Canadian Geoscience Council
Conseil Géoscientifique Canadien

President's Report, 2006

I. Introduction

We all have a role in ensuring that the earth sciences in Canada are well organized and well planned, so that the funding that drives our activity will be well spent on key priorities, in a manner that is as effective and efficient as possible, thereby ensuring that maximum benefits toward quality of life will be enjoyed by Canadians. It therefore has been an honour, a privilege, and a significant responsibility for me to have served as President of the Canadian Geoscience Council (CGC) over the past two years.

II. Geoscience Summit

During the first year of my two-year term, the principal CGC activity was to act as co-host, with the Geological Survey of Canada (GSC), of Geoscience Summit 2004, an October 2004 Parliament Hill meeting that was conceived at the first Council of Presidents meeting, held in Toronto in November 2003. Over one hundred earth science community leaders who met at the Summit concluded that we need a better sense of community, a more effective Canadian earth science union that can more effectively speak for the benefits of earth science, community-wide communication mechanisms, pooling of community resources, and coordination of association functions. Furthermore, more effective outreach and advocacy to enable Canadians to better utilize earth science knowledge, and to optimize the standing of the earth sciences in Canada was called for, as was a renewed agenda for surveys and research that will capture the imagination of our community, of the policymakers who fund us, and of the public that the policymakers listen to. In addition, it was concluded that recruitment of new human resources by providing adequate opportunities for education and work experience is urgently needed, as is optimization of the benefits of professional registration, and facilitation of professional mobility.

III. An active period of post-Summit follow-up

The Summit spurred extensive follow-up activity, much of it coordinated under the excellent leadership of Council of Presidents Facilitators Jeff Packard and Simon Hanmer. As a result, the 3rd Council of Presidents meeting, held at the Canadian Society of Petroleum Geologists (CSPG) offices in Calgary on Saturday, June 18th, 2005, was a great success. Representatives from nineteen constituency groups were in attendance, while organization and facilitation were well handled by Jeff Packard and Simon Hanmer. The focus of the meeting was presentation of a model for renewal of CGC or its successor, following much effort and discussion over the winter of 2004/2005. The meeting was carefully planned and structured by the facilitators to address expectations of outcomes, rules of engagement, overview of other national organizations, review of background, thoughts on the current situation, and the concept of a coordinating national body. A vote on whether the representatives

present at the meeting support the concept of a national geoscience organization was unanimously in favour. A review of envisioned roles and outcomes for an effective national geoscience organization ensued, as did presentation of a possible model for transition to an effective national organization that will be truly relevant, effective, representative, accountable, transparent, proactive, coordinated, professional and owned. The vote on whether the representatives agreed in principal with reservations on the proposed model again was unanimously in favour. The meeting was seen by those in attendance as a highly constructive step toward enhanced cooperation and coordination within the Canadian earth science community. The 113th CGC Council Meeting was then held on Sunday, June 19th, 2005. Following up on the Council of Presidents meeting, this business meeting established an exciting theme of renewed teamwork by earth science societies and organizations. For example, GAC was asked to launch planning and consultation for a community-wide communication mechanism, CSPG was asked to lead planning for the widest possible participation in the GeoCanada 2010 conference, CPG was asked to help lead business planning, CAG was asked to lead web site analysis, and CCCESD agreed to coordinate the successor of NSERC reallocation consultations. The CGC Annual Meeting was convened and then deferred to the autumn to allow maximum flexibility for current efforts to renew CGC or its successor. Current CGC Directors were asked to remain in place until a new slate of candidates could be assembled. The meeting adjourned with a high level of optimism, and commitment to a renewed team approach by Canadian earth science organizations.

At the next round of meetings in Ottawa on November 26th and 27th, 2005, steps were again taken on this aggressive agenda meant to achieve optimal success in bringing benefits to Canadians. The meetings were highly successful, with 23 representatives from 17 organizations in attendance, and with the facilitation role again well played by Simon Hanmer and Jeff Packard. The group reaffirmed their commitment to a renewed successor to the CGC, discussed funding options, clarified criteria for selection of a new President, and agreed that the next President should come from the Energy sector. Good discussions were held on how to adequately encompass the 'fluid Earth', to ensure that environmental earth science organizations can fully buy in. Shared services were seen as the key in binding societies to the federation. GAC led off discussion on this topic by proposing that existing offices serve as nodes for the new organization, that GeoCanada-style meetings be more frequent, that GAC-MAC and NUNA meetings be broadened, that conference services be shared, that Geoscience Canada and possibly Geolog serve the entire community, and that we expand availability of digital publications through shared e-commerce. It also was proposed that we pool efforts on student chapters, lecture tours, and administration of memberships and dues. A lively, constructive, and comprehensive discussion ensued, and working groups were commissioned to investigate insurance and liabilities, technical publications, communications, memberships, lecture tours, conventions, jobs and recruitment, student chapters, as well as resourcing of the organization that will succeed CGC. It was suggested that we may be able to pay for a new mechanism through the savings resulting from increased efficiency. Also at the November 2005 meetings, impressive CGEN plans on outreach were strongly supported, and highly promising developments regarding GeoCanada 2010 were discussed. CCCESD reported on very active efforts toward renewed and enhanced coordination and planning of NSERC-funded research. Analysis of this topic is underway, a meeting will be held this winter, and a workshop perhaps somewhat comparable to the workshop that led to Lithoprobe will be held when the NSERC-funded research community is prepared to do so. The CGC Annual Meeting was completed, and current CGC Directors were again asked to remain in place as a new slate of candidates is being assembled. As was the case in June, the meeting adjourned with a high level of optimism and commitment to a renewed team approach by Canadian earth science organizations.

The working groups commissioned to investigate the potential for expansion of shared services in fields such as publications, communications, insurance, memberships, lecture tours, conventions, careers, student chapters, as well identification of resources to support increased coordination have been active since November. The working groups are reviewing our existing activities, identifying areas in which increased sharing of services would increase the effectiveness and efficiency of the community as whole, and assessing mechanisms and resources needed to achieve the potential arrangement, such that a decision can be made on whether the shared service will be attractive. The analyses are identifying current negative impacts of the status quo, including inefficiencies in the form of duplications, unneeded expenditure of personnel effort, and financial costs. Ways to improve our activity are being identified by addressing each point raised as an inefficiency, while concurrently acknowledging the potential negative effects of sharing services, both on recipient organizations and on contributing organizations. Having assessed means for improvement and mechanisms for delivery, a determination is being made regarding whether one or more Earth Science organizations currently have the capacity to provide the service more broadly. If not, potential suppliers outside the community are being identified, and costs assessed. The analyses will determine whether the shared service will be an attractive proposition for collective action by Canadian Earth Science organizations. Appreciation has been expressed by many for this excellent work. Reports from the working groups will be key items of business at the 5th Council of Presidents & 115th Canadian Geoscience Council Meeting in Calgary on June 10 & 11, 2006.

IV. The Earth Sciences in Canada

All of this activity is very much focused on increasing the efficiency and effectiveness of the Canadian earth science community. We already are a highly organized sector, and we are determined to steadily improve. The vast majority of earth science knowledge acquisition in Canada, as measured by expenditures, is carried out in industry, primarily the energy industry, but also in the minerals and environment sectors. Expenditures on geoscience knowledge by the energy sector have been about $6B per year, and are now booming, while spending on mineral exploration and environmental earth science both have tended to be about a half billion dollars per year each, although mineral exploration is now in a sustained boom, with a doubling of expenditure over the past two years. Environmental earth sciences are a critically important and highly tangible sector of the economy from the point of view of every Canadian, due to our role in water supply, soil science, atmospheric and hydrological sciences, hazards, aggregate resources, waste disposal, geotechnical design, and surficial geology. Acquisition of information by industry is guided by sound business practices maintained by individual business units. Collectively, business activity is also coordinated by highly effective business-based associations, as well as scientific societies that serve business sectors. We also are organized as the professional registration sector, based in the provincial/territorial organizations and the Canadian Council of Professional Geoscientists. Our third sector, in addition to business and profession, is science in the form of surveys and research. Government agencies conduct surveys in the form of mapping and monitoring, while research is primarily conducted by Universities. A well-coordinated spectrum of organizations, each loyally supported and sustained by its constituency, holds conferences, publications, and communications, while several foundations receive donations and bequests to earth science. We convey our work to Canadians, and we recruit new members to the profession through outreach, we educate incoming earth science professionals, we seek to enhance policy-making through advocacy, and we are active on the international scene. It is the role of CGC to facilitate needed coordination and communication across this full range of earth science business, profession, and science.

Energy – Much activity is underway in the world of energy, as the price of oil rises, as the number of remaining opportunities for major hydroelectric power generation diminishes, as development of wind energy and geothermal accelerates, and as the search for uranium again intensifies. For example, the Energy Council of Canada has committed itself to a vigorous and effective energy strategy dialogue throughout Canada. In geoscience, by far our largest sector is exploration for oil and gas. Recent expenditures in hydrocarbon exploration have been about $6B per year, about half of which is spent on drilling, with the remainder split between geological and geophysical surveys, as well as land acquisitions and rentals. These investments in knowledge support an energy industry that provides over 6% of Canadian GDP, at $65B per year in sales, and direct employment of 225,000 people. The search for energy resources has been at the forefront of Canadian geology since the inception of our field, when coal was the primary target, and this focus continues today in the search for oil and gas, as well as topics such as uranium, gas hydrates, and geothermal resources. In our energy capital, Calgary, the geoscience community is active and vibrant. At Geoscience Summit 2004, CGC Director Gerry Reinson described the cycle from exploration to drilling, production, processing, transportation, and use of oil and gas products, leading to reinvestment in exploration. Estimates for ultimate, discovered, undiscovered, produced and untapped hydrocarbons show that while significant gas resources remain in frontier basins, limited reserves are available in more accessible regions. Two decades ago, large companies managed largely by geologists employed over a hundred geoscientists in their Calgary offices, traversed the country hiring new graduates, and provided intensive in-house training. More recently, they employ fewer than fifty geoscientists, hire selectively, limit in-house training, and few senior managers are geologists. About half of the ten thousand geoscientists presently in the industry will retire within a decade. A potential geoscientist shortage will likely be attributed to stifling government policies, short-term corporate philosophy, and overspecialization of university education. Concurrently, employment in the oil sands and east coast is primarily in engineering, so student enrolment has shifted accordingly. Working geologists are expressing a need for development of new, applied technical prospecting skills. Corporations are restructuring, downsizing, and cutting costs, technology is being leveraged to enhance production, few jobs are being created, but experienced geoscientists are in demand. While some believe that fossil fuel usage will soon peak, oil and gas will be required for many decades to come. Yet corporations are driven by short term thinking that results in intense exploitation of mature assets, and frontier exploration has suffered. Nevertheless, steadily increasing commodity prices will eventually drive corporations to explore, and there will be a need for well-rounded earth science graduates. Reinson predicted that effective advocacy by the Canadian earth science community will smooth these transitions.

Minerals – Mineral exploration investments support our mining industry that provides 4% of Canadian GDP, at $38B per year in sales, and direct employment of 355,000 people. The most recent ‘Overview of Trends in Canadian Mineral Exploration’ indicates that mineral exploration expenditures have rapidly boomed to over $1B per year, up from a level of a half-billion per year earlier this decade. The massive increase in spending recorded in 2004 reflects a rapid response by companies to a metal price outlook that improved considerably in the latter part of 2003, according to the Overview. Other factors cited included the availability of generous tax and non-tax incentives, the willingness of investors to support mineral exploration ventures, and a steady stream of positive exploration news. Price outlook for many of the mineral commodities explored for in Canada remain favourable. Previously, a solid foundation of activity had been maintained by easier access to financing, a rising gold price and a sustained search for diamonds. Governments also had been highly innovative in supporting and promoting mineral exploration through fiscal incentives, the resolution of land access issues, and the provision of geoscientific data. Recently, as well as bringing back the mineral exploration tax credit for flow-through share investors, Canada’s new federal government announced

that it would repeal the excise tax on jewelry, and work towards a single national securities regulator, much to the satisfaction of the exploration community. Canadian leadership in this industry is evident from our mineral exploration conferences, particularly the PDAC in Toronto that attracted 14,500 this year, the Roundup in Vancouver that attracted over 5000, and exploration open houses across Canada, as well as our international role in financial markets. At the Summit, Richard Moore of PDAC outlined three priority earth science issues in relation to mineral exploration: availability and mobility of geoscientists, new public earth science information, and funding for economic geology research. He stated that a current shortage of geoscientists is due to diminishing long term employment by major mining companies, cutbacks in geological survey budgets, and declining summer student employment. He observed that Provinces and Territories have enacted legislation to establish standards of practice that does not adequately recognize the highly mobile nature of geoscientists, so multi-jurisdictional licensing and reciprocal agreements with other countries are needed. Efficient exploration in his view requires comprehensive, web-accessible regional earth science data. He indicated that funding to geological surveys is an investment in future economic benefits that generates many times that expenditure by exploration companies and economic benefits of mines. He stated that Canada can remain competitive in exploration and mining due to a superior mineral endowment, stable governments, mature legislation, and availability of earth science data. In his view, the exploration and mining community also needs continual updating of mineral deposit models, regional tectonic models, and exploration technique development to become more efficient.

Environment – Environmental earth science is now an immense field that plays pervasive roles in all aspects of our lives. Meteorological and hydrological monitoring and prediction have a bearing on the daily lives of every Canadian, while profound policy debates hinge on the state of our climate modeling. The composition, structure, and conservation of soil are keys to food supply, while soil mapping also is a key to groundwater protection, tracing toxic elements, and carbon budgets. As our clients adopt GIS resources and apply our mapping to land use regulation, guidance on integrated use of soil maps and geological maps is needed. Geologists can provide an understanding of the source of deleterious elements in our source water, we can help protect water from contamination, we can design remediation, we can show how groundwater discharge governs wildlife habitat, we can help wisely utilize and manage water resources for drinking water, agriculture, industry, energy production, hydroelectric power generation, as well as shipping, and we can assist public debate by aiding comprehension of water-related hazards such as flooding and shoreline erosion. Furthermore, all engineering activity on the land requires knowledge of the substrate, in relation to excavation, drainage and availability of materials. As our insights intensify, and as population and vulnerable infrastructure increase, we are being called upon to help defend Canadians from natural hazards that cause injury and damage. Catastrophic threats include earthquakes, tsunamis, landslides, floods, volcanoes, windstorms, extreme precipitation, magnetic storms, avalanches, and impacts of extraterrestrial bodies, while chronic hazards include shoreline erosion, wind erosion, and permafrost degradation. Earth science can augment local knowledge regarding processes, we can outline the character of events predating observations, and we can assess factors that may be changing risk. The climate change topic requires insights into how the global climate system works, so that linkages are better understood, and scenarios for what can occur are outlined. This requires insight into the carbon cycle as well as climate trends and events throughout earth history. And consideration of the impacts that climate change will have and how we can adapt to these changes requires work on topics such as permafrost stability and groundwater recharge. As our knowledge on toxics advances, we have a progressively lower tolerance for deleterious materials in our food and water, particularly with respect to their impact on children. Industrial effluent that can be reduced at greater benefit to society than cost is being curtailed. Assessing options, however, requires a full knowledge of what is contamination and what is natural.

And where the deleterious material, such as arsenic in drinking water, is natural, a geological explanation is required. If a community is told that their drinking water is contaminated, they will blame the nearest industry until they are presented with a plausible geological explanation. Our highest priority with respect to waste disposal is to reduce our production of waste, but we are far from achieving zero waste production, and it is unclear that the cost will ever justify the benefit. We therefore will continue to discard wastes, and we have a large legacy of produced waste. A critical input to planning waste disposal is the geological integrity of the disposal site, whether for municipal garbage or high level nuclear fuel waste. But our oceans are our most mysterious frontier. The challenges and needs with respect to our large lakes are comparable to those of the oceans. Physical and biological oceanographic investigations closely linked to seafloor mapping and offshore geological investigations are the key to understanding and managing our oceans. New technology is allowing us to map bathymetry in vastly greater detail, studies of marine habitat are linking biology and geology, while new drill ships are opening exciting new opportunities in research. Sales of geoscience knowledge by consultants in the geotechnical field, such as slope stability and foundation analysis, and environmental fields, including topics such as water supply and waste disposal, can be estimated on the basis of a Canadian Geoscience Council census carried out in 2001 that found that 12% of the 3000 respondents were in this field. Based on an estimated total of at least 12,000 geoscientists in Canada, this implies a total of 1500 practitioners in this field who would each be supported by over $100k in revenue per year, implying about $200M in annual revenue for this sector of the industry. Combined with meteorological and hydrological topics that were under-represented in the census, a total expenditure of about a quarter billion to a half billion dollars per year is the best available estimate. Clearly every Canadian is now counting on environmental earth science, a business that now has an economic scope comparable to mineral exploration. More and more earth science is directed toward water resources, and there is a great need for much-expanded knowledge and awareness of our groundwater. In the presentation at the Summit by Alfonso Rivera of GSC, it was acknowledged at the outset that we simply do not know what the sustainable capacity of our groundwater systems is, especially at the national scale, despite being a strategic source of clean, abundant and cheap freshwater for over a quarter of Canadians. While steadily shifting to reliance on groundwater, we take this out-of-sight, out-of-mind resource for granted, and neglect its mapping, monitoring and management. But we now have an opportunity in the context of increased awareness due to contamination, conflicts, climate change, drought, and international commitments. Hydrogeology is now a relatively mature science in which we understand much about the physics and chemistry of groundwater flow. Comprehensive assessment of Canada's regional aquifer systems is required, but current efforts toward this goal are modest. The most recent national assessment of Canada's groundwater resources was published in 1967, and current tentative steps are being guided by a Framework for Collaboration on Groundwater developed in 2003. Groundwater scientists in Canada are world leaders in research, especially on point-source contamination, but we have been unwilling to commit the resources required to map and therefore manage our aquifers. New programs focusing on sustainability of regional groundwater resources and better public understanding are needed, and we must prepare a new generation of scientists in this new focus. With respect to groundwater quality, John Cherry of University of Waterloo spoke at the Summit on groundwater protection and remediation in Canada, indicating that adverse health effects are resulting from widespread neglect and contamination of this resource. This is because groundwater-reliant citizens tend to live in small towns and rural areas, while harmful groundwater contaminants tend to be tasteless and odourless, commonly date to previous years and decades, and are difficult and expensive to locate. Laws, regulations, and guidelines typically are weak, unenforced, inconsistent province to province, and scientifically ill-informed. Contaminating groundwater beneath private property continues to be legal, even though on-property contamination eventually becomes off-property contamination. Current fiscal prudence is

short-sighted, as remediation of contaminated groundwater is much more expensive than measures to prevent contamination. In fact, current spending levels on groundwater probably are adequate, but most of the effort is wasted on hasty responses to political crises rather than science-based problem solving and prevention. We thus rank far behind the US and northern European in efforts toward groundwater protection, apparently due to a governmental system that has resulted in an inadequate framework for groundwater monitoring, management and protection. But the Walkerton tragedy has presented a rare opportunity for us to become more proactive, and for governments to develop mechanisms that will lead to increased awareness, enhanced information, and more effective assessment and remediation. To support these objectives, according to Cherry, there is a great need for the government role in mapping, monitoring, and regulation to be augmented, including clarification of the necessarily overlapping roles of several federal departments. This regional work should not be done by consultants, in his view, due to inadequate expertise for some tasks, lack of continuity in personnel and information storage, transience of funding, and the need for linkage to enforcement. Hydrogeological research in Canada was, however, said to be well staffed and well funded, but an improved framework for identifying and funding research at Canadian universities is needed as the present system directs university researchers is to conduct world class research, not necessarily research relevant to Canada. In the Summit presentation addressing the geoscience required to achieve these objectives, John Gartner indicated that site and regional water supply and other environmental investigations rely on earth science in the form of maps, reports, 3D models and databases to make up the framework that everything else hangs on. Concern was expressed that this needed regional earth science is lacking over most of Canada, while geological survey activity is being curtailed. An abrupt influx of resources for geological mapping followed the deaths and illnesses at Walkerton, and excellent results such as improved usage of water well data and the Ontario Geological Survey seamless digital geology of southern Ontario have resulted. But this temporary flurry has been inadequately supported by field investigations, particularly in fast growing urbanized areas where environmental and geotechnical land use issues are acute. Awareness of the limitations of this current regional information has to increase, to ensure that needed collection of high quality information will accelerate. It was suggested that the sector needs to mimic the mineral exploration community, which has been highly effective at convincing governments of the economic benefits of the public geoscience that supports mineral development. A major constraint is our current inability to effectively demonstrate the benefit/cost ratio of environmental earth science, although such analyses are now more readily available due to the Walkerton experience. Gartner concluded that geoscientists in the environmental sector must take action to ensure that the needs of Canadians will be addressed. The Summit presentation on hazards was prepared by John Clague of Simon Fraser University. He indicated that as population and vulnerable infrastructure increase, geoscientists are increasingly being called upon to help defend Canadians from natural hazards that cause injury, suffering, and damage. Damage from a large earthquake near Vancouver or an eruption of Mount Baker could reach tens if not hundreds of billions of dollars. Landslide damage to highways and railways costs Canada $100-200M every year, while underwater landslides off the coast of BC have destroyed wharves and warehouses. Floods are the most damaging natural hazard in Canada, destroying bridges, inundating land, contaminating drinking water, and disrupting economic activity. A flood on the Fraser River in 1948 caused hundreds of millions of dollars in damage and forced thousands of people from their homes, while Winnipeg suffered major losses during 1993 basement flooding and the major 1997 flood. With respect to climate change, the Summit presentation by Don Lemmen of GSC indicated that earth science is a key to defining the scientific basis of climate change as well as informing the two policy options available, mitigation and adaptation, to reduce social, economic and environmental impacts. Improved understanding of earth system linkages, climate processes, as well as natural sources and sinks for greenhouse gases (GHG) will improve model projections. Current mitigation efforts

(reduction of net greenhouse gas emissions) focus on the short term, but long term solutions will require less GHG-intensive technologies as well as GHG capture and storage. Adaptation, actions that reduce negative impacts or take advantage of new opportunities, is a necessary complement to mitigation. Earth science will help guide issues such as coastal zone dynamics, sea level change, permafrost degradation, impact of reduced glacier cover on water resources, groundwater quality and quantity, and occurrence of climate-related natural hazards such as flooding, dust storms and landslides, with a goal of identifying critical thresholds or key vulnerabilities to current and future climate. Policy relevant science will be better achieved through partnerships with social and economic researchers and decision makers to provide a consistent, integrated analysis of risks associated with climate change and the capacity of systems to adapt. While it is critical for research to continue to refine and assess the scientific foundation of climate change, according to Lemmen, it also is important for the scientific community to recognize and respond to the need to develop mitigation and adaptation policy responses, leading to a more scientifically-informed decision making process.

Surveys – Canada's Federal Survey Agencies include Geological Survey of Canada (GSC), Canadian Soil Information System (CanSIS), Water Survey of Canada (WSC), and Meteorological Service of Canada (MSC), although few mechanisms currently exist to coordinate the work of these agencies. In addition to these federal earth science surveys, who deal with earth materials, processes, and history, coordination also is needed with Canada's federal geomatics agencies, Geomatics Canada and the Canadian Hydrographic Service (CHS), who operate in a world of measurement rather than materials, involving survey engineering, geodesy, and earth observation. Geological Survey agencies carry out the geological, geophysical, and geochemical mapping that we require. Provincial and Territorial Surveys map their regions, while GSC addresses cross-border topics, brings specialization to cooperation with provinces and territories, and addresses topics left to the federal survey. Along with their core mapping and monitoring roles, Surveys carry out research to ensure that their activity is linked to conceptual advances, and to ensure that their scientists are experts in their fields. A broader and broader range of the Canadian population is now in a position to use survey products, and they increasingly are recognizing that they require geological mapping to fulfill their objectives related to health, heritage, safety, and economic development. Canadians now expect public information to be web-accessible and readily usable, so maximum benefits will be conveyed if user interfaces are competing to make available a database of national if not international information indicating known and predicted subsurface conditions, for example. We therefore require a database depicting bathymetry, soils, onshore and offshore surficial and bedrock geology, and 3D geology depicting extent, thickness, and properties of undeformed strata, such that all undeformed strata are removable from map depictions, and so that drillhole forecasts down to deformed rocks can be issued for any point. To implement what technology now permits, and what more Canadians realize they require, legacy maps must be digitized and reconciled, with multiple generations of legends being categorized with reference to a content analysis. The synthesis will require digitizing, reconciliation, and assembly of topography, bathymetry, offshore geology, soils, surficial geology, all public domain drillhole and geophysical data, bedrock maps, and existing stratigraphic models typically expressed as structure contours. New 3D geological mapping is requiring benchmark information from cored holes logged by geologists as well as geophysical surveys. These high-quality observations are extrapolated laterally using drillhole data, commonly large quantities of water well data of varying resolution and reliability. Much effort is required to adequately georeference the drillhole data, and to parse large numbers of unique lithological descriptions. Stratigraphic modeling methods ideally use all data and an approach that permits judgment in the acceptance or rejection of data, while interpolation and extrapolation are guided by expert judgment based on the best available insights into process and history. Models are best captured as a regular grid of profiles that convey expert opinion on

interpolation and extrapolation from the data points. Reconciliation of mapping with neighbouring jurisdictions is required, as is balancing subjective definition of strata with more objective geostatistical approaches to characterizing the heterogeneous physical properties. Databases of observations and measurements can be retained with the interpreted model, and models can be assigned varying confidence levels such that the result is seen not as an end but a means for prioritizing new mapping. Pressing user requirements demand that geological survey work advance as rapidly as possible, from paper maps in libraries to web-accessible databases, from project publications to regularly-updated, version-numbered, multi-jurisdiction databases, from plan view maps to interactive drillhole databases and 3D models, and from static depictions to dynamic models such as groundwater flow models. In support of this approach, and the full spectrum of geological surveys needed by Canadians, the total annual GSC budget is about $70M, while funding for Provincial and Territorial surveys has been about $60M per year. At the Summit, Murray Duke, a GSC Director-General, described how GSC has gone through a fundamental change in the way it develops and delivers its scientific programming, transforming itself from being activity-based and capacity-driven to a results-based, issues-driven organization. Scientific programs must now more clearly respond to explicit government priorities articulated in the Speech from the Throne and the Minister's mandate letter, through mechanisms no longer considered supplementary to the core program. While outputs remain important, they are no longer ends in themselves, and the outcomes of the work in achieving public policy objectives are now the focus. Outputs that have the highest probability of leading to desired outcomes are given priority, in particular multi-disciplinary applications to a broad range of societal issues. Produced knowledge must be accessible and usable by the non-geoscientist, through effective networks that go beyond the earth science community. Current priorities are in groundwater, climate change, metals in the environment, legislated environmental and resource assessments, hazards, mineral and energy geoscience, ocean management, information management, gas hydrates, and northern resource development. Energy is an increasing priority, as is the role of earth science in public health. The transformation has resulted in an increased appreciation in government circles of the relevance of Earth science, but whether this will translate into more robust budgets remains to be seen. The functioning of Canada's geological survey agencies was also vastly improved a decade ago by the highly successful Intergovernmental Geoscience Accord, and the focus now is on ensuring the successful implementation of critically important initiatives such as the Cooperative Geological Mapping Strategies, as well as renewed Energy and Groundwater Mapping strategies. Another topic of immense and rapidly increasing importance is marine mapping. In his Summit presentation, Dick Pickrill of GSC described how coastal and ocean environments are coming under increasing pressure from resource development throughout the world, as competition for use of the seabed is often unresolved, hazards are overlooked, unique habitats are not protected, and fisheries collapse is common. We lack the knowledge base required for development of a management framework comparable to that established on land due to absence of sufficiently detailed mapping of the offshore. We now have new GPS and multibeam sonar technologies that permit us to construct detailed images and geological interpretations of the sea floor that have revolutionized, for example, the $100M Scotian Shelf scallop fishery. On the continental slope, submarine landslides and slope stability may require avoidance rather than engineering, so government-industry surveys have mapped a spectrum of landslides that was only recognized due to the regional scale of the survey. Minimum survey requirements, standards and map products are now being defined, and experience dictates that nearly all seabed resource decisions can be addressed by mapping sea floor depth and shape, texture and composition of sea floor sediments, and the composition of the benthic community. Canadian Provincial and Territorial Geological Survey Agencies are coordinated by the Committee of Provincial Geologists (CPG), and include Alberta Geological Survey, British Columbia Geological Survey, Manitoba Geological Survey, New Brunswick Geological Surveys Branch, Newfoundland and

Labrador Geological Survey, Northwest Territories Geoscience Office, Nova Scotia Mineral Resources Branch, Canada-Nunavut Geoscience Office, Ontario Geological Survey, Géologie Québec, Saskatchewan Geological Survey, and Yukon Geological Survey. Liaison between the Provincial and Territorial Geological Survey Agencies and the GSC is well coordinated by the National Geological Surveys Committee (NGSC). At the Summit, Mike Cherry of CPG indicated that provincial and territorial geological surveys tend to be located in economic development ministries, and little geoscience is carried out in other fields. The surveys were established with a narrow mandate to support mineral and energy resources, while the need to address issues such as land-use planning, water, contaminants, hazards, and climate change is growing, so institutional gaps need to be bridged through effective communication. A new approach is being taken by BC, where Geoscience BC is presenting itself as an innovative and applied geoscience centre dedicated to the collection, interpretation, and marketing of geoscience expertise, information, and products to the benefit of all British Columbians. Their mandate is to attract investment in the mineral and oil and gas industries in BC through applied geoscience work. Geoscience BC is a non-government organization formed in the spring of 2005 and funded by a $25 million start-up grant from the BC Provincial Government. These funds will be used to support the collection of new geoscience data in collaboration and partnership with industry, post-secondary institutions and government. The primary geoscience products under consideration and that are necessary to attract exploration or investment are geological mapping, geophysical surveys, geochemical surveys, remote sensing data, and consolidation of understanding of all of the above. In addition Geoscience BC supports the development of new geoscience techniques and methods that can be used to improve exploration success in BC and maintain British Columbia as a premier destination for exploration and mining companies. The Summit presentation on soil mapping was given by David Kroetsch of Agriculture and Agri-Food Canada (AAFC). He described highly functional national and regional soil information systems being developed to support agricultural environmental policy and Kyoto Protocol commitments. An updated national 1:1M scale Soil Landscapes of Canada (SLCv3) soil map and database, and standardized 1:100K soil mapping of the Prairie agricultural region are now available. New applications bring together soil data with land use, climate, surficial geology and farm management information. Statistics Canada Census of Agriculture information is now allocated to individual SLC map polygons, enabling information about land use, farm management and crop cover to be linked to soil type, climate conditions and watersheds. The National Agri-Environmental Health and Reporting Program is using soil degradation risk models, greenhouse gas emission models, and nutrient contamination of water risk models to produce indicators of environmental performance. While these applications were developed to run against the 1:1M SLC maps and databases, recent analyses have used the Prairie 1:100K mapping with excellent results. Models currently in development deal with a wider range of water quality impacts, biodiversity issues, citing of intensive livestock operations, and refined estimation of soil crop suitability. The National Carbon and Greenhouse Gas Accounting and Verification System for Agriculture, including new SLCv3 information, is a component of Canada’s greenhouse gas accounting system. Most soil mapping staff are eligible to retire within 10 years, human resources have become fragmented, and resources have recently not been available to conduct new surveys, ground truth model output, or upgrade Canadian Soil Information System (CanSIS) detailed 1:20K to 1:75K soil mapping, now only 10% digital. The new $100M National Land and Water Information Service (NLWIS) will, however, not only implement web-accessible soil mapping applications required to protect surface and groundwater supplies, it will also provide the opportunity to train the next generation of pedologists needed to ensure a future federal soil survey in Canada. The internet-based NLWIS service is being developed over the next four years to provide on-line access to information that will help Canadians make responsible land-use decisions. When the project is completed in 2009, NLWIS will be recognized as Canada's source of information, analysis and interpretation of data on land use, soil,

water, climate and biodiversity to assist land-use decision makers. Since 1908, the Water Survey of Canada (WSC) has been the national agency responsible for the collection, interpretation and dissemination of standardized water resource data and information in Canada, to define reliable supplies of good quality water, to determine hydroelectric power potential, to assess irrigation potential, and to protect Canada's sovereignty over its water resources. All major water supply systems, hydroelectric generation facilities, and irrigation projects in Canada have been designed, built and operated using the products and services of the Water Survey of Canada. Concurrently, Statistics Canada synthesizes these data as accounts for the stocks and flows of Canada's water, although the capacity and vulnerability of our groundwater resources remains a gaping gap in our knowledge. The Meteorological Service of Canada (MSC), created in 1871, helps Canadians adapt to the impact of atmospheric and related environmental conditions on human health and safety, economic prosperity and environmental quality. MSC provides weather forecasts and warnings of high-impact weather events and, together with the provinces, produces information on hazardous air quality, monitors atmospheric conditions, forecasts ice and wave conditions on navigable oceans and inland waters, monitors and predicts the state of the climate, leads the development of atmospheric science and related environmental prediction in Canada, is at the source of every weather warning in Canada, and is the principal scientific authority for standards, information and advice on the past, present and future states of the atmosphere, hydrosphere and cryosphere. Since 2003, MSC has undertaken a major modernization campaign, utilizing Government of Canada funding ~$75 million over five years and $5 million per year thereafter. These efforts include consolidation and modernization of forecast operations, as well as product and service enhancements.

Research – Earth science provides an understanding of our home planet. As our perturbations intensify, there is an ever more urgent need for us to fully understand how atmosphere, biota, oceans, freshwater, glaciers, soil, volcanoes, sediment, rock, and earth evolution as a whole interact. Canada consists of a people, and we also consist of a landmass. We know and understand this landmass primarily on the basis of the knowledge accumulated by the people who have lived on the land. And we as scientists can contribute immensely to this knowledge. In many regions, our activity in working out regional geology is one of the only ways that we occupy the land, so our work is a key to establishing sovereignty, especially in the Arctic. One of the most rapidly expanding fields at present are the genetic sciences. We can contribute to the fundamental understanding of this topic, by explaining how genomes came about, the timescales involved, and the processes by which biological evolution takes place. Total annual funding to basic earth science research in Canada, primarily distributed by NSERC and CFCAS, is about $50M - about half grants and half research partnerships, along with training support. Our success in competing for research funds in recent years has not been as impressive as that achieved by some other fields, leading to calls for greater effort in defining research targets, pursuing funding for them, attracting excellent scientists, and enhancing public awareness of the value of the work. The Council of Chairs of Canadian Earth Science Departments (CCCESD) is now coordinating activity toward the next phase of renewal in Canadian earth science research, including analyses, meetings, and an upcoming workshop perhaps somewhat comparable to the workshop that led to Lithoprobe. At the Summit, Norman Marcotte of NSERC described how Earth Science was one of the original 22 Grant Selection Committees (GSCs) when NSERC was created in 1978, and reviewed major NSERC support to initiatives such as Lithoprobe and the Ocean Drilling Program (ODP). Total NSERC support to Earth Science in 2003-04 was $56M, including Canada Research Chairs, while three Networks of Centres of Excellence (NCEs) that involve earth science, the Canadian Water Network, Geomatics for Informed Decisions Network, and ArcticNet, were funded at $5.8M for 2003-04. NSERC support to Earth Science has been about 9% of its budget, reflecting the importance of the discipline in fields such as resources, climate and the environment.

Recent successes include the Research Networks MITE, Clivar, SOLAS, GEWEX, and CASES. In Discovery Grant reallocations exercises, the Earth Sciences GSCs lost 4.2% of their budget in 1994, gained 8.2% in 1998 as the overall budget increased 10%, while the discipline lost 3.7% of its budget in 2002. Among Discovery Grants, the Earth Science budget of $17.1M made up 8.9% of the total in 1995, while the 2003 total of $21.1M was 8.0% of the total. Earth Science has been more successful in partnership programs. In the view of NSERC, Earth Science must become more cohesive in order to compete against rising disciplines such as Information Technology and Genomics, while overcoming the perception that it is a mature discipline not linked to the human dimension. The 1990 separation of Solid Earth Sciences from Environmental Earth Sciences may have been a hindrance, and NSERC is willing to assist the discipline examine itself. However, NSERC has found that the community has difficulty in getting together to agree on a vision for the whole. With an increased focus on interdisciplinary research and integration of science, a divided discipline will have difficulty providing a common front. But there are tremendous opportunities for earth science research in topics such as climate change, energy, and sustainable development, while IPY, IYPE, and the US-led Global Earth Observatory System present exciting opportunities. Lessons can be learned from Lithoprobe, one of the greatest successes in the history of Canadian earth science research. According to the Summit presentation by Ron Clowes, President of Lithoprobe, this 20-year, $110M project mapped deep geology along transects, influenced thinking in the mineral, energy, and hazards sectors, and generated spin-offs in research, training, and technology transfer. Keys to its success were grassroots involvement, widespread support, multidisciplinary research, collaborative studies, clear communications, and an effective management structure. Benefits included regional information for industry, technological innovation and transfer of science and technology to the private sector, new resources and mitigation of hazards, training of the next generation of earth scientists, and public awareness of science and technology. Grassroots initiation began in academia and the GSC with recognition of the need for a flagship project to bring cohesion to the discipline. A 1981 NSERC meeting on earth sciences in the 80s along with discussions at GSC resulted in a steering committee with representation from academia, GSC and industry. A successful Phase I on Vancouver Island and the Kapuskasing zone resulted in a Phase II proposal and 1985 national workshop. Widespread support throughout the community was a key, as were mechanisms such as University Supporting Geoscience Projects grants to NSERC-eligible scientists, and a cross-Canada lecture tour by the Director to show the value of the project for the community at large and to respond to concerns and criticisms. Multidisciplinary research was another factor, as a broad range of techniques were applied, as was collaboration among academia, GSC, provincial/territorial geological surveys, and both the petroleum and mining industries. Both direct and in-kind support from all sectors was crucial to the success of the project, but scientific involvement of representatives of industry was difficult to achieve. Communication and interaction among scientists and the public maintained enthusiasm and support, and workshops provided a key forum for interaction. As the first national centre of excellence or research network, Lithoprobe established an efficient and effective management structure now emulated broadly. Lithoprobe defined a new approach to collaborative science, redefined much of earth science, fostered an unprecedented degree of cooperation, spawned a healthy atmosphere of scientific cooperation, and enhanced the international renown of Canadian earth science, through quality scientific results derived from a unique combination of collaborative research and multidisciplinary studies. Clowes stated that we must make every effort to ensure the health, vitality and vision of our discipline, and Lithoprobe showed show we can do this much better and more efficiently through collaborative, multidisciplinary approaches that are developed by the community and that energize the community as a whole. Several comparable, immensely important, impressive, and influential research initiatives are now underway, including NEPTUNE, Polaris, the Polar Climate Stability Network, and our incipient role in the Integrated Ocean Drilling Program (IODP),

demonstrating our great ability to contribute to fundamental knowledge and the immediate knowledge needs of Canadians, while also drawing attention to the tremendous potential for even greater and more comprehensive programs of research.

Registration – Professional registration across Canada is coordinated by Canadian Council of Professional Geoscientists (CCPG), and is administered by Provincial and Territorial Licensing Bodies, including Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), Association of Professional Engineers and Geoscientists of New Brunswick (APEGNB), Association of Professional Engineers and Geoscientists of Saskatchewan (APEGS), Association of Professional Engineers and Geoscientists of the Province of Manitoba (APEGM), Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA), Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories (and Nunavut) (NAPEGG), Association of Professional Geoscientists of Nova Scotia (APGNS), Association of Professional Geoscientists of Ontario (APGO), Ordre des géologues du Québec (OGQ), as well as Professional Engineers and Geoscientists of Newfoundland and Labrador (PEGNL). In his report to CGC in November 2005, CCPG President Barry Collins reported that at the CCPG business meeting in Toronto on November5th-6th, 2005, it was decided that it is important that CCPG be engaged in efforts to revitalize the Canadian Geoscience Council. He went on to provide an outline of the present state of geoscience regulation in Canada, which is relatively new in much of the country. The first legislative mention of geology and geophysics was in Alberta in 1955. Over the past 50 years legislation governing the practice of geoscience has been enacted in all of Canada except Yukon and Prince Edward Island. In eight jurisdictions there is joint engineering-geoscience professional legislation, namely: British Columbia, Alberta, Saskatchewan, Manitoba, Newfoundland & Labrador, New Brunswick, Northwest Territories and Nunavut. Ontario, Quebec and Nova Scotia have stand-alone geoscience profession acts. In 2004, the professional associations granted 8,984 licences and licence renewals. The geographic distribution was BC - 1,228, Alberta - 4,523, Saskatchewan - 538, Manitoba – 256, Ontario - 1,202, Québec – 652, New Brunswick – 105, Nova Scotia – 82, Newfoundland and Labrador - 223, NWT and Nunavut – 175, for a total of 8,984 at the end of 2004. Each of the provincial and territorial professional statutes sets out a scope of practice and prohibits unlicenced practice. Provincial and territorial governments have enacted this legislation to protect the public from unqualified, incompetent and negligent practitioners, and from imposters pretending to be geoscientists. The professional associations are entrusted with a monopoly on the exercise of the profession in exchange for assuming the obligation to protect the public in its dealings with geoscientists. The CCPG is a national coordinating body created in 1996 by the provincial and territorial associations. Each association has appointed a CCPG Director to represent it at biannual Council meetings. The Council is answerable to its constituent associations. It has no legal authority over them and it has no legal authority over individual geoscientists. The declared mission of the CCPG is to develop consistently high standards for the licensure and practice of geoscience, to facilitate national and international mobility, and to promote the recognition of Canadian professional geoscientists. With regard to development of national standards, the CCPG has established a committee called the Canadian Geoscience Standards Board. The Board is currently reviewing the national standard for professional licensure it created in 2001. Professional mobility has been a hot topic at recent CCPG meetings. Some years ago the constituent associations took a first step toward national mobility by signing an Inter Association Mobility Agreement (IAMA). Ontario and Quebec then entered into an Incidental Practice Agreement similar to the one signed by the four western law societies. It entitles a registered professional to readily engage in limited practice in the other jurisdiction. The latest development on the mobility scene is the enhanced or super IAMA which, if adopted, will minimize the impediments to interjurisdictional practice. On the international scene,

CCPG is firmly committed to co-sponsoring the 3rd International Professional Geoscience Conference, to be held near the Grand Canyon at Flagstaff, Arizona, September 21-25, 2008. Other committed co-sponsors are the American Institute of Professional Geologists and the European Federation of Geologists. Collins closed his report by indicating that CCPG has undergone a transition from a purely voluntary organization, operated out of the president's briefcase, to an organization with a paid general manager and its own office.

Education - Since 1974, Earth Science education in Canada has been coordinated by the Council of Chairs of Canadian Earth Science Departments (CCCESD). According to their web site, a key aspect of CCCESD activity since then has been an annual questionnaire meant to obtain statistical information regarding programs, students, staff, and faculty. The Council acted informally until 1985, when a formal constitution was approved in order to accept funding from GSC, in relation to a need for more concrete human resource planning. The objectives of the Council were formally refined in 1992 to indicate that CCCESD will foster, coordinate, and promote education, training, and research in earth sciences with particular emphasis on the needs, activities, and mandate of the earth science departments in Canadian universities. CCCESD played a role in organizing the January 1981 workshop on that led to LITHOPROBE, and subsequently had much involvement in professional registration. Representations have been made to NSERC on many occasions, and problems have been tackled at the provincial level, such as school curricula. The questionnaire has been closely linked to the history of the Council, since data for the 73/74 academic year were collected. Starting with the 79/80 year, it was decided to collect information about the number of people registered in service courses, and with the 84/85 year, about the number of people who graduated at each degree level and their areas of expertise. In the early 1990s, attempts were made to obtain a more complete picture by collecting information about physical geographers registered in geography departments, in addition to those registered via earth science departments. These attempts failed partly because there were too few respondents and partly because some of those responding were listing all geography registrants. For undergraduates, a few areas were defined, but for the graduates the discipline was divided into 42 areas of interest, mainly to support the GSC human resource planning. When GSC financial support was withdrawn in 1993, the data collection was simplified. In 93/94, the number of areas of interest was dropped to 6 but increased to the present 8 starting in 99/00 with the addition of Atmospheric Sciences and Other. Starting with the year 96/97, two new categories were introduced to the Faculty and Staff list, Active Professors Emeriti and Active Adjunct Professors. The GSC needed data by the end of the year and for some time this presented no problem since nearly all programs were constructed of full year courses, and the registration numbers at the end of November were a sufficiently accurate representation for the academic year regarding service course registrants as well as program registrants. As time went on, more and more one term courses were introduced and it became difficult to obtain reliable data for the number of second term service course registrants by the end of the calendar year. Therefore, in 1992, it was decided that numbers registered in one term courses would henceforth be collected for the calendar year, resulting in an apparent doubling of the number of service course registrants from the 91/92 to the 92/93 academic year. However, a number of Chairs wanted the deadline for data submission to be in January partly because it was more likely that firm figures could be obtained for the Academic year, but mainly because the end of the calendar year is a busy time. When the GSC withdrew their financial support this meant that their imposed deadline could be disregarded and for a while the January deadline was adopted. This adoption was frustrated, however, by Universities delaying final head counts ever later into the term and other organizations, such as the CGC, were asking for reports on registration for their January meetings so the deadline was moved back into December. Initially, only totals were collected, but Federal and Provincial governments, and then NSERC, began demanding more information, such as gender distribution, visa

students, and duration of graduate programs, so the level of detail in the questionnaire increased. This level of detail was not thought to be sustainable, however, as some universities were unwilling to provide the breakdowns to non-governmental organizations for philosophical reasons, resulting in annual tables that could not be published. As more and more demands for information were received, the Council tried to ensure that the information collected would be of general use, and that production of the results of the questionnaire could be used as the response to requests from many organizations. This was not fully successful, as some parties required information beyond what was thought to be possible, such as funding levels and sources, and space assignments. The most recent compilation of data, diligently prepared by Greg Finn and Rob Raeside, apply to 2002-2005, although gender balance data are incomplete. All schools responded for some part of this time frame, and extrapolation was limited to only four schools. Total undergraduate and graduate student enrolment showed a downward trend in undergraduate program registrations from 1998-2003, bottoming out at about 60% of the peak values in the late 90's, and increasing slightly since 2003, mainly as a result of increased enrolment in Ontario and the West. Quebec has seen a decline in undergraduate enrolments since 2003. Considering only Geology/Earth Science majors, thus excluding Environmental Science, Atmospheric Science, and Geophysics, the enrolment in undergraduate programs increased significantly in 2004 and 2005, 5% and 15% respectively. The 1990-2001 upward trend in B.Sc. graduations appears to have dropped to about the 1998 level, and stayed constant. Numbers of first year and service course registrations are increasing very rapidly again after a decade in the 20,000 range. This increase is most dramatic in Ontario in 2005, with a 66% increase in one year. This presumably represents the bulge from the double entry cohort in 2003 now seeking elective courses in science to complete degree programs. The number of registrations for graduate work is rising modestly. Of note is the 33% growth in PhD registrations from 2002-2005, although graduations don't show any change. There is no obvious correlation between enrolment in undergraduate programs and M.Sc. or PhD registrations. An analysis of the three-year running average of the ratios of numbers of students registered in M.Sc. and PhD programs to the numbers of students graduating shows that, over a period of time during which registration and graduation numbers do not change rapidly, this is a macroindicator of time in program. It must be noted that students who drop out of a program will skew the values toward higher numbers. Of note in the past decade is an increase in "time in program" for PhD students, but this may be due to the recent increase in new enrolments in PhD programs already described. Faculty numbers are level over the past 4 years, after a 10% climb from 2000 to 2002 which might have been the result of CRC appointments. If so, more recent appointments have been balanced by losses elsewhere. The steady decline of support staff from 1988 to 2000 appears to have leveled off, while the number of post doctoral assistants is showing a steady rise with a 60% increase since 1998. The ratio of support staff to faculty continued a steady decline to 2004, but has rebounded in 2005 as a result of appointments of technicians in Ontario and the West. At the Summit, Joe White, CCCESD Chair, summarized these trends by describing how the success of reorganizations driven by perceived opportunities for efficiencies of scale, salary savings, and elimination of units has been determined by timing relative to faculty turnover, initiatives, and hiring, as well as cultural differences between the units being combined. Enrolment fluctuations have been unpredictable, while enrolment cycles have been more out of phase with industry cycles than in previous years. Student attitudes and interests are similar to those of previous decades, while their range of opportunities has changed, as has their tendency not to follow in the paths of their predecessors. Students need to be convinced of the value of certain options, based on compensation, stability, challenges, and opportunities. A smorgasbord approach rather than coherent program has resulted from the perception that core courses are not innovative. The goals of students are not in our control, so we need to demonstrate the range of opportunities available. If there is a shortage of geologists with mapping skills, for example, it is because they are choosing to do something else. Student choices are not necessarily incompatible with traditional requirements or new

directions, if a sufficiently solid core curriculum is taught. There is a need to avoid inappropriate dilution of content without undue rigidity. Faculty demographics are skewed and there is inadequate renewal, but staffing of many positions is not controlled at the departmental level. Competition to attract people is increasingly intense, candidates are not quick to accept offers, and negotiations have been much more intense than in the past. Roles and responsibilities are fragmented as too few are attempting to do too much. Demographics are shifting, and there is inadequate renewal, while universities do not answer to a single community. We have leverage through student mentoring, alumni influence, and departmental interaction with the community.

Outreach – Communication designed to enhance medium to long-term outcomes, for the benefit of earth science and for all Canadians, whether through Museums or through volunteer activity, is very active. At the Summit, Alan Morgan, President of the Canadian Geoscience Education Network (CGEN), suggested that although our science is world class, and regardless of low funding and department closures, our outlook is bleak due to inadequate recognition by the educational system and general public, an aging geoscientist population, and a worsening replacement rate. This will lead to a human resources crisis in 2015 to 2020, just as the world is grappling with a population in excess of 7.5 billion, diminishing easily accessible natural resources, increasing water problems and more impact from hazards and climate change. We therefore must accelerate our recruitment immediately, as seven to ten years are required to train a geoscientist. Promotion of our discipline has been made through disbursement of 54,000 CGC "Careers in Geoscience" booklets and an additional 5,000 CD-ROMs. New promotional activities are being undertaken and more are needed. Our outreach must demonstrate relevance to the public such as in provision of energy and mineral resources, we must ensure earth science instruction at all levels of education by qualified teachers, and our research must address societal interests and needs. The public is keenly interested in volcanic eruptions, earthquakes, paleontology, mineralogy, and water, and a select group of geoscientists are addressing this demand, but employers commonly do not reward outreach. Nevertheless, tremendous success has been achieved in Canadian earth science outreach, such as the GeoSciEd IV Congress in Calgary in 2003. CGEN currently is focusing on EdGEO workshops for teachers, the EarthNet web site, Geoscape and Waterscape posters, and the What On Earth newsletter. Canada will play an important part in the outreach activities associated with the International Year of Planet Earth (IYPE). John Clague, Past President of CGEN, reported to the Summit that there currently is no organized effort to recruit students to Canadian university geoscience programs. Earth science either isn’t taught in schools or is taught by underqualified teachers, so students have little awareness of geoscience or jobs in the field, and we lose bright students to biology, chemistry, and physics. We therefore must institute a nationwide program of earth science education and recruitment consisting of teacher training, web-based resources, increased summer student employment in all sectors, and public education. A CGEN Careers in Earth Science website now in prototype will be aimed at the Grade 9 level, will encourage students to consider the geosciences, and will provide basic information about qualifications, job prospects, and salary expectations. A printed flyer advertising the website will be widely distributed. The web site will be visual in style, will emphasize adventure, travel, and linkage to broader interests, skills, and hobbies. Grants and content are needed to complete the website and its promotion, and we must all contribute to increased summer employment, promotion of earth science school curricula, and outreach.

Advocacy – Our communications designed to influence policy decisions over the short to medium term are very active, through the highly effective activity of the business groups, and through Parliament Hill mechanisms such as the Partnership Group for Science and Engineering (PAGSE). Simon Hanmer, Chair of PAGSE, described Parliament Hill advocacy in support of earth science at the

Summit. While business-based groups and those responsible for professional registration tend to their own advocacy, activity in support of science is primarily carried out through PAGSE, a cooperative of more than 20 national Science and Engineering (S&E) organizations who speak for fifty thousand individuals. PAGSE communicates the economic benefits of research in Canada, sponsors analyses, addresses intellectual property issues, showcases the international dimensions of research initiatives, and supports decision makers with information on the importance of S&E to Canada. PAGSE meets regularly with the Presidents of the principal S&E funding agencies, as well as senior officials in federal science-based departments, and with the National Science Advisor. PAGSE holds an annual fall symposium in Ottawa, and submits a brief to the House of Commons Standing Committee on Finance each fall. PAGSE strongly supported the creation of the Canada Foundation for Innovation (CFI), the Canada Research Chairs, and Canada Graduate Scholarships. Since 2000, PAGSE briefs have made recommendations on governance gaps in S&E research in Canada, support for university-based S&E research, support for S&E students and young scientists, and support for S&E research in industry. This has been in tune with recent federal actions on funding for indirect costs of university research (2002), increased funding to granting councils (2003), creation of the position of Science Advisor to the Prime Minister (2004), and recognition of the need for support for the commercialization of university-based research (2004). The 2004 PAGSE brief, for example, recommended support for the National Science Advisor, creation of the Canadian Academies of Science, optimization of government science, strengthening the capacity of the granting agencies, capacity for research in remote areas, coordination of Arctic logistics, commercialization, and support for young scientists and engineers. In partnership with NSERC, PAGSE sponsors the widely-acclaimed Bacon and Eggheads breakfast lectures held monthly since 1998 on Parliament Hill while parliamentarians are in session. Earth Science has been well represented at Bacon and Eggheads by Harvey Thorleifson, John Clague, Verena Tunnicliffe, John Smol, Alfonso Rivera, Robin Riddihough, Kirk Osadetz, Louis Fortier, Mark Bustin, Barbara Sherwood Lollar, and Kenneth Reimer.

International – Canadian earth scientists are active internationally through organizations such as Association of Applied Geochemists (AAG), Association of Geoscientists for International Development (AGID), International Association of Engineering Geologists and the Environment (IAEG), International Association of Hydrogeologists (IAH), International Association on the Genesis of Ore Deposits (IAGOD), International Geographical Union (IGU), International Permafrost Association (IPA), International Society of Rock Mechanics (ISRM), International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), International Union for Quaternary Research (INQUA), International Union of Geodesy and Geophysics (IUGG), International Union of Soil Sciences (IUSS). Society for Geology Applied to Mineral Deposits (SGA), Society of Economic Geologists (SEG), and Society of Exploration Geophysicists (SEG). International Year of Planet Earth (IYPE) in 2008 will be the most ambitious scientific and outreach program ever designed in the earth sciences. This international multidisciplinary Earth Science initiative was conceived by the International Union of Geological Sciences (IUGS), which represents about 250,000 geoscientists from 117 countries. Planning began in 2000 with seed money from IUGS, UNESCO, and Shell Exploration & Production BV. The aim of the Year is to increase public understanding of the relationship between people and Planet Earth, and to demonstrate that earth scientists are key players in creating a balanced, sustainable future. Recent declines in funding for the earth sciences, and in student enrolment, mean that we must make public and political awareness a top priority. Selected themes provide the Year with an initial focus, and planning will respond to the demands of the community. Outreach is especially important, as the public, policy makers, and politicians commonly make decisions about our changing environment without adequate knowledge and understanding of Earth history, materials, and processes. Themes have been chosen for their societal impact, potential for outreach, multidisciplinary nature, and

high scientific potential. Fliers for each of the priority themes have been or will be published, including groundwater sustainability, hazards, public health, climate, resources, urban geology, Earth systems, oceans, soils, and life. International Polar Year (IPY), in 2007-2008, is envisioned as an intense, internationally coordinated campaign that will initiate the dawn of a new era in polar science. IPY will be multi- and interdisciplinary in scope and truly international in participation. It will educate and excite the public, and help train the next generation of engineers, scientists, and leaders. It will include elements from a wide range of scientific disciplines. International themes include determination of the present polar environmental status, quantification and understanding of past and present environmental and human change in the polar regions in order to improve projections of future changes, advancement of our understanding on all scales of the links and interactions between polar regions and the rest of the globe and of the processes controlling these, investigation of the frontiers of science in the polar regions, use of the unique vantage point of the polar regions to develop and enhance observatories from the interior of the Earth to the Sun and the cosmos beyond, investigation of the cultural, historical, and social processes that shape the sustainability of circumpolar human societies, and identification of their unique contributions to global cultural diversity and citizenship. Canada intends to promote emphasis on the human dimension of IPY scholarship along with activity in the natural and physical sciences. Leadership in northern communities has been sought, and the emphasis will be on the legacy left by the program, including capacity building, infrastructure, education, traditional knowledge, monitoring, information dissemination, and archiving.

Conferences – There is increasing effort in coordinating and cosponsoring conferences, to ensure that we have the right mix of large and small meetings. At the Summit, Kevin Ansdell described the essential role that conferences play for all of us, whether academic, industry, or government, professional or student. Keys to success include venue, program, partnership, marketing, timing, critical mass, and short courses. Meetings permit exchange of ideas and knowledge, professional development, and networking, while financially sustaining sponsors. Conferences serve academic, government, hydrocarbons, minerals, or environment, or a combination. Retreats such as GAC Nuna meetings are best for advancing specific topics. Large, multi-society conferences are most successful in impact and profit. The calendar tends to be Roundup in January, PDAC in March, CIM, GAC-MAC, CGU, and CSEG in May, and CSPG in June or so. Most provinces and territories hold lively mining open houses in the fall, and interspersed among these dates are specialist meetings such as CANQUA, nearby US-based meetings, and international conferences. GAC-MAC with their partners typically attract 500 to 1000, CSPG with partners attract up to 5000, while PDAC attendance now exceeds 14,000. We all struggle to choose which meetings to attend, and funds for travel compete with professional registration fees and other expenses. Meeting choice is driven by technical program, interest, location, cost, and loyalty, and the ability and willingness to attend multiple meetings seems to be diminishing. An astonishing number of conferences is being held, and it is hoped that they all attract the desired attendance. Whether this activity is sustainable remains to be seen, or even whether it is desirable, in view of widespread recognition that fragmentation is our principle handicap. A permanent office staff organizing larger, multi-society meetings would probably be ideal, and the practices of Canadian chemists may be a model. GAC will co-sponsor meetings in Yellowknife in 2007, a mining theme for Quebec City in 2008, a water theme for Toronto in 2009, and GeoCanada 2010 in Calgary.

Publications – There is a need for us to influence private sector earth science publishing to the extent that we can, and to concurrently define, coordinate, and optimize the role of public sector publishing in the progress of our science. Examples of active public sector earth science publishers in Canada include Canadian Institute of Mining, Metallurgy and Petroleum (CIM), Canadian Society of Petroleum Geologists (CSPG), Geological Association of Canada, Geological Survey of Canada,

Mineralogical Association of Canada, and NRC Research Press. At the Summit, Jennifer Bates, GAC Publications Chair, described the essential role that printed and digital, formal and informal, public sector earth science publishing in Canada plays alongside the large role of commercial publishers. This includes publishing that scientific societies do for reasons of science, service to members and community, and for profit to support other operations, and institutional publishing by geological surveys, museums, and the National Research Council (NRC) done largely to fulfill mandate. Most publications are author-driven, small-market relative to most commercial publications, and directed at scientist peers, although publishing directed at the public, students, teachers, policy-makers and decision-makers is expanding. Public sector earth science publishing in Canada could probably be improved for the good of Canadian earth scientists and our clients, to increase effectiveness and financial viability, and to prepare for increased digital publishing. Increased cooperation could perhaps be achieved while identity is maintained. GAC and GSC have recently co-published, while GAC and MAC are teaming up on marketing, and the potential for wider distribution of a magazine such as Geoscience Canada is being investigated. Digital initiatives such as GeoScience World are examples of cooperation elsewhere. Ideally, public sector publishing will fill a needed niche not adequately served by commercial publishers. Consolidation, which may become essential, could increase critical mass, efficiency and clout on the national and international scene, while ensuring quality publications, healthy finance, and a national and international presence that will serve the Canadian earth science community well.

Foundations – We are increasingly wealthy, and willing to donate money to causes that we care about, through donations and bequests to earth science specialty groups, or through donations to all of Canadian earth science through the Canadian Geological Foundation (CGF). This giving is likely to accelerate dramatically in coming years, and optimal mechanisms are needed to receive and disburse these funds. Canadian Geological Foundation (CGF) carries out the wishes of benefactors whose objective is to support Canadian earth science, thus complementing the foundations that serve a sector of the community. Since 1968, CGF has awarded over 300 grants with a value exceeding $1M. The Foundation is led by 14 members from which an Executive and Board of Directors are elected. Membership is specified in the Foundation's Bylaws to be representative of the Canadian geoscience community. The fund was launched by a gift of $0.25M from Thayer Lindsley in 1969, and Jérôme H. Remick III has given $0.5M to support grants to support development and awareness of geosciences in Canada. The Foundation holds annual meetings at GAC-MAC to conduct business and act on the reviews by the Grants Selection Committee of proposals received by March 31. Available annual funding ranges from $25K to $50K, depending on the performance of investments. A call for applications is made in Geolog and on the CGF website. Grants support activities of national interest and broad significance, such as geoscience outreach, teacher-training, career booklets, publications, meetings, and special cooperative projects of national and long-term significance. CGF is actively soliciting new contributions and bequests. Other earth science foundations in Canada include Canadian Society of Petroleum Geologists Trust, Canadian Mining and Metallurgical Foundation, Canadian Foundation for Geotechnique, Mineralogical Association of Canada Foundation, Prospectors and Developers Association of Canada Mining Matters, Canadian Mineral Industry Education Foundation, SEG Canada Foundation, Burgess Shale Geoscience Foundation, and the Hutchison Young Scientist Foundation.

Coordination – Defragmentation was called for at the Summit, and we all have a responsibility to ensure that we have the right spectrum of groups serving business interests, regulation of professional registration, and supporting earth science specialty groups. We also need to ensure that earth science as a whole is appropriately served with needed communications, conferences, and publications, and that

we have required mechanisms in place to facilitate needed communication and coordination between the Canadian business, professional, and science sectors. Canadian basic earth science societies include Canadian Association of Geographers (CAG), Canadian Geophysical Union (CGU), Canadian Geotechnical Society (CGS), Canadian Meteorological and Oceanographic Society (CMOS), Canadian Society of Soil Science (CSSS), Geological Association of Canada (GAC), Mineralogical Association of Canada (MAC). Canadian specialized & applied earth science societies include Canadian Association of Palynologists (CAP), Canadian Exploration Geophysicists Society (KEGS), Canadian Geomorphology Research Group (CGRG), Canadian National Chapter of the International Association of Hydrogeologists (CNCIAH), Canadian Quaternary Association (CANQUA), Canadian Society for Coal Science and Organic Petrology (CSCSOP), Canadian Society of Exploration Geophysicists (CSEG), Canadian Society of Petroleum Geologists (CSPG), and the Canadian Well Logging Society (CWLS). Canadian industry-based associations whose membership includes significant numbers of earth scientists include Canadian Institute of Mining, Metallurgy and Petroleum (CIM), and the Prospectors and Developers Association of Canada (PDAC). Canadian earth scientists also optimize their activity through regional groups, such as the GAC Pacific Section, the GAC Cordilleran Section, the Calgary-based cluster of highly active societies, the GAC Edmonton Section, the Saskatchewan Geological Society, the GAC Winnipeg Section, the Sudbury and Toronto Geological Discussion Groups, l'Association québécoise des Sciences de la Terre, the Atlantic Geoscience Society, and the GAC Newfoundland Section. At the national level, professional registration is coordinated by Canadian Council of Professional Geoscientists (CCPG), while provincial and territorial surveys are coordinated by Committee of Provincial Geologists (CPG). Federal survey agencies, including Meteorological Service of Canada (MSC), Water Survey of Canada (WSC), Canadian Soil Information System (CanSIS), and Geological Survey of Canada (GSC) each have their own coordination mechanisms, such as the National Geological Surveys Committee (NGSC). University education and research are coordinated by Council of Chairs of Canadian Earth Science Departments (CCCESD).

V. The role of CGC

The purpose of the Canadian Geoscience Council (CGC) is to support coordination needed to optimize the efficiency and effectiveness of the earth sciences in addressing the needs of the people of Canada, in relation to economic prosperity, natural hazards, public health, as well as appreciation and preservation of our natural heritage.

Canadians are served by about 15,000 Canadian earth scientists, who also in many cases respond to needs around the world. Earth scientists ensure a prosperous and needed supply of energy, minerals, and water, help Canadians deal with natural hazards and climate change, they provide knowledge needed to conserve our soils and deal with deleterious materials in the environment, and they provide a rich and profound insight into our natural heritage. We are applying a broad and well-coordinated range of approaches to serving the needs of Canadians. Mapping accounts for spatial trends, while monitoring assesses temporal trends. Research obtains answers to conceptual questions. Exploration facilitates business decisions, consultants ensure good design, while synthesis reviews progress and sets priorities. Education passes on existing knowledge while facilitating its progresses, outreach better equips our society to be good stewards and helps ensure our future, while advocacy influences decision-making to enhance the standing of our profession for the good of society as a whole. Some of us have responsibilities in regulation, management, and ongoing field activities, while our work is facilitated by required consultation and coordination. Canadian earth scientists organize themselves as self-sustaining associations who serve their constituency well by sponsoring communications, conferences, and publications, as well as academic, governmental, and industry organizations. CGC

supports the coordination between all Canadian earth science organizations that is needed to optimize the benefits that earth science bring to Canadians. CGC also facilitates the Canadian role in international earth science programs.

CGC also advises public agencies, by advocating an optimal role for earth science in our society, by appointing representatives to advisory committees, by commenting on legislation and programs in earth sciences, by advocating an optimal role for education and professional registration, and by appointing teams of experts to advise government agencies, on request. In addition, CGC informs Canadians, by identifying national issues that require input from earth science, by increasing awareness of the knowledge Canadians need, and by recruiting talented Canadians to careers in the earth sciences.

Over the past year, therefore, in addition to helping in the coordination of regular CGC and associated meetings, I represented the earth science community at the Energy and Mines Ministers conference in New Brunswick in September 2005, at meetings of the Natural Resources Canada (NRCan) Minister's National Advisory Board on Earth Sciences (MNABES), as well as the GSC Advisory Committee and the Canadian Geological Foundation. CGC also is active in advocacy in support of Canadian earth science through the Partnership Group for Science and Engineering (PAGSE), which speaks for our community on Parliament Hill. We are very active in Canada's international role in earth science, and in promoting earth science outreach through the Canadian Geoscience Education Network (CGEN). CGC activity is, of course, made possible by the generous contributions of volunteers, the commitment of our members, and through the financial support of the Geological Survey of Canada.

V. Acknowledgements

I would like to acknowledge with immense appreciation the roles played during 2005-6 by CGC Directors Don James, Alan Morgan, Gerry Reinson, and Bryan Schreiner, by Council of Presidents Facilitators Jeff Packard and Simon Hanmer, and by CGC representative to PAGSE Denis St-Onge, as well as the excellent, dedicated efforts of CGC Executive Officer Bob Mummery. I will look forward to the continuing evolution of CGC or its successor in coming months and years, as we all commit ourselves to optimizing the role that the Canadian earth science community plays in our society.

Harvey Thorleifson, President of the Canadian Geoscience Council, thorleif@umn.edu

http://www.geoscience.ca/

June 11, 2006