some would say gaudy) plaques in virtually every common-use area in the department. Excellence EMR – a "quality management initiative" - followed hard on the heels of the Mission. Predictably, GSC rank and file were not enthralled by these initiatives and their ill-concealed distain undoubtedly reinforced the Deputy's perception of "the Jesuits".

THE TEN PERCENT SOLUTION

In the autumn of 1988, shortly after becoming ADM, Ken Babcock announced an internal resource reallocation exercise. Accordingly, the budget of each division would be reduced by 10 percent. Directors were required to identify program activities within their Divisions that would be eliminated to accommodate the reduction. The staff and financial resources that were freed-up would then be used to support new program proposals. Staff

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[13] A Special Operating Agency is a discrete unit within an otherwise conventional department structure that is given increased management flexibility to enhance service delivery. The Passport Office, which became an SOA in 1990, is perhaps the most familiar example.

[14] Although not *formally* proposed, SOA conversion was briefly considered in as one option to mitigate the impact of Program Review process in 1994-95.

[15] *Increased Ministerial Authority and Accountability*

[16] Johnson (2006) *op. cit*.

that could not be accommodated in the new initiatives would be declared surplus to requirements.

The process played out in a series of difficult meetings over the over the winter of 1988-89. It represented a significant departure from past practice in terms of budget allocation. GSC had been operating in a context of increasing resources for a number of years, and directors had had considerable discretion in allocating resources once division budgets were established. The new approach was a zero-sum game across division boundaries. It required consensus not only about new program directions, but also on activities to be eliminated.

The ADM formally announced the results of the reallocation process on 5 July 1989 in a memorandum entitled *In Search of Excellence - The Best Geological Survey in the World.*[17] Funding was allocated to seven new science initiatives and two corporate priorities:

Initiative	Funding
National Geoscience Mapping Program (NATMAP)	$ 50,000
Western Canada Sedimentary Basin	$ 300,000
Coastal Environmental Geology	$ 250,000
Exploration Science & Technology (EXTECH)	$ 200,000
Environmental Geochemistry	$ 250,000
Global Change	$ 250,000
Earthquakes and Geodynamics	$ 400,000
Communications	$ 150,000
Technology Transfer	$ 15,000

Although the funding allocated to each of these initiatives was not large, it leveraged much larger amounts from divisional reference levels. Also, the allocation to the National Geoscience Mapping was for program planning and development. A National Workshop was held in Toronto in March 1990, which ultimately led to initiation of a robust NATMAP Program in 1991. The NATMAP budget exceeded $1.2 million once the program was fully implemented.

Notwithstanding the difficulty of the resource allocation process, I think that the resulting program shift was a step in the right direction. The bottom line, of course, is whether it resulted in positive change. Were these really new initiatives or simply a re-packaging of activities that would have been carried out in any event? Did they meet their scientific and policy objectives?

I think it is fair to say that by and large the initiatives were successful from both the scientific and policy perspective. NATMAP and the more modest EXTECH each spawned a series of successful projects over more than a decade. After overcoming initial suspicion on

[17] The title of the memorandum may have been inspired by *In Search of Excellence*, the popular management treatise by Peters and Waterman (1982).

the part of some provincial surveys, both programs became highly sought after vehicles for federal-provincial collaboration. As many as six NATMAP projects were underway at any given time and thirteen had been completed by the end of the program in 2003. An evaluation completed in 2000 estimated that NATMAP produced more than 500 geological maps and 1500 reports.[18] Funding for EXTECH, which focussed on mining camps, was sufficient for just one project at a time, and four were completed over the life of the program - Snow Lake (MB), Bathurst (NB), Yellowknife (NWT), and Athabasca (SK).

The Environmental Geochemistry and Global Change initiatives each provided a springboard for GSC to play an important role in emerging policy issues. The former evolved into the Metals in the Environment Program, which I describe in some detail below. The Global Change Program was able to leverage funds from the government's Green Plan (1990) and laid the foundation for later work on Climate Change.

Another positive result was that these initiatives fostered a culture of large, multidisciplinary, multidivisional and, in some cases, multi-agency projects. In his account, D.C. Findlay describes early efforts to depart from the "one scientist, one project" approach in mineral deposits research. This change was not immediately embraced by all scientific staff, many of who had become accustomed to considerable autonomy. Moreover, some of those who took on the leadership of large projects found that it came at the expense of their own scientific production and, they feared, career advancement. New recruits adapted well to this approach – they had little choice – and in time, most long-serving scientists also learned to use it to their advantage.

A New Strategic Plan and the Beginnings of Program Management

At about the same time, the GSC embarked on another strategic planning exercise. Development of a new program structure was integral to this process.[19] Up to that point, the program and organizational structures were identical. The problem with that arrangement was that the mandates of the eight operational divisions[20] were a mixture of regional and disciplinary responsibilities. This led to some duplication of expertise among divisions, but more importantly, was virtually incomprehensible to policy makers, parliamentarians and the general public.[21] The motivation for having a program structure

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[18] Robertson, Blyth (2010). NATMAP – Canada's National Geoscience Mapping Program: 1991 – 2003. *Geoscience Canada,* v.37, no.3.

[19] "Program" is used here in the informal sense of an arbitrary subset of GSC activities rather than in the formal context of the government's expenditure management system, in which a program is a larger entity described in the Estimates and approved by Parliament. In the 1980s, the GSC was funded as an "Activity" under the Minerals and Earth Sciences Program, and the various GSC Divisions constituted "Subactivities".

[20] Cordilleran and Pacific Geoscience, Sedimentary and Petroleum Geology, Atlantic Geosceince Centre, Mineral Resources, Lithosphere and Canadian Shield, Quebec Geoscience Centre, Geophysics, Terrain Sciences.

[21] This was not a new issue. For example, the GSC Annual Report for 1972-73 described the relationship between the program and government priorities in the form of a matrix.

was to make "….a clear link between activities and the [societal] needs that they serve".[22] This approach was well-received by outside observers: for example, it was chosen as one of five case studies of service improvement by federal agencies.[23]

The new structure comprised five programs: **Geoscience Surveys**, **Minerals**, **Energy**, **Environmental Geoscience**, and **Geoscience Information**. Although this, too, was a hybrid, it should have been more understandable to the outsider. There was much debate at the time about the Geoscience Surveys Program. The largest program by far, it incorporated most of the Survey's traditional mapping activities. The debate was whether to consolidate the latter in a separate program or to capture the various surveys under the most relevant area of application. Ultimately it was felt that any given geoscience map potentially serves a range of applications. The decision was probably influenced as well by the belief that mapping remained the core role of the GSC.

The responsibility for developing and updating the strategic plan of each program was assigned to a senior manager – for example, I was designated leader of the Minerals Program. Once program priorities and resource requirements were established, budgets were allocated to divisions as before. Because the programs were inherently national in scope and multidivisional, division directors were typically accountable for delivery of components of more than one program. Program "leaders", on the other hand, had little formal control over program components delivered by other branches and divisions.

Although the approach worked reasonably well as a means for planning and presenting GSC activities, the reconciliation of organizational structure and program management would be an ongoing management issue for the next 15 years. I shall return to this below.

Although not the first such document produced by GSC, the *Long Term Strategic Plan* of 1991 was, as far as I know, the first to be published and widely distributed. Looking at the document now, with the benefit of 20 years hindsight, I think that it stands up reasonably well in terms of the identification of emerging issues and of users' needs and priorities, especially the renewed interest in the environment. For example, it committed the Survey to re-institute research in hydrogeology, which had been transferred to Environment Canada in the 1960's, enhanced work in Global Change, and initiated a new effort in environmental geochemistry.

In the case of the Minerals Program, for which I was responsible, five strategies were identified: a shift of emphasis of metallogenic and mineral deposits research from gold and precious metals to base metals, piloting a multidisciplinary approach to exploration for buried deposits through the EXTECH initiative, a commitment to document major Canadian deposits and mining camps, and studies of off-shore minerals – in particular, the anticipated

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[22] Geological Survey of Canada (1991) *Long Term Strategic Plan*, p.1.
[23] Doern, G. Bruce (1994) *The road to better public services: progress & constraints in five Canadian federal agencies*. Institute for Research on Public Policy, Montreal, 107 pp.

Ocean Drilling Program exploration of massive sulphide deposits on the Juan de Fuca Ridge, which had been discovered by GSC scientists in the mid-1980s.

REVENUE GENERATION, JOINT PROJECTS, AND THE INDUSTRIAL PARTNERS PROGRAM

Revenue generation became an explicit priority of EMR in about 1990. Although the *user pay principle* had long been government policy, it began to be pursued more aggressively in the late 1980s. The goal was not only to recover some or all of the costs of providing services, but also to reduce demand where possible:

> *…to promote the efficient allocation of resources (i.e., to eliminate the excess demand that often exists with "free goods", by subjecting programs to a market test of supply and demand)….. to promote an equitable approach to financing government programs, mandatory or otherwise, by fairly charging clients or beneficiaries who benefit from services beyond those enjoyed by the general public…to earn a fair return for the Canadian public for access to, or exploitation of, publicly-owned or controlled resources…* [24]

Departments were given greater financial flexibility under the provisions of *Increased Ministerial Authority and Accountability (IMAA)* agreements negotiated with the Treasury Board. These included mechanisms to retain a portion of revenues that would otherwise accrue to the *Consolidated Revenue Fund*. However, because departments were not supposed to profit from cost recoverable activities, this flexibility came at the cost of reduced reference levels.

The vote-netting mechanism allowed the Survey to retain the revenues from fees charged for a variety of goods (*e.g.*, publications, data, rock and mineral sets) and services (*e.g.*, consulting, laboratory analysis). In practice, however, opportunities for revenue generation were limited by several considerations. One of the most important was that the government must not compete for business with the Canadian private sector. The Survey did have some unique laboratory capabilities, for example, which could serve external clients without competing with commercial labs. However, it was more difficult to make the case for consulting services, especially in the resource sectors, where there was a large industrial presence.

The noteworthy exception was international development assistance (IDA), where government involvement could help Canadian companies generate business from either foreign governments or international development banks. In many instances, bidding for these IDA contracts was limited to governmental organizations, and national geological surveys from Europe, in particular, had become very active in this respect. The GSC partnered with Canadian companies in a number of such projects during the 1990s in the

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[24] Treasury Board Secretariat (1997) *Cost Recovery and Charging Policy*. http://www.tbs-sct.gc.ca/archives/opepubs/tb_h/crp-eng.asp

Middle East, Africa and South America. In some cases, GSC acted as project leader and subcontracted work to Canadian companies. In others, the roles were reversed.

Whereas vote-netting allowed retention of revenues from the sale of goods and services to clients outside government, Incremental Cost Recovery was used to offset expenses incurred in supporting other government departments. Examples included work that GSC undertook in support of Mineral and Energy Resource Assessments to inform decisions about the locations of proposed national parks (Heritage Canada), the Comprehensive Nuclear Test Ban Treaty (DFAIT), and CIDA-funded international development assistance. Whereas costs recovered through vote-netting could include overheads, Incremental Cost Recovery applied only to direct expenditures.

Although cost recovery never did become a significant source of revenues, the GSC was able to attract a considerable amount of external funding for joint projects using Specified Purpose Accounts (SPAs). Accordingly, a company wishing to support a particular GSC project could deposit funds in an SPA, which could then be used to defray certain eligible costs (*i.e.*, incremental costs incurred in the project, but not overheads or salaries of permanent staff). This type of cost-sharing had a significant impact on GSC activities in the mid-1990s from both the financial and programmatic perspectives.

Philosophically, joint projects were consistent with both the market-driven ideals of the New Public Management and the government's S&T policy that promoted collaboration and partnerships. As noted above, a key element of the latter was to promote innovation and technology diffusion in the private sector. It followed that where unique scientific capabilities existed in government, these should be deployed to assist industry. Towards this end, GSC implemented the Industrial Partners Program (IPP) in 1992. Projects were selected by a competitive process from proposals solicited from staff, and funded in part from a central pool. The IPP was reasonably successful in accomplishing its objectives, as demonstrated by an external evaluation of 26 projects conducted in 1994[25], and "IPP-like" projects continued to be part of the GSC portfolio well after the demise of the formal program in 1996. The IPP was not without its detractors, including some provincial geological surveys that felt they should be more fully consulted and involved in the projects.

External funding typically accounted for 10 to 15 percent of GSC expenditures during the 1990s. Some observers at the time said that this was an appropriate level of external funding for a government department: enough to ensure that it was "connected" to the market, but not enough to detract from mandated activities. For example, Stuart Smith, former Ontario Liberal leader and Chair of the Science Council of Canada, made this point a few years later during an Earth Science Sector management retreat. Others thought the proportion of external funding should be higher; for example, in 1993, the ADM projected that funding from industry would increase to 20 percent within two years. However, because external funds were mostly used to cover O&M expenditures rather than salary and capital, the 10 to 15 percent effectively leveraged 30 to 45 percent of the total budget.

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[25] Described in *Geoscience Making a Difference* (GSC Annual Report 1994-95).

As noted above, the concern about competing with the private sector limited fee-for-service opportunities. The more serious implication, in my opinion, was that the emphasis on revenue generation, joint projects, and industrial partnerships threatened to undermine the Survey's core public good mission and its cherished image as an honest broker of geoscience information. For the economist, public goods are characterised by non-rival consumption and non-excludability.[26] The former means that one person's consumption of a good or service does not decrease its availability to others. The latter means that it is impossible or impractical to limit access to the good. In general, the marginal cost of providing a public good is negligible, which, in turn, means that it is inefficient to charge for its use. The lighthouse is a classic example described by John Stuart Mill in1848. The cost of running the lighthouse is independent of the number of ships using it for navigation (zero marginal cost), use by one ship does not limit its use by others (non-rival), and there is no practical way to prevent certain ships from using the light (non-excludable). Because these characteristics militate against market forces, the provision of public goods is an important *raison d'être* of government. The provision of geological information as a public good has long been among the principal justifications for government geological surveys everywhere. I have reviewed this literature in more detail elsewhere.[27]

When staff and facilities were devoted to a partnership project, they were not available for other mandated activities, and because such projects were normally carried out under a contractual agreement, they would take priority. Moreover, partnership projects typically afforded the private sector partner a period of privileged access to the results of the research. In some cases, the line between consulting and a joint project was very fine indeed. The dilemma facing managers in deciding whether to approve a project was whether the benefits accruing to private interests in the short term were offset by the benefits to the public in the longer term.

By the nature of its activities, Mineral Resources Division routinely faced such questions. For example, in the early 1990s we embarked on a series of major base-metal deposit studies (Sullivan, Kidd Creek, Brunswick, and Flin Flon-Snow Lake). The mine operators arguably stood to benefit should the research help identify new reserves, both from advanced access to results and by virtue of holding the mineral rights. Balanced against this was the public interest in sustained production at these declining deposits, as well as the benefits of what economists call "information externalities": in other words, the possibility that public information about a deposit would stimulate successful exploration in the area by other companies. It was also important, in our view, to ensure that these world-class deposits were adequately documented before they ceased production and became inaccessible to future researchers and explorationists.

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[26] The distinction between "the public good", which in the vernacular is synonymous with the public interest, and "public goods", as used by the economist, is important in this context.
[27] Duke (2010) *op. cit.*

PROBING THE THIRD AND FOURTH DIMENSIONS

One of the GSC's over-arching scientific objectives in pursuing its traditional mandate in the 1980s and 1990s was to enhance understanding of the Earth's crust in the third and fourth dimensions – depth and time. The framework for much of this effort was LITHOPROBE, the largest and arguably most successful geoscience research project ever undertaken in Canada. From its start in 1984 to its completion in 2005, LITHOPROBE had involved more than 900 scientists drawn from 32 university departments, 50 private companies, and most of the government surveys in Canada, and had produced about 1500 publications. The program was directed by Professor Ron Clowes of the University of British Columbia, who has summarized its accomplishments in a number of review articles.[28]

The GSC was one of the principal partners, devoting more than $40 million to LITHOPROBE over the life of the program. This was a significant amount, especially given that it came from the Survey's base budget. More important than the money, however, was the involvement of GSC staff. In the early 1980's, GSC senior managers and scientists had a lot to do with developing the vision of LITHOPROBE and securing the funding needed to make it a reality. People like Ray Price, Mike Berry, Alan Green, Roy Hyndman, Chris Yorath and Charlotte Keen played a strong role in shaping the program at the outset, and dozens of GSC scientists were subsequently involved in its delivery.

LITHOPROBE studies focussed on ten transects, selected to elucidate tectonic processes of continental or global significance. Seismic reflection profiling was at the heart of the program, but was complimented by augmented by seismic refraction, electromagnetic, and magnetotelluric methods. The geophysics was accompanied by integrated geological mapping, geochronology and structural studies. Several NATMAP projects, for example, were focussed in the vicinity of LITHOPROBE transects. While the program's contribution to the understanding of the architecture and tectonic evolution North American continent was immense, there were also numerous practical benefits. Several geophysical methods first applied in LITHOPROBE were refined and used successfully in hard rock mineral exploration. GSC contributions in this area were noteworthy, including, for example, 3-D seismic imaging of a sulphide ore bodies.

Advances in geochronology also made critical contributions to GSC's mapping programs and ultimately to the understanding of crustal evolution. A revolution in U/Pb Thermal Ionization Mass Spectrometry (TIMS) began in the 1970s. It was led by Canadian Tom Krogh, initially at the Geophysical Laboratory in Washington, D.C. and later at the Royal Ontario Museum, who developed techniques that allowed zircon ages to be determined with a precision of a few million years. The revitalization of geochronology in the GSC had begun in 1981 with the arrival of Otto van Breeman to head the labs. Under his leadership, GSC scientists refined and improved Krogh's methods. The laboratories also

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[28] e.g., Clowes, Ron M. (2009) Initiation, development, and benefits of Lithoprobe — shaping the direction of Earth science research in Canada and beyond. *Can. J. Earth Sci.,* v. 47 no. 4 p. 291-314.

determined ages using the argon-argon, neodymium-samarium, and Rubidium-Strontium systems. The operating philosophy evolved from that of a service lab to one in which geochronologists were actively involved in field research.

In 1996, GSC inaugurated the Sensitive High Resolution Ion Microprobe (SHRIMP), the first in Canada and one of only four in the world. Although less precise than TIMS, which required laborious and difficult physical and chemical extraction, the SHRIMP allowed *in situ* analysis of a spot as small as 5 microns in diameter. The SHRIMP Laboratory was named in memory of J.C. (Chris) Roddick, the GSC geochronologist in charge of its development until his tragic death in a ski accident.

THE 150TH ANNIVERSARY

The GSC marked its sesquicentennial in 1992. April 14th was selected as the "official" birthdate on the arbitrary but entirely reasonable grounds that it was on this date in 1842 that Sir William Logan received his letter of offer from the Canadian government. Preparations for the year of celebrations were proceeding slowly until Charles H. Smith was brought on board to organize the effort. Smith, a former GSC scientist who had risen through the ranks to become Associate Deputy Minister in the 1970s, was extraordinarily successful. The events associated with the 150th are too numerous to list here, but have been documented elsewhere by Dr. Smith.[29] Some of the highlights were a gala banquet and dance held in the Canadian Museum of Nature, an International Conference of Geological Surveys, special issues of journals dedicated to the GSC, unveiling of a plaque on the Survey's first Ottawa location on Sussex Drive, a "Where's Willy" game inspired by the "Where's Waldo?" children's books, and numerous reports in the popular media. One of the most unusual was an ascent of Mt. Logan by a team of GSC staff, sponsored by the Royal Canadian Geographical Society, with the goal of making an accurate measurement of the height of Canada's tallest mountain, which turned out to be 5959 metres.[30]

STRATEGIC RE-ALLOCATION

The sesquicentennial celebrations were an extraordinarily positive experience for everybody associated with the GSC. Behind the scenes, however, there was increasing realization that the program as it existed could not be sustained in the face of protracted budget reductions. Reference levels had been declining since 1987 (Figure 1) and Abase reductions of more than 8 percent were already booked over the next four years. The situation was likened to "death by a thousand cuts". This led senior management to initiate a priority setting process in the winter of 1992-93. The intent was that budget reductions would be allocated on the basis of an evaluation of the relative importance of programs.

The process, which ran through most of 1993, began with the definition of forty program components, similar to those in the Long Term Strategic Plan. Each of these components was rated against eight criteria: relevance to mandate, societal impact, direct

[29] Dr. Smith's report is available in the departmental library.
[30] Schmidt, M. (1992) *To the Top*. Canadian Geographic, Sept/Oct 1992, pp. 22-35.

client impact, scientific advancement, feasibility/timeliness, GSC leadership and uniqueness, internal impact, and program balance. The process played out over a series of facilitated meetings in which the ADM, Directors General, Directors, and Chief Scientist rated the program components. The program was also rated by the Minister's National Advisory Committee for the GSC (MNIAC) primarily on the basis of client impact. The third source of input was a program-wide evaluation conducted by a private consultant on behalf of the department's audit and evaluation branch. The ranked components were grouped in quartiles across which notional budgets were progressively reduced, from about 4 percent in the first quartile, about 16 percent in the second, 25 percent in the third, and 30 percent in the fourth.[31] Upward adjustments were made to components that stood to lose from the winding-down of the Mineral Development Agreements (MDA). Implementation of the results of the re-allocation was identified as a priority in the Department's Annual Management Report for 1993-94. However, the process was overtaken by a series of events that unfolded over the next year.

New Department, New Government, But No New MDAs

The GSC's budget prospects suffered a further blow in the 1993 federal budget, which announced that the government would not renew the Mineral Development Agreements.[32] These had funded a significant portion of GSC's mapping and minerals related programming over the previous decade. This decision would also have a severe impact on the provincial geological surveys, which had also come to rely on MDA funding. In June 1993, Kim Campbell became leader of the Progressive Conservative Party and Prime Minister. Although her government lasted only a few months, it did initiate a major reorganization that would result in the formation of Natural Resources Canada from the merger of the departments of Energy, Mines and Resources and Forestry Canada.[33] The federal election on October 25, 1993 returned a Liberal majority government under Jean Chrétien. The Liberal platform had included a commitment to clarify the role of the federal government in mining and to consider renewal of the MDAs when the fiscal situation improved. A review of the federal role in mining was undertaken by the Intergovernmental Working Group on the Mining Industry (IGWG) in the spring and summer of 1994.[34] This review would ultimately result in a new framework for federal-provincial cooperation in geoscience – the Intergovernmental Geoscience Accord, which I discuss in some detail below.

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[31] *Back to Basics: Defining the GSC's Core Activities and Budget Allocations, 1994-1998. ADM* Memorandum to staff.

[32] The Budget in Brief, April 26 1993. Department of Finance Canada. p.9.

[33] The Canadian Forest Service had been batted around like a Ping-Pong ball over the previous years. In 1968 it was combined with the Department of Fisheries and then in 1970 it was transferred to the new Department of Environment. It was moved from Environment to Agriculture in 1984, back to Environment in 1985, and became an autonomous department again in 1989. Although announced in 1993, NRCan did not formally come into existence until January 1995.

[34] IGWG comprised Assistant Deputy Ministers and other senior officials responsible for mining issues from the federal provincial and territorial governments.

HITTING THE WALL: GOVERNMENT-WIDE PROGRAM REVIEW

My earliest recollection of the term "hitting the wall" in the context of government debt was in a presentation by David Dodge, then Deputy Minister of Finance, to an NRCan Managers' Conference. The reference was to the economic crisis facing the government of New Zealand in 1984, which led to major restructuring of the government sector. Dodge's message was that the recently elected Chretien government and, in particular, Finance Minister Paul Martin, was determined to avoid a similar crisis in Canada and that the public service should expect severe austerity measures. What transpired over the next three years left no doubt about the seriousness of this commitment.

In the 1994 budget, Minister Martin announced Program Review, "the most far-reaching exercise in government cutbacks in Canadian history".[35] The plan was to undertake a fundamental re-evaluation of the role of government and to this end, government programs were subjected to six tests:

1) *Is the program still in the public interest?*
2) *Is its delivery a legitimate and necessary role for government?*
3) *Is the current federal role appropriate or should the program be realigned with the provinces?*
4) *Should it be delivered in partnership with the private or voluntary sector?*
5) *How can it be redesigned for efficiency?*
6) *Is it affordable, given fiscal constraints?*

Despite the government's assertion that Program Review was not an across the board, arbitrary cut but rather a process carefully structured around the six tests[36], academics have concluded in retrospect that this was not the case:

> *With budget-cutting becoming the goal of the process, any pretence to administrative rationality and systematic planning in refashioning the very foundations of government and public sector management was quickly lost.*[37]

This latter view is certainly consistent with my own impression. The process began as intended. Following the announcement in the 1994 federal budget, GSC management built upon the groundwork established in the previous year's strategic allocation process to address the six tests for each element in the program structure. In the end, however, the budget decisions ostensibly made by the Departmental Management Committee did not appear terribly strategic. (To be fair, I should say that as a Division Director, I had no first-hand knowledge of the recommendations made by senior GSC management, advice received from external reviewers, including the Ministers' National Advisory Committee for the GSC, or the basis of particular decisions taken at the departmental level.)

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[35] *Johnson (2006) op. cit., p. 392.*
[36] Treasury Board Secretariat (1997) *Getting Government Right – Governing for Canadians*. p.4
[37] *Johnson (2006) op. cit., p. 394*

The results of Program Review were announced in February 1995 in the federal budget: for GSC, this would mean a 32 percent reduction appropriation funding, to be implemented over three years. This was in addition to loss of Mineral Development Agreement funding announced earlier. The GSC's plan to accommodate this reduction, as presented to the National Geological Surveys Committee in March 1995, included the following:

- The number of divisions was reduced from nine to seven through the amalgamation of the Vancouver and Victoria groups into a single division, and the Geophysics Division was eliminated, with most of its staff and program responsibilities absorbed by the Continental Geoscience Division.

- Closure of a small office housing Continental Geoscience and Terrain Sciences staff in Yellowknife.

- Programs were re-oriented to reduce costs; for example, energy geoscience would focus on the Western Canada Sedimentary Basin at expense of work in the north, marine geoscience activities in the north and in deep water would be limited, and environmental geoscience would be limited to coastal studies, natural hazards, and metals in the environment.

- There would be increased emphasis on partnering and cost-sharing, particularly in respect to work in the provinces related to mineral and energy resources.

There were a number of activities eliminated at the margins. For example, Mineral Resources Division ended production of rock and mineral sets for sale to the public (which had been ongoing from 1872), as well as operation of the Skyvan aircraft, and appraisal of Canada's undiscovered uranium resources in support of "URAG process". However, the scope of the overall GSC program was little changed:

> *The survey will continue… to maintain its commitment to national programs connected to energy and minerals deposits research, resource assessments, marine geoscience, bedrock and surficial mapping, the development of new exploration technology, and research related to natural, hazards, climate change and groundwater.* [38]

This amounted to a decision to "do as much with less". Some argued that it would have been preferable to eliminate entire program elements in order to ensure that those that remained were robust. If, on the other hand, one believed there were opportunities for new funding on the horizon, it made sense to maintain a core of relevant expertise. Broad expertise is also necessary if the provision of information to policy-makers is seen as an important role. As it happens, significant new funding did materialize over the next five years as did increased demands for geoscience input into policy formation and regulatory decisions.

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[38] *Geoscience Making a Difference*, GSC Annual Review 1994-95, p.3

In order to sustain a credible level of mapping activities, it was necessary to reduce the Energy, Environment, and Minerals Programs disproportionately (see Table 2, p.24). As the Director responsible, I found the reductions to the Minerals Program particularly gut-wrenching. Over the preceding two decades, the GSC's economic geology group had become recognized as among the world's finest in terms of breath, depth and quality of expertise.

The decision to close the GSC office in Vancouver and consolidate activities in Victoria evoked a significant negative public response. I was frankly surprised by this decision, given the importance of the Vancouver-based mining industry, and was told afterwards that circumstances required that it be taken quickly without time for careful analysis or stakeholder consultation. In any case, it quickly became a political issue and led to a commitment by the Minister to reconsider, pending a more thorough analysis of costs and benefits. In the spring of 1995, I accompanied ADM Ken Babcock and Sandy Colvine, Director of Continental Geoscience Division, on a fact-finding mission to Vancouver. We met individually with representatives of a dozen or so exploration companies to better understand their expectations of the GSC. It was clear from the interviews that the most troubling aspect of the proposal from the industry perspective was the loss of the local GSC library and sales office. The presence of GSC staff was less important than I had expected (and hoped).

A cost-benefit analysis subsequently commissioned from Gartner Lee Ltd. indicated that in addition to the decreasing service to the exploration industry, the proposed consolidation on the island was unlikely to result in net savings. The Vancouver staff could not be accommodated at the Department's existing facilities near Victoria, there was an opportunity to rent new quarters on Robson Street in Vancouver at a favourable rate, and an island location would incur additional ongoing travel costs for scientists working primarily on the mainland. The proposal quietly died during the winter of 1995-96.

The budget reductions resulting from Program Review entailed a commensurate reduction in GSC staffing levels. The government hoped to achieve part of the necessary reductions through attrition and retirements, and put in place a number of incentives to facilitate this. The problem with this, of course, was that some of the employees that chose to take an incentive were needed in the future program. The next step was to identify positions that were "surplus to requirements". Notwithstanding the copious amounts of training we were given in the mechanics and human aspects of Work Force Adjustment, as it was called, this was a very difficult process in both respects. My recollection is that voluntary and involuntary separations accounted for roughly equal proportions of the total reduction in force. Program Review, with its staff and budget reductions as well as organizational changes (below) had a significant impact on staff morale, from which the GSC had still not fully recovered by the time I retired in 2006.

PICKING UP THE PIECES (1995-2000)

Earth Sciences Sector Redux - The Policy Imperative- Strategic Plan for Geoscience 1996-2001 More Struggles with Program Management - Intergovernmental Geoscience Accord – Making the Case for Public Geoscience: The Mines Ministers Process - Targeted Geoscience Initiative (TGI) – Metals in the Environment – Canada Nunavut Geoscience Office – Information Technology - The Millennium Bug - From Mt. Logan to Mt. Trudeau and Back Again

EARTH SCIENCE SECTOR REDUX

The other shoe of Program Review dropped in June 1995 with the announcement of a major departmental reorganization. The Geological Survey of Canada and Geomatics Canada were to be amalgamated in the new Earth Sciences Sector (ESS). Minerals and Energy Technology Sector (METS or CANMET) was broken up, with the energy and minerals components becoming part of Energy Sector and Minerals and Metals Sector, respectively. Marc Denis Everell, who had been ADM of METS, assumed responsibility for Earth Sciences.

Superficially, the reorganization was a return to the situation that had existed prior to 1986, when GSC, Surveys, Mapping and Remote Sensing Branch, and Earth Physics Branch were part of an earlier Earth Sciences Sector. There were two important differences, however. In the new incarnation, the GSC comprised two branches rather than one, meaning that no single person was responsible for the GSC and only the GSC. In fact, the GSC did not exist as a formal entity: it was identified on the ESS organization chart by a dashed line around the two branches. The same applied to Geomatics Canada, of course, except that it comprised four asymmetrical units - two branches and two divisions. Another significant difference from the pre-1986 ESS was that most corporate and management support functions were consolidated at the sector level. These included the library, cartography and publishing, communications, project information management, and business development, among others.

I would have much preferred that the GSC had been constituted as a single branch within the new structure. This was the option favoured by many of us and seemed logical, given that Mike Berry, DG of Minerals and Regional Geoscience Branch, had recently retired, leaving Richard Haworth as the Survey's only incumbent Director General. It soon became apparent that this was not in the cards. Moreover, it was not clear that the position of Chief Geoscientist would be retained in the new structure and the incumbent, Jim Franklin was appointed to act in the Mike Berry`s position. Within a few weeks, it was decided that Franklin would continue as Chief Scientist, but for ESS as a whole, and I became acting Director General of Minerals and Regional Geoscience. It would be another year before there was a formal competition for the position.[39] In order to promote GSC unity, Richard

[39] Acting executive appointments were common in the public service during those years. Program review had generated numerous vacancies through re-organizations and retirements, which, coupled with a slow and cumbersome permanent staffing process, made this the only practical route. The

Howarth and I consolidated our offices and support staff, an arrangement that continued when Jan Boon succeeded Howarth a few years later. The two DGs and Chief Scientist met each morning at 8:30 to ensure that we were "singing from the same song sheet" in respect to GSC matters. We also continued a unified set of programs across the survey.

The process of fusing of GSC and Geomatics was undertaken by a number of "transition teams" made of managers from each side of the new house. Some issues evolved reasonably smoothly, others less so. Regardless, while those involved generally acted in a spirit of goodwill, there was little doubt that we came from different corporate cultures. GSC viewed itself as primarily a scientific research organization. Although there were strong research groups in the Canada Centre for Remote Sensing and the Geodetic Survey, the larger part of Geomatics Canada devoted to surveying and map production - what was referred to in government circles as "Related Scientific Activities".[40] Geomatics Canada was also more entrepreneurial in the sense of *Reinventing Government*. As noted above, it had started down the road towards Special Operating Agency status following the 1993 federal budget and was heavily dependent of revenue generation using the "revolving fund" mechanism.

Notwithstanding the amalgamation, the ADM understood that retention of the individual identities of the component parts of ESS was of symbolic importance. To this end, the Sector Management Team[41] decided that the letterhead and other communications materials would display the names and logos to GSC, Geomatics Canada and the Polar Continental Shelf project. Also, GSC continued to have its own published annual report and Minister's advisory committee. Importantly, GSC and Geomatics Canada would continue to operate their own scientific and technical programs. Unfortunately, this would continue for only a few years.

THE POLICY IMPERATIVE

The government's vision for the public service following Program Review, as formally set out by President of the Treasury Board, embodied several principles of the New Public Management including cost-recovery, alternative service delivery, quality service, and increased accountability for results.[42] The evolving perception of government's role had been captured in the metaphor popularized by Osborne and Gaebler - that

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downside was a domino effect created because an acting appointee was unlikely to vacate his or her old position until his new one was made permanent. In this instance, it would be nearly three years before my former position was filled, leaving Mineral Resources Division in limbo.

[40] Statistics Canada recognizes two categories of government science expenditures. *Research and Development* is creative work to increase knowledge and to use it in new applications. *Related Scientific Activities* include gathering, processing and analysing data. The distinction is not always clear, as in the case of geological mapping, which GSC has categorized differently over the years.

[41] It was common in these years for "committees" to be replaced by "teams", the theory being that team members share common goals whereas committee members represent their constituencies and are inherently adversarial.

[42] *Getting Government Right: Governing for Canadians – released February 20, 1997. 19pp.*

government should be "steering rather than rowing". In their view, governments should play a catalytic role – it should "set policy, deliver funds to operational bodies (public or private), and evaluate performance, but they rarely play an operational role themselves".[43]

This philosophy was apparent in the new federal S&T released in March 1996.[44] It envisioned universities, other non-governmental public institutions, and the private sector as the favoured venues for research and development. Government departments should only undertake in-house research where it was essential to their policy, regulatory, or operational mandates. This preference was born out in subsequent federal budgets that significantly increased university research funding, including for new university programs such as the Canada Research Chairs and Network Centres of Excellence, while the appropriations for most intramural R&D other than in the National Research Council were either constant or reduced.

It became clear that program enhancements or additional funding for scientific activities would have to be directly linked to government policy priorities. This "policy imperative" might be addressed in two distinct ways – the program could either inform policy-making or support policy implementation. In the former, government itself was the intended consumer of the results, whereas in the latter, the likely users were largely outside of government. The Metals in the Environment program and Targeted Geoscience Initiative, which I describe below, are examples these two different approaches.

Of course, the notion that government science should support government policy and departmental mandates was hardly a novel idea - the GSC can trace its origins in 1842 to an explicit government mandate. Moreover, the fact that the Survey had survived for so long was testament to the fact that it had been responsive to government priorities. Recent examples had included the Mineral Development Agreements, the Frontier Geoscience Program and the Radioactive Waste Disposal program. What had changed was that whereas such initiatives had theretofore been seen as "add-ons" at the margin of the GSC portfolio, policy-driven programs would henceforth become the core. Although the GSC Mission Statement continued for the time being to highlight the provision of "a comprehensive geoscience knowledge base", the government was not about to allocate additional resources for such a general goal: it sought direct linkages to specific priorities.

The increased policy focus played-out in a number of ways within ESS. The new sector developed a more robust policy capacity under a Director-General of Policy, Planning, Coordination and Information. The first incumbent was Peter Fisher who was succeeded after a few years by Monique Carpentier. They and their staff were enormously helpful to their scientist colleagues in navigating the policy waters, and were instrumental in ESS success in securing new funding. When drafting ministerial briefing notes and correspondence, a significant responsibility of senior managers, in many cases it was important to reference the government's various policy pronouncements. These included

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[43] Osborne and Gaebler (1992) op. cit., p.58.
[44] *Science and Technology for the New Century: A Federal Strategy* – released March 1996. 38 pp.

the Red Books, which set out the platform of the governing Liberal party in unusual detail.[45] Similarly, the *Speech from the Throne,* or SFT as we called it, to which I had paid scant attention in the past, was now must reading. The policy group produced annual Strategic Overview documents intended to help align program planning with policy drivers.

Each Director General was assigned sector leadership of one or more policy files and, where appropriate, encouraged to seek opportunities for ESS involvement in new initiatives. For example, my colleague Richard Haworth was instrumental in promoting the importance of adapting to climate change.[46] This led to the establishment of the Canadian Climate Change Impacts and Adaptation Research Network, which operated successfully from 2001-2007. Richard also continued his longstanding involvement in the Law of the Sea negotiations, whereby national offshore boundaries beyond the 200 mile Exclusive Economic Zone are defined by geological criteria. Similarly, Jan Boon, Haworth's successor, played an important role in developing the *Canadian Framework for Collaboration in Groundwater*. My principal "upwards and outwards" responsibilities were in three areas: making the case for what many would regard as the traditional role of the Survey in providing public geoscience in support of mineral and energy exploration, implementation of the *Intergovernmental Geoscience Accord*, and ensuring that geoscience was factored into decisions bearing on managing the risk posed by naturally-occurring toxic substances. I will describe each of these in more detail below.

One aspect of my new role as Director General that surprised me was how little of my time was actually devoted to managing my branch. Indeed, in reviewing my Accountability Accords from those years, I was reminded that one of my aspirational targets was to spend at least 35 percent of my time on branch management. This was partly due to the fact that executive cadre was regarded as a "corporate resource", available for service on a variety of departmental and interdepartmental committees, many of which were only peripherally related their nominal responsibilities. Most of us also sat on a number of external boards and management committees, and while these did provide valuable opportunities to influence priorities and programs, they did consume a lot of time.

STRATEGIC PLAN FOR GEOSCIENCE 1996-2001

One of the first tasks of GSC management following the formation of ESS was the development of the *Strategic Plan for Geoscience 1996-2001*, a process led by Chief Geoscientist, Jim Franklin. A comparison of this document with the *Long Term Strategic Plan* of 1991, described above, provides a clear example of the new "policy imperative". The 1991 plan was largely framed in terms of the needs of clients, of which the federal

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[45] The Liberals published three Red Books during this period: *Creating Opportunity* for the 1993 election, *Securing Our Future Together* in 1997, and *Opportunity for All* in 2000.

[46] By the late 1990s, the scientific community had reached a consensus that global warming was occurring and that human activity played a significant role. Two complimentary approaches to dealing with climate change had emerged: "mitigation", which seeks to reduce greenhouse gas emissions, and "adaptation", which seeks to understand the impact of climate change and how to adapt to it.

government was just one. The *Planning Environment* section emphasized internal concerns such as staff morale, budget restrictions and project management. Although societal issues such as sustainable development and global change were mentioned, there were no specific references to government policy priorities. In contrast, the corresponding section of the 1996 plan was entitled *Policies and Political Directions* and dealt almost entirely with how the GSC would respond to the new federal science and technology strategy. Similarly, a subsequent section on *Guiding Principles to Meet New Needs* devoted six pages to partnerships, another priority of *Science and Technology for the New Century.* There was only one short paragraph devoted to this topic in 1991. (I hasten to add that one plan was not intrinsically better than the other – each was appropriate to the government ethos of its day.)

The scientific substance of the new strategic plan was similar to the previous one. The program roster had changed only slightly. Elements of Geoscience Surveys, Energy, and Environment Programs were combined in a new Marine Geoscience Program, and some program and subprogram names were made more understandable. Perhaps the best example of this was the earlier Environmental Geoscience Program, which comprised three subprograms in 1991: Modern Geophysical Processes, Modern Geological Processes, and Paleo-environments. This became the Geological Hazards and Environmental Geoscience Program, with elements described in more "user-friendly" terms such as *National Earthquake Hazards*, *Nuclear Test Ban Monitoring*, *Understanding Climate Change through Time and its Impacts*, and so on.

Table 2: Comparison of GSC Notional Program Funding in 1991 and 1997

Long Term Strategic Plan (1991)		Strategic Plan for Geoscience (1996)		Change
Program	Budget 1991/92	Program	Budget 1997/98	$/%
Geoscience Surveys (excluding Marine)	$24.4M	Bedrock & Surficial Geoscience	$20.1M	-$4.3M/-18%
Marine Component*	$5.7M	Marine	$6.0M	+$0.3M/+5%**
Minerals	$12.7M	Minerals	$7.1M	-$5.6M/-44%
Energy	$12.7M	Hydrocarbon Geoscience	$7.3M	-$5.4M/-42%
Environmental geoscience	$16.9M	Geological Hazards & Environmental Geoscience	$9.6M	-$7.3M/-43%
Geoscience Information	$14.2M	Geoscience Information	$9.6M	-$4.6M/-32%
Administration	$13.1M	Administration	$10.7M	-$2.4M/-18%
Total Notional Budget	$99.7M	Total Notional Budget	$70.4M	-$29.3M/-29%

Although the breadth of program activities was little changed from that prior to Program Review, there was a significant re-balancing of program budgets, with the Minerals, Energy and Environmental Geoscience programs being reduced more than twice as much in percentage terms as Geoscience Surveys. This is illustrated by the comparison of notional program budgets for 1991/92 and 1997/98 from the strategic plans (Table 2).[47]

More Struggles with Program Management

The new ADM was a strong proponent formalized management processes and, in particular, of Total Quality Management (TQM). To this end, he appointed a Quality Advisor to help ensure that various branches and divisions implemented quality plans. ESS' yearly Business Plans as well as senior managers' performance agreements were, for a time, framed in TQM terms (client/stakeholder focus, process management, etc.). It also was clear from the outset that the management of the GSC was among his particular preoccupations. He said that he had no concerns about the quality of the Survey's science, but that he would like to see it attain the same recognition for its management practices. This implied that GSC management was perceived as having been deficient: whether this was mainly the ADM's perception or a more widely held opinion, I am not sure. In either case, I expect that it was fuelled by the GSC's lukewarm response to the management reforms of the early 1990s and, in particular, by some of the very public airing of differences prior to and during program review. Perhaps Bruce Howe's characterization the GSC as "the Jesuits" still resonated in the upper reaches of "the black tower" (as NRCan's corporate headquarters building at 580 Booth Street was colloquially known).

I believe that the underlying concern was similar to the one that had led to the introduction of the program structure back in 1990: that is, the inherent difficulty of managing and representing a series of activities that cut across the hierarchical division structure. The program structure had mitigated the problem of planning and presenting the Survey's activities in a coherent way, but accountability for program delivery remained diffuse. Although there was a strategic plan for each program, budgets were still allocated to divisions, and there were few constraints on how directors allocated their staff and operational funds. In other words, GSC was operating a matrix program without the benefit (or curse) of a formal matrix management system.

As a first step in addressing this issue, a consultant was engaged in 1996 to examine GSC management arrangements. The result was a decision to develop an operational plan from each program that would "put meat on the bones" of the strategic plan as well as attach more constraints to resources allocated to divisions. There was also a desire to engage staff more in planning and this began in earnest in February 1997 with the Bedrock

[47] Marine surveys were part of Geoscience Surveys Program in 1991, thus total budget of Surveys Program was $30.1M. **The Marine Program in 1997 comprised elements not only of the old Geoscience Surveys Program, but also the Energy and Environmental Programs: however, because the 1991 budgets of the latter two components are unknown, there was probably an overall decrease in Marine Program spending.

Geoscience Program Workshop.[48] The process informed GSC input to the first National Programs Workshop, which was mandated by the Intergovernmental Geoscience Accord (see below) and held in Vancouver in January 1998. The completed program plans, six in all, were reviewed by the Committee of Provincial Geologists in March 1998.

Notwithstanding the new program planning process, however, there was increasing concern that the organizational structure continued to inhibit scientists' participation in projects beyond their home divisions. This message surfaced in the Bedrock Geoscience Program Workshop and, in particular, in focus groups convened as part of the ESS S&T Capacity Study undertaken in 1998.[49] This concern led to another ADM-led, consultant-facilitated process beginning in the spring of 1999 that became known as the "GSC Management Pathway". The three principal outcomes of this process were (1) a program structure framed in terms of departmental priorities rather than scientific activities or disciplines, (2) priority setting and resource allocation became be the responsibility of the GSC Program Committee[50] rather than of individual divisions, and (3) a GSC-wide proposal-driven system of project selection and review. The first of these was reflected the fact that NRCan was one of five departments piloting a change in reporting structure from a business line approach (science and technology, policy development, etc.) to one based on horizontal departmental goals (e.g., To enable Canadians to make balanced decisions regarding natural resources.)

Some of the reasons behind the new approach were explained in a memorandum from the GSC Management Team to staff on 23 December 1999:

> *The decision to embark on the PDS [Proposal Driven System] was influenced by a number of factors. Not the least of these was the recommendation emanating from the broad cross section of staff that participated in the Bedrock Geoscience Workshop in 1997. Secondly, our experience with existing proposal driven programs such as NATMAP, MITE, Hydrogeology and ResSources has demonstrated some of the potential benefits. Finally, proposal driven project selection has long been the norm in the academic research community, and government labs are coming under increasing pressure to play by the same rules.*

The Proposal Driven System (subsequently renamed Project Approval System or PAS) was to be implemented over three years to allow existing projects to be wound down in an orderly fashion. As it turned out, only two of the three phases were completed before the system changed again under a new ADM (see below).

A few words are warranted about the mechanics of the process. Each cycle began with a call letter, which identified priorities for new project proposals. Scientists, as individuals or groups, responded with brief letters of intent (LOI) describing a potential

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[48] Lucas, S. (1999) *Final report on the Geological Survey of Canada Bedrock Geoscience Program workshop, February 23-25, 1997*. GSC Miscellaneous Rpt. 65. 39 pp.
[49] Earth Sciences Sector *S&T Capacity for the Next Decade – Summary Status Report 4 Feb 1999*.
[50] The Science Program Committee comprised the Directors General and Division Directors.

project. Proponents whose projects were judged to be most relevant to corporate goals were invited to submit a full proposal. The full proposals were assessed by five reviewers (a mix of managers and scientists from both inside and outside the federal government) using ProGrid©, a commercial software package that seeks to quantify qualitative judgements. The final decision to accept or reject projects was then taken by the Science Program Committee. In the first cycle, staff submitted 144 LOI, 56 of which were invited to proceed to full proposal, and 24 projects were ultimately approved.

INTERGOVERNMENTAL GEOSCIENCE ACCORD

The *Intergovernmental Geoscience Accord (IGA)* was of among the most important factors in the evolution of the GSC in the 1990s. Its development spanned the transition of GSC from a sector in its own right to its incorporation in ESS. The stage was set for a new framework for cooperation among the federal, provincial and territorial geological surveys by the review of the federal role in mining undertaken in 1994 study by the Intergovernmental Working Group on the Mineral Industry (IGWG). It was determined that there was a continuing GSC role, albeit with a new working relationship. Specifically, the provinces and territories took the position that they would like to see an ongoing involvement of the GSC in geoscience related to promoting mineral development, but with two major *caveats*: (1) That each province and territory should receive a fair share of GSC resources, and (2) they should have a greater role in GSC program planning.[51]

Negotiations towards a new working relationship began in earnest at the meeting of the National Geological Surveys Committee in Victoria in September 1994. Ken Babcock was still ADM and Mike Berry, my predecessor as DG, led the file for GSC. The "fair share issue" has been raised by various provinces over the years, but GSC has generally declined to discuss the matter. In the words of one ADM, "we're not in the fair share business".[52] On this occasion, the GSC counter proposal sought to address the issue through greater transparency. Specifically, GSC would formally table annual and three year work plans for review by the NGSC, and NGSC would be strengthened through a formal reporting relationship to IGWG.

The second provincial demand – a greater role in GSC program planning – fell on more fertile ground. It was not new, having been raised in a brief submitted to Mines Ministers by the Committee of Provincial Geologists in 1989. Moreover, the GSC and its provincial and territorial counterparts had become accustomed to formal joint planning under the Mineral Development Agreements and in the flagship NATMAP program. Thus, the GSC proposed what amounted to an extension of the MDA process to its entire program: it would enter into a bilateral MOU with each jurisdiction and jointly undertake a geoscience

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[51] Federal-Provincial/Territorial Cooperation in Mining: Natural Resources Canada Perspectives. Discussion Paper. September 1994.

[52] The Department's enabling legislation implies no particular distribution of GSC's effort in delivering its core programs. Moreover, even if the notion of fair share were accepted, on what basis would it be calculated – provincial population, land area, share of GDP? The political reality, of course, is that the GSC should be seen to be operating throughout the country.

needs assessment as a basis for developing annual and longer term work plans. The MOUs would be modelled on an agreement that was then being developed between GSC and the British Columbia Geological Survey Branch.

At the meeting, CPG opined that the GSC response to the fair share issue fell short of expectations and upped the *ante* by recommending "a formal drawdown from GSC budgets for provincial programming".[53] Not surprisingly, this was a non-starter for the GSC, which agreed to develop a more specific proposal for discussion the following March.

A revised proposal was sent to the Committee of Provincial Geologists in February 1995, timed with the release of the federal budget and the results of the Program Review. This proposal included provision for a multilateral accord among all jurisdictions to serve as an umbrella for bilateral agreements. At its March 1995 meeting, NGSC resolved to develop a "National Geoscience Accord". This resolution was approved by IGWG, which directed that the agreement was to be ready for signing at the next Mines Ministers' Conference, scheduled for Saskatoon in September 1995.

The draft agreement was finalized at a two-day NGSC meeting in Winnipeg in May and approved by IGWG in July 1995. The intent at this point was to have the Accord signed by officials rather than by ministers, and to maintain a relatively "low-profile". In the meantime, the Québec government had announced that the province's second sovereignty referendum would be held on October 30, 1995 and thus at their closed session in Saskatoon, Ministers approved the Accord in principle, but agreed that signing be delayed until after the referendum. Although the signing of the Accord had been deferred, the next steps were to be hammered out at the NGSC meeting in Saskatoon. Marc Denis Everell, who had recently taken over from Ken Babcock as ADM, was attending his first NGSC meeting. To everyone's surprise, he told his provincial and territorial colleagues that he would not commit to signing the agreement, and would prefer to proceed on the basis of bilateral agreements.[54] This had the effect of a bombshell, and the meeting was suspended to allow the two sides to caucus. When the meeting reconvened, we were informed that the provincial geologists had resolved that no bilateral agreements would be signed until the national accord had been ratified.

While this was playing out, the government was considering whether it should continue to have any involvement in mining:

> *The Government is prepared to withdraw from its functions in such areas as labour market training, forestry, mining, and recreation that are more appropriately the responsibility of others including provincial governments, local authorities or the private sector.*[55]

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[53] NGSC Minutes, 14 September 1994
[54] National Geological Surveys Committee, Minutes of Meeting, 13 September 1995.
[55] Speech from the Throne, February 27, 1996.

I have no doubt that the work of IGWG in 1994 and the successful negotiations leading to the IGA meant that GSC's role in supporting mineral exploration was essentially "off the table" in these discussions of federal involvement in mining.

Notwithstanding his initial reservations, the ADM soon became a strong proponent of the agreement, which was renamed the Intergovernmental Geoscience Accord. Among other improvements, he argued that the IGA should be signed by ministers rather than by officials as had theretofore been the plan, and ensured that it was approved by the federal Privy Council Office, which characterized it as a good model for federal-provincial cooperation in other areas of program delivery. The IGA was finally signed at the Mines Ministers' Conference in Yellowknife in 1996.

The agreement defined the respective roles of the GSC and its provincial and territorial counterparts, and set out principles and mechanisms of cooperation. It included provisions for joint program planning, advisory committees, and annual work plans. Considerable effort was devoted to implementation, which typically involved a bilateral accord – in some cases signed by ministers – followed by a planning workshop with staff, industry and university representatives, and development of a joint work plan. The IGA also called for periodic review of national priorities and the first of the first National Programs Workshop was convened in Vancouver in 1998.

It is perhaps a measure of the success of the IGA that most jurisdictions that chose the bilateral agreement route did not see a need to renew the bilateral after the initial five year term. I think this was an indication that a sufficient level of trust had developed that planning could proceed in a less formalized way. The IGA also led to multilateral collaboration within the NGSC framework in such matters as the development of common digital data standards and building industry support for government geoscience (see The Mines Ministers Process below). The IGA has proven to be durable, having been renewed every five or six years, most recently in Charlottetown in 2012.

MAKING THE CASE FOR PUBLIC GEOSCIENCE: THE MINES MINISTERS PROCESS

Despite a rocky start with his National Geological Survey Committee colleagues, ADM Everell went on to provide significant leadership to the group. At his first meeting in September 1995, after the contretemps over the geoscience accord, he emphasized the need for NGSC to raise its profile with IGWG and with Ministers, and to play a more active role in Mines Ministers Conferences. He said that it should build on the momentum of the IGA by planning at least one prominent event at each annual Mines Ministers Conference. The first steps were taken the following year in Yellowknife where in addition to the signing of the IGA, there was the formal launch of the new Geological Map of Canada (Map 1860A), the first revision in more than 25 years, and a presentation by Chief Scientist Jim Franklin to Ministers on the role of government geoscience.

The approach gathered steam in 1997 in St. John's where the NGSC and the Prospectors and Developers Association of Canada (PDAC) co-sponsored a workshop

entitled *Canada's Geoscience Knowledge Base: Maintaining Our Competitive Advantage.* The PDAC had been raising concerns about the decline in geological survey funding for a number of years, in part in response to Canada's declining share of world exploration spending. After ranking first for many years, Canada had fallen behind Australia in 1991. At the same time, the investment climate for mining in Latin America was much improved, which meant that that region was attracting a greater share of exploration.[56]

The workshop results[57] were presented to Ministers Open Session by the inimitable Mary-Claire Ward, and included the following three recommendations:

1. That all levels of government recognize the critical importance of the geoscience knowledge base and commit to ensuring that it is maintained and enhanced.

2. That the continued erosion of government geological surveys be immediately halted, for a period of at least one year.

3. That an industry-led task force be struck to examine funding options for federal and provincial survey and to bring recommendations to the 55th Mines Ministers Conference in Calgary in 1998.

Ministers accepted the first and third recommendations but, not surprisingly in respect to the second, reserved the right to determine survey budgets as they saw fit. It is noteworthy, however, that the precipitous decline in total survey budgets halted the following year and then began a gradual increase (see Fig. 2 above).

The task force established pursuant to the third recommendation comprised four representatives from industry, three from provincial surveys and one from the GSC. It was chaired by Mary-Claire Ward and I represented the GSC. Much of the background research was undertaken by NGSC Secretary Mike Cherry, who headed the GSC Federal-Provincial-Territorial Relations Office. The report presented to Ministers in 1998 examined the pros and cons of various service delivery options (*e.g.*, government department, special operating agency, crown corporation, etc.) and funding arrangements (appropriation, cost recovery, revenue generation, etc.), and reviewed practices in other countries.[58] The report recommended that appropriation was the most appropriate source of funding, although this might be augmented by a share of resource royalties, and partnerships with industry. It also drew attention to the fact that mapping must be renewed to incorporate new scientific understanding and to provide greater detail in mature areas. This led to a recommendation of a follow-up study "to determine appropriate levels of geoscience map coverage as a basis for determining future funding requirements of geological surveys".

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[56] A popular in-joke of the period: Question – "What do you call a room full of geologists in Vancouver?" Answer – "Spanish class".
[57] Ward, M.-C. & Blackwood, F. (1997) Workshop Report - Canada's Geoscience Knowledge Base: Maintaining Our Competitive Advantage*. Provincial Geologists Journal*, v.15, pp. 75-76.
[58] IGWG Task Force (1998) Alternative Funding Arrangements for Government Geological Surveys, *Provincial Geologists Journal*, v.16, pp. 69-118.

The Task Force's new study looked at the state of regional and detailed coverage of each jurisdiction for four types of maps: bedrock geology, surficial geology, aeromagnetics, and drainage geochemistry. It compared existing coverage to a target level established for each map type and jurisdiction and estimated the cost of filling the gap. For example, it was concluded that there were adequate regional bedrock geology maps for approximately 65 percent of the Canadian landmass. It would cost $216 million to complete coverage at a scale of 1:250K, the current budget for such mapping was $114 million over 10 years, leaving a shortfall of $102 million. Whereas complete bedrock coverage at a regional scale was considered a first order requirement, the targets for other types were less ambitious. In any case, the bottom line was that the cumulative requirement over 10 years was $674 million as compared with a budget of $311 million, leaving a gap of $363 million. The report[59] presented to Ministers in 1999 recommended at "this target be achieved through a cooperative approach such as a national geoscience mapping strategy". I will return to the national strategy below.

TARGETED GEOSCIENCE INITIATIVE (TGI)

Notwithstanding the severe reductions during Program Review, there was a sense that the government's purse strings might loosen once the deficit was eliminated. Thus, as the Mines Ministers process was getting underway, the ADM instructed me to develop an internal proposal for an enhanced effort in geoscience to support exploration. This would become the known as the Targeted Geoscience Initiative or TGI, and at the ESS management retreat in October 1997 it was identified as one of three "flagship proposals" for which the sector would seek funding opportunities. (The others were the Canadian Geospatial Data Infrastructure, which became known as Geoconnections, and Geomatics Market Assessment.)

In the meantime, Ralph Goodale had replaced Ann McLellan as Minister of Natural Resources following the federal election in June 1997. In July, he co-chaired the Mines Ministers Conference in St.John's where he heard industry's strong endorsement of government geoscience. Minister Goodale set out a departmental agenda that reflected the government's priorities. This "Work and Innovation Strategy" (WINS) comprised five elements: climate change, resource innovation, work opportunities, trade and investment, and creating national consensus.[60] As luck would have it, I represented ESS at a meeting of Directors-General to identify departmental leads for each of these elements and volunteered to take on the Resource Innovation Initiative (RII). I will come as no surprise that my motives were not entirely altruistic: I saw this as an opportunity to advance ESS' flagship proposals, including TGI.

The development of RII would play out over the next four years or so and was a fascinating experience for me. A working group that was assembled from across the

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[59] IGWG Task Force (1999) Funding government geological surveys: How much is enough? *Provincial Geologists Journal*, v.17, pp. 79-99.
[60] NRCan Report on Plans and Priorities 1999-2000, p. 6.

department decided that the needs of the department's client industries were sufficiently diverse that the best approach was to bundle a series sector-specific programs. Thus RII would comprise two initiatives from each sector: Energy, Minerals and Metals, Forestry, and Earth Sciences. TGI was one of the latter.

We devoted considerable effort to ensuring that the proposals were technically sound and supported by external stakeholders. The champion of each initiative was required to develop a detailed business case, which then underwent rigorous third party review and ranking. For TGI we employed an outside consultant to develop a cost-benefit model, which concluded that:

> *Every $1 million of government investment to enhance the geoscience knowledge base will likely stimulate $5 millions of private sector exploration expenditures, which, in turn, will result in discovery of new resources with an average in situ value of $125 millions.*[61]

The postulated five to one leverage factor has subsequently been cited in many jurisdictions to justify government survey activities in support of mineral exploration, in some cases without due regard for the underlying assumptions and caveats.

Although we were confident that the proposals were technically sound and defensible on cost-benefit grounds, the greater challenge was to develop a coherent storyline or "problematique" linking eight diverse sectoral proposals. This is where the involvement of the policy specialists was invaluable. Steve Lucas, whose background was as a research scientist and manager in GSC's Continental Geoscience Division, had become Director of Policy and Planning in ESS, and played a crucial role in steering RII along the long road from technical proposal to a submission to Cabinet, which ultimately resulted in "policy approval" in November 1999.

As gratifying as it was to receive cabinet's blessing, policy approval did not mean that funding would be forthcoming. It simply meant that RII would be in the long "wish list" considered by the Minister of Finance for his forthcoming budget. As it turned out, innovation was a significant focus of the federal budget that was released at the end of February 2000, with about $2.6 billion allocated to research and development. However, in accordance in *Science and Technology for the New Century*, most of this new funding was destined to be spent outside of government through foundations, research institutes and the like (Canadian Foundation for Innovation, Genome Canada, Canada Research Chairs, etc.). However, although there was no mention of either the Resource Innovation Initiative or TGI, the budget did allocate $15 million over three years to NRCan for geoscience to "stimulate new investment in the mining sector".[62]

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[61] R.B. Boulton and Associates (1999) *Refinement and Validation of a Costs, Benefits and Impacts Model for the Targeted Geoscience Initiative.* Unpublished Report. 57 pp.
[62] The Budget Plan 2000, pp. 112-113.

I do not know for certain why this happened, although it seemed at the time that geoscience was "on the radar screen" at Finance. I was aware that the PDAC had made a strong pitch during pre-budget consultations. Then, in January 2000, during the lead-up to the federal budget, a colleague in NRCan's Minerals and Metals Sector called to relay a question that he had had from an official in Finance. It seems that the latter had seen the industry presentations to Mines Ministers as well as the IGWG Task Force reports and wanted more information about the role of geoscience. I called this official and at his suggestion, arranged to brief a group in Finance more directly involved in the budget process. I am also sure that the Minister played an important role in the result: he had by that time heard industry's demands for increased geoscience at three successive Mines Ministers Conferences, and had signalled that he would look for opportunities as the fiscal situation improved.

In any case, we were told in no uncertain terms that TGI must be up and running by the upcoming field season, a scant ten weeks away. There were a number of challenges to overcome in order to meet this goal. First, the program had to be scaled back considerably, given that the approved funding was only about one-third of the amount requested for TGI in the Resource Innovation Initiative (i.e., $15 million/3 years rather than $44 million/5 years). Second, the TGI Business Plan prescribed a steering committee and formal project selection and review process that would not have been feasible to implement in the few weeks available. Third, plans of the GSC and its partners for the upcoming field season were already well-advanced. Finally, before any of the new money could be spent, we were required to make a submission to Treasury Board to secure the funds, which was not a trivial process.

As luck would have it, the regular bi-annual meeting of the National Geological Surveys Committee was scheduled for the week following the budget at the PDAC Convention. Although all the details of the revised TGI had not been worked out, our provincial and territorial colleagues were pleased to learn that we intended to follow the principles that we had jointly developed for the Cooperative Geological Mapping Strategies (see below).

The various challenges were overcome, allowing a full field program in 2000. Ultimately, TGI comprised 29 projects. The original intent was to have fewer, larger projects, but the late start did not allow for the extended planning and preparation involved in NATMAP and EXTECH style operations. An external evaluation of TGI near the end of its third year indicated that the program was largely meeting its objectives, with about 60% of projects having already stimulated private sector exploration activity. [63] As I write this account, TGI is about to enter its fifth cycle, having been renewed for 2 years in 2004, and for successive 5 year terms in 2005, 2010 and 2015.

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[63] Boulton and Associates (2003) *Evaluation of the Targeted Geoscience Initiative of the Geological Survey of Canada.* Report E04-999 prepared for the Audit and Evaluation Branch, NRCan, 26 pp.

The advent of TGI did not decrease the effort to build support for public geoscience within the framework of the Mines Ministers Conferences. As a result of the 1999 conference in Charlottetown, NGSC was in the midst of developing a "national geological mapping strategy" at the time that TGI was announced. Negotiations involved all NGSC members. I represented GSC and the process was facilitated by Jan Boon, former head of the Alberta Geological Survey, who was on secondment to GSC to lead the Federal Provincial Territorial Office. Jan had replaced Mike Cherry, who had become Director of Mineral and Energy Resources Division in the Nova Scotia Department of Natural Resources.

The negotiations were straightforward for the most part, building on the principles and structures already in place by virtue of the Intergovernmental Geoscience Accord. One surprising area of difficulty concerned the name of the strategy. Anyone familiar with the history of federal-provincial relations could have foretold that the working title – National Geological Mapping Strategy – would not be acceptable to Québec, which had a sovereigntist government at the time. The Québec survey had kicked the name issue upstairs, and we were then negotiating with a senior policy representative. From Québec's perspective, neither "National" nor "Canadian" were acceptable, but there was no problem with "Cooperative". However, we did want to include some reference to Canada in the title and suggested that "in Canada" be added at the end. This was problematic, but changing the preposition "in" to "across" settled the issue. Finally, Québec's interlocutor did not think that the notion of a single strategy for the entire country would sit well with his Minister, and so "Strategy" became "Strategies". This is the reason that the initiative ended up with such a cumbersome, bureaucratic name.

Negotiations were successfully concluded and the *Cooperative Geological Mapping Strategies across Canada* proposal was unanimously accepted at the 2000 Mines Ministers Conference in Toronto in September 2000.[64] In the Action Agenda issued following the conference, Ministers from all jurisdictions committed to seek new funding to make CGMS a reality. The CGMS document was fairly innocuous and there was little downside risk for Ministers in accepting it. The document was crafted in such a way as to maintain the momentum of the case for enhanced geoscience without forcing an immediate decision on funding. It included a set of principles, largely mirroring those in the IGA, as well as a governance structure for a new program. Although a firm budget and timeframe was not set out, it was suggested that an amount similar to that proposed by the IGWG task force (about $500 million for both minerals and energy related geoscience) be allocated over 10 years, beginning in 2001. It was also indicated that funding would be roughly half federal-half provincial. It proposed that

> *as a first step, the Minister of Natural Resources Canada determine the total amount of federal funds that would be available for investment in the strategies. The provincial and territorial ministers would then, in turn, indicate how much their respective jurisdiction is pre pared to invest. The final allocation of funding to the Cooperative*

[64] National Geological Surveys Committee (2000) Cooperative Geological Mapping Strategies across Canada. *Provincial Geologists Journal*, v.18, pp. 89-95

Geological Map ping Strategies in each jurisdiction would then be determined through bi lateral negotiations. (p.91-92)

Minister Goodale was supportive and although he obviously could not make a commitment to new funding, he did refer to the recently implemented TGI as a "down payment" on the new strategy. Our intent was to prepare a submission to Cabinet, likely as part of an updated Resource Innovation Strategy, with a view to funding in the next federal budget. However, our plans were soon overtaken by political events, when the Liberal government called an early election in November 2000. This was not the end of CGMS – indeed it would become my principal preoccupation for the remainder of my GSC career. I will return to it in my next chapter.

METALS IN THE ENVIRONMENT

One of my corporate responsibilities was to ensure the provision of geoscientific advice in respect to the risks posed by metals and other naturally-occurring substances in the environment. This was of particular interest to NRCan's Mineral and Metals Sector (MMS), which was concerned about potential regulatory burdens on the mining industry. At the same time, as the federal government's principal repository of geoscience knowledge, GSC had to be an honest broker of information. This was sometimes a challenge, but I think that after a difficult beginning, when GSC was sometimes seen as the "skunk at the [Environment Canada] picnic", we emerged as a valued partner in multi-agency research.

A small program in environmental geochemistry had been initiated in the GSC in 1990 as a consequence of a resource reallocation process (see *The Ten-Percent Solution* above). It is clear from the GSC Long Term Strategic Plan of 1991 that environmental issues were "on the radar screen". Environmental geochemistry, including research on processes that control the distribution of toxic substances, was identified as a focus, and it was noted that it would be essential to develop partnerships with health and environmental agencies. However, the only specific project mentioned in the LTSP in this area was a study of the concentration of toxic elements in black shales.

In the meantime, the Canadian Environmental Protection Act (CEPA) had been passed in 1988. Among other things, CEPA required Environment Canada (EC) and Health Canada (HC), to carry out risk assessments of 44 "priority substances" to determine whether they were "toxic" as defined in the Act. The first round of assessments had to be completed by 1993. There were some working level discussions between EC and GSC scientists about these risk assessments, and GSC funded a small contract to review geochemical information for Environment Canada, but the Survey did not fully engage in CEPA until very late in the process, in August 1993, when Environment Canada sent several draft risk assessment reports to EMR for review. The first Priority Substances List (PSL)

included four metals or semi-metals: nickel, chromium, cadmium and arsenic, and those reports were forwarded to GSC through the Mineral Policy Sector (MPS).[65]

The GSC review of the draft risk assessments raised a number of issues. In particular, we did not believe that the draft reports dealt adequately with either the variability of natural background concentrations of these substances or the importance of speciation - the chemical form of the element. These concerns were of more than academic interest. In the case of nickel, for example, the draft report concluded that "nickel and its compounds" were toxic under CEPA. Taken at face value, this would have implied that stainless steel posed a risk to the environment or to human health. In reality, only a handful of the hundreds of different alloys and compounds of nickel (oxides, sulphides, chlorides, etc) were known to be potentially toxic. In the event, EMR became involved in both the scientific and the policy dimensions of the PSL process, resulting in more robust and credible assessments. In the case of "nickel and its compounds", for example, the final report is very careful to distinguish those forms that pose a risk from those that do not.[66]

A few Environment Canada scientists and senior managers were somewhat disgruntled with the Survey`s role in the PSL process. This was understandable in my opinion. From their perspective, GSC had not taken an opportunity to be more fully engaged at the outset, but arrived at the eleventh hour demanding significant changes. More serious was the suspicion on the part of some in Environment Canada that scientific differences were being used by EMR to dilute regulatory measures that might be detrimental to the mining industry. In any case, differences were ultimately resolved and a more productive working relationship began to emerge. A breakthrough of sorts occurred in 1994 with the publication, by Environment Canada, of the *Toxic Substances Management Policy*. The involvement of GSC geochemist Bob Garrett in policy development had helped ensure "a two track approach" that recognized that naturally-occurring substances could not be subject to virtual elimination.

All was not yet "sweetness and light", however. Any bad blood engendered by the PSL experience, paled by comparison to the scientific disagreements about Long Range Transboundary Air Pollution (LRTAP). The principal impetus for GSC involvement in LRTAP was negotiation of the Heavy Metals Protocol under the United Nations' Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution. Environment Canada was the lead department and from 1993 to 1996, GSC participated in in the technical working group developing the Canadian position. The specific scientific debate in respect to LRTAP from our perspective was the provenance of metals in pristine ecosystems. In particular, "source apportionment" - how much was derived locally and how much was carried in from industrial sources hundreds or thousands of kilometers away.

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[65] EMR had not yet become NRCan and MPS had not yet amalgamated with CANMET to become MMS.
[66] Environment Canada-Health Canada (1994) *Nickel and its Compounds.* Canadian Environmental Protection Act - Priority Substances List Assessment Report. 82 pp.

GSC recruited Pat Rasmussen, a recent Ph.D. in environmental geochemistry, to help bring a geoscience perspective to the issue. Pat completed a literature review pertaining to source apportionment as a Canadian contribution to the UN-ECE Science Working Group, which was scheduled to meet in Geneva. As the meeting approached, we were informed that Environment Canada had decided to not table Pat's report. After unsuccessful protests from our department, a way was found to ensure that each delegate at the meeting received a copy of the report "unofficially". The report, which was formally published as a GSC bulletin[67], was hardly controversial. Its principal conclusion was that there were insufficient data to allow robust estimates of the source apportionment of metal loadings in remote ecosystems. In the end, the Heavy Metals Protocol, which was signed in 1998 and came into force in December 2003, undertook to limit emissions from *anthropogenic* sources.

During this same period, GSC scientists also dealt with LRTAP under the rubric of the Continental Pollution Pathways agenda of the North American Commission for Environmental Cooperation (NACEC). In this case, after several technical meetings, there was no consensus on natural sources. The final report included the statement "Dr. Robert Garrett and Dr. Patricia Rasmussen, scientists involved in the Expert Advisory Panel, have registered their concerns that the report does not adequately reflect the complexity associated with source apportionment where aerosols have both natural and anthropogenic origins."[68]

The LRTAP episode included some of the worst examples of "scientists behaving badly" that I had ever encountered. These included *ad hominem* attacks and attempts to suppress debate. Although, from my perspective (admittedly biased), GSC scientists acted honorably, the same cannot be said about some from other departments and from academia. The interdepartmental squabbling that occurred in the context of PSL and LRTAP was highlighted in 1999 by the OAG[69], five years after the problems had been largely resolved. I recall pointing-out to a member of the audit team that we had enjoyed a good working relationship with EC for several years: much to my amazement, he responded that although that might well be the case, it wouldn't make a very good headline!

Interdepartmental tensions had already been mitigated by a framework established in 1995 by the departments of Agriculture and Agrifoods, Fisheries and Oceans, Environment, Natural Resources and, from 1998, Health to promote scientific cooperation on cross-cutting sustainable development issues. The "5NR MOU", as it became known, set up a number of scientific working groups.

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[67] Rasmussen (1996) "Trace Elements in the Environment: A Geological Perspective". GSC Bulletin 429. 26 pp.

[68] NACEC (1997) Continental Pollution Pathways: An Agenda for Cooperation to address Long-Range Transport of Air Pollution in North America. 44 pp.

[69] 1999 Report of the Commissioner of the Environment and Sustainable Development: Chapter 3—Understanding the Risks From Toxic Substances: Cracks in the Foundation of the Federal House http://www.oag-bvg.gc.ca/internet/English/parl_cesd_199905_03_e_10169.html#0.2.2Z141Z1.NBS3AG.78WQBF.31

At the time of the establishment of ESS in 1995, GSC did not have a robust research program dealing with metals in the environment. The contributions described above were made by a small number of scientists relying on their existing knowledge and data. The small budget set aside for environmental geochemistry 1990 had atrophied in the face of ongoing budget reductions and the work on toxics was largely funded from external sources, including the Mining Association of Canada, Ontario Hydro, and the International Council on Metals in the Environment. Despite being described in the 1996 Strategic Plan, the GSC Management Committee had little appetite to reallocate funds to support the proposed MITE program. The tide changed as a result of two significant events. The first was a meeting in Val Morin, Quebec in October 1996, convened by the Canadian Network of Toxicology Centres on behalf of the Mining Association of Canada, with the goal to identify knowledge gaps that inhibit sound risk assessment of metals in the environment. It was attended by 33 scientists and science managers drawn equally from government, industry and academia. The result was a consensus on research priorities, including recognition of the importance of having a better understanding of natural sources. The group also agreed to develop a research network proposal, which ultimately led to the NSERC-funded MITE Research Network.

The second event was the tabling in November 1996 of the Final Report of the Standing Committee on Natural Resources entitled *Streamlining Environmental Regulation for Mining*. It included the recommendation that

> *...the government should strive to ensure that the Metals in the Environment Program now being developed by the Geological Survey of Canada be completed promptly.*

As might be expected, this had a salutary effect on senior management of the sector, which gave the go ahead to the MITE program in spring 1997, with an internal re-allocation of $500K O&M and $1500K salary/year for 5 years.

Bob Garrett took on leadership of the program, which was overseen by a blue-ribbon advisory committee comprising respected scientists and managers from industry, government and academia. MITE pursued several research priorities defined at the Val Morin meeting, including fluxes from natural and anthropogenic sources, records of historical deposition, long range atmospheric transport, and transformations to bio-available forms. The MITE projects were integrated with two other university-government-industry programs: the Toxic Substances Research Initiative (1998-2002) and the NSERC MITE Research Network (1998-2003). In the former, GSC scientists led one major project – a study of elevated mercury levels in loons in Kejimkujik National Park, Nova Scotia (a "cause celeb" of the environmental community) and played a major role in an EC-led study of emissions from Noranda smelter. The GSC's smelter-centred work built on a pre-MITE quaternary geology study under the NATMAP Shield Margin Project that included organic surface soils around Flin-Flon, Manitoba, as well as research around smelters at Belledune, NB, and Trail, B.C.

One scientific controversy in the LRTAP debate concerned the validity of lake sediment profiles as evidence of atmospheric deposition and, in particular, the extent to which the commonly observed upward enrichment of metals was due to derived from the atmosphere, on the one hand, or diagenetic processes on the other. The MITE studies elucidated the relative importance of various processes. Close to point sources, anthropogenic inputs dominate and are clearly recorded in many profiles. Diagenetic processes become dominant at some distance from the point sources, depending on dominant wind direction and topography. In general, particulates from smelter point sources could be detected at distances up to 40 to 70 km (and up to 100 km in the case of mercury).

Unlike in the first round of PSL assessments (1988-1993), the Survey was actively involved from the outset in the second round, beginning in 1999. Mineralogical and chemical studies undertaken in the MITE smelter project provided important background for the PSL assessment of primary and secondary copper and zinc smelters and refineries. The atmosphere was completely different due to the scientific collaboration in the TSRI and MITE-RN projects, as well as participation of the Program Manager, Bob Garrett, in the relevant working groups established under the "5NR MOU" described above.

Over the period of the MITE Initiative, 1997-2002, relationships with other departments changed from one of confrontation to one of collaboration. The value of the Survey's science and knowledge was appreciated and contributed to policy and regulatory development. Perhaps one of the most important outcomes was the recognition that natural processes need to be considered, and that all that society does to the landscape is imposed on a natural geochemical background.

CANADA-NUNAVUT GEOSCIENCE OFFICE

The new territory of Nunavut came into being on April 1, 1999. This was the result of the comprehensive land claims settlement of the Inuit of the Northwest Territories in 1993. In the course of negotiations to implement the Nunavut Act (S.C. 1993, c. 28), it was agreed that the federal government support the new territorial government in a number of areas, including geoscience information and services. The framework for provision of geoscience was set out in a Memorandum of Agreement among Natural Resources Canada, Indian and Northern Affairs Canada (INAC), and the Nunavut Department of Sustainable Development. This included establishment of the Canada-Nunavut Geoscience Office (C-NGO) in Iqaluit with a "mandate to establish geoscience capacity in the Territory and to collect and distribute geoscience information in support of sustainable development".[70] Implementation began in earnest in 1998 with Janet King, Director of Continental Geoscience Division, taking the lead for GSC. David Scott was appointed C-NGO's first Chief Geologist in February 1999, relocated to Iqaluit in April, and worked quickly to ensure that facilities, staff and equipment were in place so that full field operations could commence in

[70] Provincial Geologists Journal, vol. 17, p. 73.

the summer of 2000. He has provided a detailed description of the early years of C-NGO in another contribution to this series.[71]

C-NGO was intended to fill the "province-like" geological survey role in Nunavut, in much the same way as the Yukon Geology Program (now the Yukon Geological Survey) and the NWT Geology Program (now the Northwest Territories Geological Survey). Unlike its counterparts in Yukon and NWT, which were each jointly operated by INAC and the relevant territorial government department, C-NGO was established as an integral part of NRCan, specifically as a unit of GSC's Minerals and Regional Geoscience Branch. This meant that our department was the employer of record of C-NGO staff, provided management and administrative services, and was accountable for operation of the Office. However, GSC did not define the C-NGO science program: this was approved by the C-NGO Management Board acting on the advice of the C-NGO Scientific Review Committee.

The C-NGO's staff comprised in addition to the Chief (a bedrock geologist), a bedrock mapper, a surficial mapper, a metallogenist, a sedimentologist/stratigrapher, two GIS specialists, and an administrative assistant. Despite its small size, C-NGO has made a significant impact not only in advancing the understanding of Nunavut geology, but also in increasing public awareness of geoscience. For example, the Office spearheaded the production of GEOSCAPE and Climate Change posters for Nunavut, the development of geoscience information packages for tour operators, and a GIS internship program for graduates of Arctic College.

INFORMATION TECHNOLOGY

The explosion of digital technology beginning in the mid-1980s had an immense impact in the GSC as elsewhere in society. As well as the typical applications in office and laboratory automation, and the displacement of conventional postal and facsimile communications by email, it greatly accelerated the production and distribution of geological maps and reports. This latter development deserves elaboration.

The GSC had long enjoyed an enviable reputation among its clients for the quality of its maps, reports and data, but frequently heard criticisms of the delay between field work and the release of maps. This changed with the use computers for direct digital capture of geological data in the field, with accurate locations determined by GPS. The GSC FieldLog AutoCAD© module allowed the field geologist to import and manipulate the digital field observations, and then export "an almost ready for prime time" map to the cartography unit for final revisions and publication. FieldLog was initially developed by Boyan Brodaric at the Ontario Geological Survey in 1988. He was recruited shortly thereafter to lead development of GSC's digital field mapping systems.

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[71] Scott, D.J. (2012) *Canada-Nunavut Geoscience Office.* Friends of GSC History, Series A - Historical Contributions no. GSCHIS-A017, 7 pages.

Once maps were produced through a digital process, it was not much of a leap to distribute them in digital format, and, by 1994, many GSC products were available on CD-ROM (compact disks). This became a contentious issue in the newly amalgamated Earth Sciences Sector. For its part Geomatics Canada was still wedded to the cost recovery model and sought to generate revenues through sale of its digital topographic data. This policy extended to the topographic base used in GSC digital geological maps, which at the time were distributed on CD. This required that the price of a geological map on CD-ROM, for example, be in the range of $100 to $150, most of which was the license fee for the topographic base. Predictably, this raised the hackles not only of industry and other users but more particularly our partners in the provincial surveys. The latter, quite rightly in my view, were upset that they were required to sell the products of joint projects at prices that would limit their distribution. This egregious practice was soon to be overtaken by the Internet revolution.

The increased penetration of the Internet and widespread use of Geographic Information Systems (GIS) made it feasible to distribute maps directly in digital format, without a CD or other physical medium. In 1996, GSC released the *Surficial Materials of Canada* map over the Internet in three GIS formats as a pilot project for digital map distribution. The next step was to make it possible for users to search and display map data online an ultimately to customize maps to their specific needs. The British Columbia Geological Survey was at the forefront in this respect with *The MapPlace* website, launched in about 1997. The other provincial surveys and the GSC were quick to follow the BCGS lead.

In 1998, the Survey initiated *ResSources GSC* as a vehicle to evaluate and demonstrate approaches to the Internet distribution of the Survey's information holdings.[72] It built upon *GeoConnections*, a national initiative led by Geomatics Canada to implement the *Canadian Geospatial Data Infrastructure*. Also in 1998, the National Geological Surveys Committee convened a workshop to explore development of the *Canadian Geoscience Knowledge Network (CGKN).* The ultimate goal was to "provide a single Internet portal for the discovery and evaluation of geoscience data [held by all of Canada's geological survey organizations] and link the client to the data provider". An early accomplishment was the Canadian Geoscience Publications Directory, a map-based, on-line catalogue of survey publications. It allowed users to display the extent of coverage of all maps and reports pertaining to a specified area produced by federal, provincial and territorial governments. The initiative was abandoned by GSC in late 2006, but in the meantime, CGKN had been the catalyst for cooperative development of data infrastructure (catalogues, tools, data models), much of which is still in use.

[72] *ResSources GSC* was initially called the *Geoscience Knowledge Network* but the name was changed to in 1999 to avoid confusion with the like-named NGSC initiative.

THE MILLENNIUM BUG

In the mid-1990s, the world gradually became aware of potential catastrophic implications of a quirk in computer software. The so-called "millennium bug" was a result of the practice of expressing years as two rather than four digits. Thus, on January 1, 2000, a computer would think that the date was actually January 1, 1900. This led governments and businesses alike to work feverishly to ensure that computer-dependent systems were modified and contingency plans in place, at global cost in the hundreds of billions of dollars.

In Canada, the federal government identified Government Wide Mission Critical Functions that were considered "essential to the health, safety, security and economic well-being of Canadians".[73] There were only three such functions in Natural Resources Canada, all of them the responsibility of ESS: aeronautical and technical services in Geomatics Canada, and seismic monitoring (including that in support of the nuclear test ban treaty) and geomagnetic monitoring, both in GSC. As it turned out, the new millennium began without any significant incidents, leading some pundits to suggest that it was much ado about nothing. The contrary view, of course, is that disaster was avoided by virtue of the preparations. Regardless, one lasting benefit of the "millennium bug" was that it caused organizations to develop or upgrade their contingency plans for emergencies. For the GSC, it also raised the profile of elements of our Natural Hazards Program as "Government Wide Mission Critical Function".

FROM MT. LOGAN TO MT. TRUDEAU AND BACK AGAIN

One of the more bizarre incidents in my GSC career began late in the afternoon of October 4, 2000. I was in my office when I received an urgent call from the Deputy Minister. He was attending a Cabinet meeting where the Prime Minister had suggested that Canada's highest peak, Mt. Logan, should be renamed in honour of former Prime Minister Pierre Elliot Trudeau, who had passed away the previous week. The DM's question for me was whether Sir William Logan had any living descendants who would be upset by the proposal. I told him that I understood that Logan had never married and, as far as anyone knew, there were no offspring, legitimate or otherwise. However, I added that Logan was revered by the 10,000 or so geologists in Canada, who would likely react negatively. The DM also asked about the process for naming mountains and other features. While I knew that Geomatics Canada hosted the secretariat of the Geographical Names Board of Canada, I had to admit that I was not familiar with its operations. In the event, he asked to me to join a group of advisors in the DM's boardroom for a meeting as soon as he could return from Parliament Hill. The story had broken on a radio newscast by the time the DM had returned to Booth

[73] Office of the Auditor General, November 1999, Chapter 25—Preparedness for Year 2000—Final Preparation.

Street. Apparently, the Prime Minister had announced his intention to reporters following the Cabinet meeting.[74]

As I recall, much of the ensuing discussion dealt with the hurdles that would have to be overcome to make the change. To start with, it had been determined that the Prime Minister's proposal was not within his authority or, indeed, the purview of the federal government – the responsibility for naming geographic features had been transferred to the provinces in 1961 and the territories in 1984. Mt. Logan is in southern Yukon and any name change would require authorization of the designated territorial cabinet minister on the recommendation of the Yukon Geographical Place Names Board. To complicate matters, the mountain was in the Kluane National Park Reserve and probably subject to aboriginal land claims. Strangely enough, none of the contemporary news reports that I reviewed in writing this account make note of the fact that the federal government does not have the unilateral authority to change the name.

Public reaction was swift and overwhelmingly negative. A "Save Mt. Logan" website sprung-up and the BC and Yukon Chamber of Mines organized a letter-writing campaign. Politicians including Alberta Premier Ralph Klein, opposition MPs and even a few Liberal backbenchers soon jumped on the bandwagon. Interestingly, a few individuals claiming to be "descendants" of Sir William Logan came out of the woodwork. I remember spending more than an hour on the telephone with a gentleman in Quebec who believed that Sir William had impregnated his great grandmother. On October 16th, CBC reported that the Prime Minister was recanting his decision[75] and, in the fullness of time, a peak in the Caribou Mountains of BC was named in honour of Mr. Trudeau.

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[74] *Mount Logan to become Mount Trudeau*. CBC News, October 5, 2000, http://www.cbc.ca/news/canada/story/2000/10/05/mountain001005.html

[75] *Prime Minister backs down from renaming mountain*. CBC News October 16, 2000. http://www.cbc.ca/news/canada/story/2000/10/16/logan001016.html

THE VIRTUAL GSC (2001-2006)

One Sector – Results for Canadians - ESS S&T Strategy and Issues-Driven Programs –Revenge of the Matrix– Cooperative Geological Mapping Strategies Across Canada – Groundwater - Nine/Eleven and CRTI

"ONE SECTOR"

Marc Denis Everell left ESS in late 2000 to become ADM of the Canadian Meteorological Service, and was replaced by Irwin Itzkovitch. Irwin had been a Director General in CANMET in the early 1990s and subsequently Vice President and Chief Technology Officer of Noranda Mines.

There were other changes in the senior management roster. Susan Till, originally from the Canada Centre for Remote Sensing, was appointed Associate ADM of ESS. Richard Haworth, DG of Sedimentary and Marine Geoscience Branch left to become ADM of Minerals and Metals Sector. His position was taken by Jan Boon, a former Director of the Alberta Geological Survey who had come to Ottawa to head-up GSC's federal-provincial-territorial liaison office under an interchange agreement.

Given the experience of CANMET during his tenure, I think that many of us expected the new ADM would move the sector towards greater cost-recovery and perhaps even a quasi-commercial mode of operation. We were pleasantly surprised that this was not to be the case: Irwin turned out to a strong proponent of public geoscience as well as of the Survey's role in informing government policy process. This probably reflected the evolving view of the role of government, which had come under scrutiny during Program Review. In any case, I believe that clearly defining a public good mission for GSC was an important positive step. This mission had been fully integrated by 2006, when ESS characterized itself "as a world leader in the provision of public-good earth sciences data and information".[76]

On the organizational front, in a departure from his predecessor, the new ADM wanted ESS to become fully integrated into "one sector". In practical terms, as discussed in more detail below, this meant the GSC and Geomatics Canada would no longer have their own programs or budgets. Program planning and budgeting would be combined and, in theory at least, staff could be assigned to projects anywhere in the sector. Existing programs and projects would be wound down and replaced by a series of sector-wide programs. On a more symbolic level, GSC would no longer have its own vision, mission and values statements, or its own published Annual Report. GSC had in effect become a virtual organization, existing in name, but not as a single, unified entity.

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[76] *Earth Sciences Sector Business Plan 2006-2009*, p. 4.

RESULTS FOR CANADIANS

In 2000, the government released *Results for Canadians: A Management Framework for the Government of Canada.*[77] This set out a number of guiding principles, some of which had been broached in the past and probably seemed self-evident to many. However, in retrospect, I believe that this document, or at least the philosophy behind it, had a profound impact on the evolution of the Survey. In particular, it embraced three recent trends in public administration: the whole-of-government approach, results-based management, and citizen-centred government.

The whole-of-government approach emerged in the UK in the late 1990s under the rubric of "joined-up government" and has subsequently spread to many countries. The rationale is that many contemporary public policy issues do not fall neatly within the purview of a single government department but require an integrated response. It was a reaction to some elements of the New Public Management, in particular the latter's tendency to promote single purpose organizations, which led, in some cases, to departments working at cross purposes.[78]

Citizen-centred government can be viewed as the application of the whole-of-government approach to serving the public. At the most basic level, the goal is to facilitate access:

> *Citizens want the government to respond to their needs and provide choice: one-stop, integrated access via Internet, telephone or mail, or in person. (Results for Canadians, p.7)*

Discussions of citizen-centred government typically point to initiatives such as Service Canada or common look and feel of the federal web presence.[79] However, it also reflects more subtle changes. It is a departure from the New Public Management, which emphasized serving "clients" or "customers". Some scholars have gone so far as to suggest that the NPM mantra of "steering rather than rowing" has been replaced by "serving rather than steering", and that "the public interest is the aim, not the by-product".[80] *Results for Canadians* reasserted the primacy of the public interest, and I think reinforced the notion of an unambiguous public good mission for ESS.

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[77] Treasury Board Secretariat (2000): *Results for Canadians: A New Management Framework for the Government of Canada. http://www.tbs-sct.gc.ca/report/res_can/rc-eng.pdf*

[78] Christensen, T. and Lægreid, P. (2007) The Whole-of-Government Approach to Public Sector Reform. *Public Administration Review*, v.67, pp. 1059-1066.

[79] The consolidation of federal web presence under the *Canada.ca* umbrella isjust now coming to fruition (in 2015). Although integrated access may well hold many advantages for the general public, it remains to be seen whether it will ensure effective dissemination of scientific information to the specialist communities in industry, academia, and civil society that have traditionally been the principal users of public geoscience.

[80] Denhardt, R.B. and Denhardt, J.V. (2000) *The New Public Service: Serving Rather than Steering*. Public Administration Review, v.60, p.549-559.

Giving a nod to citizen-centred government, the ESS Business Plan 2002/05 included "A Key Question that Canadians Ask" for each program. For example, under Groundwater "How do we ensure that we have access to a lasting, abundant supply of clean water?", and under TGI, "Will mineral deposits be found to maintain or increase mining-related jobs?" A small gesture to be sure, but indicative of a desire to make the program relevant to the general public.

Results-based management was an outgrowth of Management by Objectives, which had been popularized in the 1960s by management guru Peter Drucker. It is consistent with the "funding outcomes, not inputs" principle of *Reinventing Government*. The intent was described in *Results for Canadians* as follows:

> *Historically, governments have focused their attention on resource inputs (what they spend), activities (what they do) and outputs (what they produce). Accurate information at this level is important, but insufficient to achieve the results orientation demanded by this management framework.*
>
> *A modern management agenda requires managers to look beyond activities and outputs to focus on actual results - the impacts and effects of their programs. (p.11)*

This new policy led to wholesale changes in how programs were defined and performance was measured across government, and was incorporated into the Main Estimates, the formal reporting system to Parliament. Beginning in 2005, departments were required to develop a Program Activity Architecture (PAA), which showed the linkage between individual activities and Strategic Outcomes, defined as a broad, enduring societal benefit[81]. Because it explicitly links activities at the project level to broad government objectives, the PAA is one means of implementing the whole-of government approach.

As noted above in my account of the GSC Management Pathway, NRCan was one of five departments that began piloting elements of the new approach as early as 2000, and ESS was "ahead of the curve" in implementing "issues-driven programs", which I describe in the next section.

ESS S&T Strategy and Issues-Driven Programs

Before returning to the department, the new ADM had been a member of the Council of Science and Technology Advisors (CSTA), which was established in 1997 to provide external advice to the federal Cabinet Committee on the Economic Union about the government's intramural science and technology. CSTA produced a series of reports that were noteworthy not only for the soundness of the advice provided (and it was good

[81] Treasury Board Secretariat (2005) *Management, Resources and Results Structure Policy*

advice!), but also for the clever acronyms defined by their titles.[82] This experience strongly influenced our ADM's approach to ESS, including his introduction of the "ESS S&T Strategy".

The actual strategy was essentially a brief statement of principles, which could have applied to virtually any government scientific organization (Table 3). The reaction of rank and file staff to such pronouncements generally ranges from indifference to skepticism, and this case was no exception. However, implementation of this strategy would have far-reaching consequences:

> *In 2002, on the basis of recommendations from the Council of Science and Technology Advisors, ESS began to implement an innovative strategy to integrate S&T into policy and decision-making at NRCan. At that time, ESS ended all existing S&T activities and created a new program portfolio that was more clearly aligned with government objectives…*[83]

Although the strategy shares much in common with earlier such statements, there are two points in particular that illustrate the government's evolving expectations. The first is the emphasis on the sector's role in the *"integration of science and technology policy and decision-making by NRCan…"* Contrast this with the mission statement from the GSC's two preceding strategic plans - *"to provide Canada with a comprehensive geoscience knowledge-base…"*

The second point is the reference to ESS as an *"issues-, outputs- and outcomes-driven organization*", as set-out in *Results for Canadians.* The difference in approach may be illustrated by the different ways in which geological mapping activities are described in the 1996 strategic plan and the 2002 business plan. According to the former, the aim of the Nechako Plateau NATMAP project was *to increase our understanding of the tectonic history and mineral potential of this little understood part of the BC interior*. By contrast, one outcome of the Northern Resources Development program stipulated in the latter plan was *an increase of 50% in investment in northern resources exploration and development.*

A key element in the implementation the ESS S&T Strategy was the creation of an entirely new portfolio of "issues-driven" programs. This meant that virtually all existing programs and projects were terminated, including highly successful initiatives such as NATMAP and EXTECH. The Proposal Driven System, which had been launched in 2000, was abandoned. Many in the GSC were understandably frustrated, given that this was the second radical change in program management practice in as many years.

The "issues" that would "drive" the new programs were identified on the basis of various considerations, including the Department's legislated mandate, the Minister's

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[82] SAGE, Science Advice for Government Effectiveness (1999); BEST, Building Excellence in S&T (1999); STEPS, S&T Excellence in the Public Sector (2001); READ, Reinforcing External Advice To Departments (2001); EDGE: Employees Driving Government Excellence - Renewing S&T Human Resources in the Federal Public Service (2002); SCOPE: Science Communications and Opportunities for Public Engagement (April 2003).

[83] *Earth Sciences Sector Business Plan 2006-2009*, p. 4.

instructions from the Prime Minister (the "mandate letter"), departmental goals, priorities set out in the Speech from the Throne, and so on. Individuals were then charged with proposing programs that would address these issues.

Some observers may have perceived this as merely a re-packaging exercise – bundling traditional activities differently to be more politically saleable. Certainly, there was little doubt that geological mapping, for example, would continue to be an important activity and, moreover, that the programs that incorporated mapping would have to be aligned with government policy. The process of program development and project selection, however, meant that the result was much more than this. The results-based approach requires a "logic model" beginning with the target outcomes and working backwards towards outputs and activities.[84] This process was guided by the ESS Office[85], which had been directed by the ADM to play the role of devil's advocate, forcing program proponents to make a strong case, and did so with relish.

Obviously, the slate could not be wiped entirely clean as the sector had certain legislated or regulated responsibilities that could not be eliminated. Similarly, certain other activities were more appropriately managed as services, which unlike programs would likely be ongoing for many years. Thus, within the first year or so, two new categories were introduced: Knowledge-based Services and National Initiatives. The monitoring of earth quakes and magnetic storms were examples of the former. National Initiatives were government-wide programs, the management of which had been delegated to ESS, the Polar Continental Shelf Project being an example.

The end result of rebuilding sector programs was an edifice of dazzling complexity, comprising 17 issues-driven programs, three national initiatives, six knowledge-based services (Table 4). There were two additional categories – leadership and people support – that encompassed many of the activities included in the Administration Program in the previous regime. Whether or not this was really more transparent or understandable to the outsider is debatable, but there is no question that expanding GSC's portfolio from six programs to 15 programs and services complicated management considerably. Moreover, although the intent was to integrate GSC and GC activities, only a handful of programs and services actually involved staff from both GSC and Geomatics Canada.

Moreover, the separation of programs and related services sometimes created artificial barriers. For example, research on earthquake hazards was conducted in the Natural Hazards and Emergency Response Program, but the seismic array upon which the research was largely based was managed separately under the National Earthquake Monitoring System.

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[84] See also Treasury Board Secretariat (1999) *Managing for Results.*

[85] At the beginning of implementation, there were separate program offices for GSC and Geomatics Canada: however, by 2004, these had been consolidated into the ESS Office.

Table 3: ESS S&T Strategy (ESS Business Plan 2002/05)

Vision
ESS will be, and be recognized to be, a leader in the development, deployment and integration of science and technology into policy and decision-making by NRCan, the federal and provincial governments, industry and other stakeholders.

Strategy

- Have and maintain a highly motivated innovative and focused staff;
- Have a balanced S&T portfolio;
- Do the right S&T and do it at the right time;
- Own only what you must; influence all you can; and
- Use the best resources, wherever they exist, through the use of internal and external networks, partnerships and alliances.

Implementation
ESS will be a high-performance, issues-, outputs- and outcomes-driven organization, aligned with government priorities, linked with other parts of Canada's innovation system, and known for excellence in everything it does making it the employer of choice.

REVENGE OF THE MATRIX

Given the continuing difficulties with program management and the ADM's desire that ESS operate as a single integrated entity, it was probably inevitable that sector adopt a true matrix management structure. Matrix management had emerged in NASA in the 1960s and was embraced by many large corporations in the 1970s. After falling out of favour in the 1980s, it enjoyed a resurgence in the 1990s.[86] The essence of the matrix approach is that project or program management authority cuts across the traditional divisional or functional hierarchy. In ESS, this meant that responsibility for running programs was vested in a series of Program Managers who reported to an Executive Director of Programs[87], and program budgets were determined by the Sector Management Team. Program managers could in principle utilize staff from any part of the sector, but had to negotiate with Division Directors to contract the necessary number of person-months of an individual's time.

A great deal of effort was expended on defining and refining the roles and responsibilities of the management cadre, which was now much larger with the addition of Program Managers. Branch Director Generals and Division Directors no longer had direct authority over program budgets or program delivery. Instead, they had two principal

[86] *e.g.*, Anderson, Richard E. (1994) Matrix Redux *Business Horizons*, v. 37, no.6, p. 6-10.
[87] Initially, each Program Manager reported to a designated Director-General within the existing structure. When the matrix was fully implemented, they reported to one of two Directors who reported, in turn, to a Director General of Programs.

responsibilities designated as Leadership and People Support (Table 4). Under Leadership, a given executive would typically have responsibility for strategic planning for specific program areas, liaison with one or more provincial governments and industrial sectors, and certain corporate files. People support included the usual human resources responsibilities, not the least of which was ensuring that staff time was fully allocated to projects in one or more program areas.

Not surprisingly, given the number of program elements (23), organizational units (18), and geographic locations (15), the matrix turned out to be exceedingly difficult to manage. The inherent difficulty was exacerbated by the absence of adequate financial and human resource administrative systems. A noteworthy example resulted from the decision to pay staff salaries from program rather than division budgets. In theory, Program Managers would determine the expertise they required (and could afford) for their projects in the upcoming fiscal year and then negotiate with Division Directors to buy the time of qualified staff. For their part, Division Directors needed to ensure that the time of their staff was fully allocated so that sufficient funds were available to pay salaries. To complicate matters, a time tracking system was introduced to monitor the actual amount of time devoted to each project and to make adjustments as necessary. This system caused much consternation and many scientists either ignored it altogether or made no effort to enter accurate information. It also attracted the attention of their union, which erroneously but perhaps understandably was concerned that scientists would not be paid for time that was not fully subscribed. Similarly, the costs of laboratory and other internal services were paid from program budgets, causing cash-flow problems for laboratory managers, particularly when major equipment required maintenance before revenues had accrued. These difficulties contributed to a widespread disdain for the new program management regime.

I do not think that many of those involved were very happy with the new matrix arrangement. Directors general and especially directors grieved their loss of program management responsibilities and found their leadership roles to be constrained and ambiguous. Scientific staff felt "commoditized", their worth defined in terms of "competencies" rather than their research career paths. Provincial and territorial colleagues were frustrated to find that their traditional contacts in the GSC no longer had the authority to deal operational matters, and found it difficult to know who to talk to about a given issue. The one positive outcome was that the approach did promote horizontal communication and interaction among scientists in different divisions and locations.[88]

[88] One occasionally heard the metaphorical adjective "stove-piped" used to describe the perceived shortcomings of the traditional structure. One wag observed that we had merely replaced vertical stovepipes with horizontal ones, and everyone knew how well those worked.

Table 4: Earth Science Sector – Issues-driven Programs, ESS-led National Initiatives, and Knowledge-based Services (*Business Plan 2002/2005 – 2004 Update and Progress Report*)

Issue: A Clean Environment
- Groundwater (GSC/GC)
- Reducing Canada's Vulnerability to Climate Change (GSC/GC)
- Metals in the Environment (GSC)
- Legislated Environmental and Resource Assessments (GSC)

Issue: Strong and Safe Communities
- Natural Hazards and Emergency Response (GSC/GC)
- Aeronautical Charting (GC)
- Canada/United States International Boundary Maintenance and 1925 Treaty Implementation (GC)

Issue: Connecting Canadians
- Geomatics for Connecting Canadians (GC)

Issue: Sustainable Development of Natural Resources
- Consolidating Canada's Geoscience Knowledge(GSC)
- Geoscience for Oceans Management (GSC)
- Sustainable Development through Knowledge Integration (GSC/GC)
- Geomatics for Sustainable Development of Natural Resources (GC)
- Gas Hydrates – Fuel of the Future? (GSC)
- Targeted Geoscience Initiative (GSC)

Issue: Development of the North
- Northern Resources Development (GSC)
- Geomatics for Northern Development (GC)

Issue: Aboriginal Peoples
- Geomatics for Aboriginal Property Rights Infrastructure (GC)

Issue: Global Opportunities/Trade and Investment
- Global Opportunities (GSC/GC)

ESS-Led National Initiatives
- GeoConnections
- Climate Change Impacts and Adaptation
- Polar Continental Shelf Project

ESS Knowledge-based Services
- Canada Lands Survey System (GC)
- Canadian Geodetic Service (GC)
- Earth Observation Data Services (GC)
- National Earthquake Monitoring System (GSC)
- Geomagnetic Monitoring Service (GSC)
- Nuclear Test Ban Monitoring System (GSC)

Leadership

People Support

COOPERATIVE GEOLOGICAL MAPPING STRATEGIES ACROSS CANADA (CGMS)

In the preceding chapter, I described the multi-year effort to enhance funding for public geoscience in support of mineral and petroleum exploration, culminating in September 2000 when federal, provincial and territorial mines ministers approved the NGSC's proposal for the Cooperative Geological Mapping Strategies across Canada or CGMS. In order for the plan to become a reality, however, it was necessary for the federal government to indicate how much money it intended to invest in the program. Our next step would have been to prepare a cabinet submission with a view to securing funding in the federal budget. However, this was put on hold when the governing Liberals called an election for November 27, 2000, a year earlier than expected.

The Liberals were returned with a majority government. Minister Goodale remained in NRCan, and work began on incorporating CGMS in a revised Resource Innovation Strategy. Once again, we were overtaken by events. The 2001 federal budget, which normally would have been tabled in February or March, was delayed until December. The fact that the economy was going into recession, coupled with the Al Qaeda terrorist attacks in the United States on September 11, 2001, meant that the December 2001 budget included few new initiatives other than for security measures. Then, in January 2002, Herb Dhaliwal became NRCan Minister in a cabinet shuffle. Although Minister Goodale's departure effectively ended the Resource Innovation Strategy, the new minister would include CGMS among his priorities, and we began to develop a standalone submission to cabinet.

Support for CGMS among industry and other stakeholders continued to grow. The PDAC and other exploration industry groups had been on board from the beginning of the Mines Ministers process. However, the fact that the Mining Association of Canada (MAC), which represented the major companies and had traditionally not focused on the exploration sector, became a strong advocate was important. MAC support emphasized the link between exploration, production and the long term viability of the industry and the communities that depended on it. There was also increasing recognition that the state of geoscience knowledge was impacting development in northern Canada. This was highlighted in 2001 in two influential reports by non-industry groups.[89] [90] Indian and Northern Affairs Minister Robert Nault announced his Northern Geoscience Strategy in April 1993. This was positioned as an interim measure in anticipation of CGMS, which would ultimately be sponsored by Ministers of both NRCan and INAC.

The Action Plan coming out of the 2003 Mines Ministers' Conference in Halifax charged the NGSC with developing an Implementation Plan for CGMS. The document approved in 2000 was largely an agreement on principles and Ministers felt that a more concrete plan would be needed to justify new funding. (The cynically-minded might suggest

[89] Vail, Stephen and Clinton, Graeme (2001) Nunavut Economic Outlook 2001. Conference Board of Canada. 62 pp.
[90] National Round Table on the Environment and the Economy (2001) Aboriginal Communities and Non-renewable Resource Development. 124 pp.

that the new request afforded an opportunity to once again "kick the can down the road".) In any case, Simon Hanmer, a senior GSC research scientist, accepted the assignment to develop the plan and did an outstanding job in working with the provinces and territories to define geoscience needs and gaps in each jurisdiction, in convening a series of regional workshops, and communicating with a broad spectrum of stakeholders. The Implementation Plan was tabled as requested at the Mines Ministers' Conference in Iqaluit in July, 2004.

The Plan set out an implementation schedule including, in particular, the audacious suggestion that funding be allocated in the federal, provincial and territorial budgets in the spring of 2005. Once again, however, political events had intervened. The Iqaluit meeting came barely two weeks after the June 2004 federal election. Thus, the federal government was represented by NRCan Deputy Minister George Anderson, rather than by the Minister, and the Deputy was obviously not in a position to comment on the direction that the newly elected Martin government might take. In the event, John Efford, who had replaced Mr. Dhaliwal late in 2003, retained his portfolio. Like his predecessors, Minister Efford supported CGMS, and we were also heartened by the fact that Ralph Goodale, under whom the push for CGMS had begun, had been named Minister of Finance. We worked through the fall to secure policy approval and reinforce expressions of stakeholder support.

We were quite sure that the planets were finally aligned, but our optimism turned out to be ill-founded. There was no mention of CGMS in the 2005 federal budget. I have my suspicions about why it was omitted, but speculation on my part would be inappropriate. There was, however, a "consolation prize" – renewal of the Targeted Geoscience Initiative for $25 million over 5 years. In any case, the lack of action on CGMS elicited strong negative responses from provincial and territorial ministers as well as from industry. Federal ministers indicated that the proposal was still on the table, but the fall of the Martin government in late November 2005 and the subsequent election of the Conservative government left CGMS very much in limbo.

I had already announced my intention to retire in June 2006 and my one regret was that we had been unsuccessful in securing funding for CGMS. Nevertheless, I believe that our efforts had paid dividends in two ways. First, there was wide understanding among policymakers of the importance of public geoscience in support of private sector exploration. Second, the working relationships among Canada's federal, provincial and territorial geological survey organizations had been much enhanced through the experience of making the case for CGMS and then developing an implementation plan. Moreover, I have no doubt that the work on CGMS laid the groundwork for the Geoscience for Energy and Minerals (GEM) program, for which the new Conservative government provided $100M over 5 years.[91] I subsequently learned anecdotally that the name "CGMS" was perceived to be too arcane as compared with the more marketable "GEM". GEM also differed from CGMS in that 75 percent of the program was to be in Yukon, NWT and Nunavut. This was understandable in the context of the new government's priorities and the need was

[91] Renewed in 2013 at a level of $100 million over 7 years.

arguably the greatest in the territories. Nevertheless, I was disappointed that the principles originally established for CGMS had not been followed.

GROUNDWATER

As described above, the Long Term Strategic Plan of 1991 signalled the GSC's intent to re-institute research in hydrogeology, the responsibility for which had been transferred to Environment Canada in the 1960's. However, apart from mentioning applications to issues of water quality, groundwater flow in permafrost, and geothermal energy, the plan did not say how the Survey would be involved. Wisely, I believe, it was decided undertake a more thorough evaluation of the Survey's potential role in this field. A committee of division directors chaired by Grant Mossop, Director of GSC Calgary, was struck to collect the opinions of staff and stakeholders, and to recommend a course of action. The report outlined a range of possible areas of involvement, but ultimately it was agreed that the GSC should focus on groundwater as a resource. Our review had indicated that the hydrogeology efforts of the federal and provincial environmental agencies, as well as academic research, aimed for the most part at water quality issues, often on a site specific basis. No attention was being directed at the magnitude of Canada's groundwater resources, which was an important problem and an appropriate niche for the Survey to occupy. Jean Serge Vincent, Director of Terrain Sciences Division, played a key role in negotiating a memorandum of understanding on groundwater studies with Environment Canada. Two early projects were initiated in the Portneuf area of Québec and the Oak Ridges Moraine in greater Toronto. Notwithstanding the success of these efforts, hydrogeology received only a brief mention in the context of surficial geoscience in the 1996 Strategic Plan. I think the cautious approach reflected not only budget realities in the wake of Program Review but also concerns about overlap with provincial and municipal responsibilities. I recall similar concerns being raised in a discussion of possible GSC involvement in urban geology at about the same time.

Another early decision that would stand the Survey in good stead was to recruit a Chief Hydrogeologist to guide the development of a more robust program. The recruitment took longer than anticipated, but Alfonso Rivera assumed the position in 1999. A National Workshop on Groundwater convened in Québec in June 2000, which ultimately led to a multijurisdictional, multi-agency agreement on priorities and cooperation - the *Canadian Framework for Collaboration in Groundwater.*

In the meantime, groundwater finally emerged as a program in its own right in the 2002 ESS Business Plan. The focus of this program was to be an inventory of Canada's groundwater resources and, in particular, the study of the dynamics (recharge, discharge, yield and sustainability) of Canada's major regional aquifers. An evaluation of the program on its tenth anniversary concluded that it had been very successful and was on track to complete evaluation of 19 of 30 major aquifers by 2014.[92]

[92] NRCan Audit and Evaluation Branch (2013) Evaluation of the Groundwater Geoscience Program.

NINE/ELEVEN AND CRTI

September 11, 2001 will forever be remembered as the day that terrorists hijacked commercial airliners and crashed them into the World Trade Center in New York City and the Pentagon in Washington, D.C. I had arrived home the previous evening from the Mines Ministers Conference in Quebec City. The Minister, Deputy, and ADM had remained in Quebec for the Energy Ministers Conference. We were also in the midst of a strike by PSAC[93] members, who were picketing on Booth Street, and so our building was relatively quiet. Shortly after nine in the morning, I had a call from Steve Green, Executive Assistant in Mineral Resources Division, telling me that I had better turn on the news. I rushed down to the lobby, where there was a television set at the Commissionaire's desk. The first plane had already crashed into the World Trade Center, and the assumption was that this had been an accident. However, we watched in disbelief as the second plane struck, leaving little doubt that it was an act of terrorism.

I called the ADM in Quebec City and then Susan Till, who was Acting ADM that day, neither of whom had yet heard the news. I then called Rob Shives of our Radiation Geophysics Section who was responsible for GSC's participation in the Federal Nuclear Emergency Plan, in the event that an attack on a nuclear facility was part of the terrorists' plans. The FNEP had been developed in 1984 in response to two events: the crash of COSMOS 954, a Russian nuclear-powered satellite, near Yellowknife in 1978, and the accident at the Three Mile Island nuclear plant in Pennsylvania in 1979. Our involvement in FNEP was because GSC expertise and equipment had been instrumental in locating the debris of COSMOS 954. GSC's in-house airborne gamma-ray spectrometry equipment had been a casualty of Program Review, and we relied instead on commercial contractors. There was no guarantee that contractors would be available at short notice in an emergency, but on this occasion we were lucky: Rob was able to confirm that six airborne systems would be available should they be needed. When I relayed this information to the ADM in Quebec City, who informed the Minister and senior department management, I had the distinct impression that the latter had been theretofore been unaware of the department's responsibility in this area.

The events of 9/11 focussed the government's attention on the threat of terrorism. The 2001 federal budget, which was tabled in December, allocated $7.7 billion to national security initiatives. One of these was the Chemical, Biological, Radiological-Nuclear and Explosives Research and Technology Initiative (CRTI). The goal of this five year program was "to enhance Canada's ability to prepare for, prevent and respond to chemical, biological, and radiological-nuclear (CBRN) terrorism-related threats to public safety and security".

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[93] The PSAC (Public Service Alliance of Canada) represented administrative, clerical and technical support staff of the GSC: scientists were represented by the Professional Institute, which was not on strike.

GSC played an important role in developing capacity to deal with radiological-nuclear threats under CRTI. Systematic airborne radioactivity mapping had begun in 1969 and accelerated during the Uranium Reconnaissance Program in the 1970s. Applications other than uranium exploration had been developed, including geological mapping and assessment of natural radon hazards. Under CRTI, GSC regional capability meshed well with that of National Defence, which was adept at finding radioactive sources in small areas.

CONCLUSION

I have attempted to show how the Geological Survey of Canada responded to the evolving policy environment in which it operated during the years from 1988 to 2006. My first chapter describes efforts to come to grips with the New Public Management, which sought to apply market principles and private sector managerialism to government services. The emphasis on revenue generation coupled with a federal science policy that favoured applied over basic research threatened to weaken the Survey's traditional public good mission. Another overriding factor in these years was a protracted decline in appropriation funding, culminating in 1995 with government-wide Program Review. By the end of Program Review in 1997, GSC expenditures had decreased by about 60 percent in constant dollar terms from the historic peak in 1987. Staffing levels declined over the same period from more than 1100 to about 600.

The federal government emerged from Program Review with a balanced budget and a public service ostensibly more focussed on the priorities of the government of the day. The GSC had been combined with Geomatics Canada in the new Earth Sciences Sector. Among the most significant government policy initiatives from the GSC perspective during this period was *Science and Technology for the New Century: A Federal Strategy* that was released in 1996. According to this policy, universities, other non-governmental public institutions, and the private sector were the favoured venues for research and development. Government departments should only undertake in-house research where it was essential to their policy, regulatory, or operational mandates.

One implication of this policy was that increases of the ongoing, Abase appropriation of department-based science organizations were unlikely. There would, however, be opportunities to fund program enhancements that were clearly targeted at government priorities - I have referred to this as "the policy imperative". GSC was able to take advantage of some of these opportunities with programs such as the Targeted Geoscience Initiative (TGI), Climate Change Impacts and Adaptation, and the Toxic Substances Research Initiative. As a result, funding increased over the next decade, albeit to levels that were only about half those of the late 1980s in constant dollar terms.

The signing of the Intergovernmental Geoscience Accord in 1996 was, in my opinion, critical to the evolution of the GSC, and perhaps even to its survival at a time when the federal government was redefining its role. The IGA established principles and mechanisms of cooperation between the Survey and its provincial and territorial counterparts, and thereby addressed one of the six tests of Program Review in a very tangible way. The Accord also provided the impetus for joint action on a number fronts, including a concerted effort to demonstrate the importance of public geoscience. The latter occurred in the framework of the annual Mines Ministers Conferences and ultimately resulted in significant new funding for geoscience to promote resource exploration.

The late 1990s also saw the beginnings of what would become known as the "whole-of-government" approach to public administration. This was formalized in 2000 in *Results for Canadians: A New Management Framework for the Government of Canada*. Although we may not have realized it at the time, this foretold profound changes in the way in which programs were defined and managed. Earth Sciences Sector was quick to adopt the results-based management approach: in 2002, ESS replaced almost its entire existing project roster with a new set of outcomes-based, "issues driven" programs. Results-based management was rolled-out across the federal government in 2005 and I have been told that the sector's early embrace of the new approach was well-received by central agencies and likely contributed to its success in securing new funding.

In the meantime, the Survey had become a "virtual organization". After the amalgamation with Geomatics Canada in 1995, there was no longer a single senior executive responsible for all of the GSC and only the GSC. Then, with the implementation of the issues driven programs in 2002, there were no GSC programs *per se*.[94] Instead, programs were managed in a sector-wide matrix system: GSC Directors and Director-Generals were no longer responsible for program delivery. It was probably inevitable that the matrix management approach would prove to be too cumbersome and would eventually be abandoned. The publication of a new GSC Strategic Plan in 2014 was a further step in the right direction.[95]

Given the significant decrease in its size and funding, as well as its reduced status within the department, it is hardly surprising that the GSC has a lower public profile and less influence in Canadian and international scientific circles than it once did. From the perspective of those of us with a longstanding association with the GSC, this has been a worrisome trend. But is our reaction merely sentimental? Does the decline really matter in the larger scheme of things? Is it important that a federation like Canada have a robust national geological survey? Since leaving the public service, I have devoted a considerable effort to analyzing the rationale and impact of public geoscience on behalf of various federal, provincial, and territorial government departments as well as the private sector. This experience has left me convinced that geoscience information provided by governments as a public good will likely become even more important in addressing the issues faced by humankind, ranging from the sustainability of mineral, energy and water resources, and reducing the risk of natural hazards, to environmental stewardship and climate change. As honest brokers of geoscience information, geological surveys can contribute to both the transparency of public policy decisions and a "level playing field" for industry, civil society and the general public. I am also convinced that the leadership that the Geological Survey of Canada can and should provide would be welcomed by the broader geoscience community.

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[94] Whereas the 2002-2005 Business Plan identified programs as GSC, Geomatics or joint, the 2006-2009 Business Plan lists only ESS Programs.

[95] *Geological Survey of Canada: Strategic Plan 2013–2018.* 30 pp.