CHAPTER 10 DYNAMICS OF CHANGE

Cautionary comments were given in the Introduction to this report on the ability to predict future challenges to, and trends in, the geosciences. A principal reason is the escalating rate of change that is so prevalent in so many national and socio-economic systems. The remarkable political changes in recent years in the former Soviet Union and in South Africa after long periods of relative stasis have been largely unpredicted events. Likewise, the assembly of different trading blocks or agreements (*e.g.*, European Economic Community; North American Free Trade Agreement); the rapid greening of societal values; the demise of the Cold War, and the spread of democratic governments have all resulted in a substantially different world. As scientists, we have seen phenomenal scientific and technological advances, of which the impact of computers, satellites, and rapid communication systems are particularly profound. Today, we are in the transition from the Industrial Age to the Information Age. In Canada, this is heralding significant changes in the economic fabric, with the reduction in relative importance of the resource and manufacturing sectors and the progressive diversification of the information, knowledge-based, and service sectors.

For the geosciences such rapid rates of change are expressed in a host of technological advances (*e.g.*, computers, database development, the information highway, satellites, geochemical analytical techniques, seismic imaging, horizontal drilling, remotely operated vehicles). They also affect the means of geoscience information display and dissemination (*e.g.*, computer generated maps, sophisticated visualization, CD ROM databases). The change of emphasis noted earlier from geoscience exploration and exploitation to the growth of environmental geoscience has diversified the science, widened career opportunities, and created the paradigm shift towards a multidisciplinary earth system approach.

All these changes have occurred during a time of economic depression and when the average age in government and academic geoscience departments is between 48 and 52 years. The conservatism induced by both economic restraint and age commonly does not facilitate adjustments to rapid change. Our times demand a flexible, optimistic, and creative attitude to change. In a few instances there is evidence of an opposite scenario. In the petroleum industry the major staff reductions of the 1980s and the move of some of the larger multinational companies (the Seven Sisters) away from Canada has resulted in the growth of new small- and medium-sized companies in the mid-1990s. Many are staffed with young entrepreneurs or new graduates with an average age of between 30 and 35 years. Such companies may be well adapted to change but have little in-house corporate memory and long-term experience to respond well to the next phase in the traditionally cyclic industrial development.

Given the extent and dynamics of such changes, the management of change becomes a critical skill. In many of the government and academic institutions, with restructured budgets and staff with high average age, the capacity to adapt to new challenges, trends, and technologies is limited; mobility of staff is minimal affecting the transfer of ideas and the revitalization of units. Because of this situation which will last for another decade and a half (to about the year 2010), collaborative projects and programs become the key to bringing intellectual vigour and scientific and technological advances.

Academic institutions must develop new and different programs for retraining individuals as current new graduates can expect at least 3 to 5 different careers in their working life. Those in more stable career paths need to take an array of short courses and special training to maintain themselves at the forefront of their science. Most academic degree programs are largely structured for students leaving high school, not for individuals with wide experience and training in the process of changing career paths later in life. With a doubling of knowledge in the world every 18 months, academic institutions must increase the rate of curriculum revision and reform. Rather than use external generic or specialized educational courses, many companies are adopting a life-long learning approach for their staff and instituting a Learning Organization Approach. The dynamic change in the knowledge base must be matched with an upgrade of knowledge-skills of employees, rather than a decline to obsolescence, given the cost of the investment in formal education paid for by society. The efficiency of technology transfer (*i.e.*, of ideas, people, knowledge, and technologies) may well be the most critical factor in a nation remaining internationally competitive in the Information Age.

When scientific advances are so rapid, as in the last three decades, then the scientific frontier is expanding proportionally. Maintaining excellence or a competitive industrial edge becomes a serious challenge. The relatively low level of Canada's investment in science compared to most of the G-7 nations has made it increasingly difficult to develop or sustain excellence. In some instances, a reduced level of excellence is ignored or disguised: in other areas, excellence is redefined or condensed to a few well-funded projects (*e.g.*, National Network of Centres of Excellence of NSERC; no geoscience projects were included); or in the reduction of infrastructure and core program support (*e.g.*, 1995 plans for NSERC and GSC); or in the university sector where student to faculty ratios have gradually increased while research grant and infrastructure support has

progressively decreased. R & D expenditures as a percentage of GERD in the higher education sector decreased from 15% in 1971-1975 to 10% in 1991-1993 (Statistics Canada, 1994). The ability of the nation and of its institutions and industry to reverse these trends over the next decade is limited given the deficit problem. In managing change over this interval credit, recognition, and promotion must be given to those individuals and programs that achieve national and international levels of excellence; entrepreneurship in resourcing, management, and programming must be nurtured.

The dynamic changes in earth sciences and in socio-economic factors combined with the deficit problem has led past and present federal governments and some provincial governments (notably Alberta) to focus institutional reorganization, programming, and funding on economic return and in support of Canadian industry. This is evident, for example, in the current priority setting in the GSC and in some of the NSERC programs. Whereas the partnership principle is to be favoured, the protection of the public good cannot be eroded. Public good has been a principal responsibility of government agencies and often a key rationale in their initial establishment. In the geosciences, the work on earthquakes, landslides, waste-disposal, groundwater, weather and climate are examples in which the economic benefits are indirect, and only government agencies can develop and maintain an adequate knowledge base for public information and policy development. The role of geological surveys in assisting the public good was eloquently addressed by Price (1994) and McRitchie (1994).

At times of rapid change, systems will be inevitably restructured, some by careful strategic planning, others by appropriation. Under the present federal S & T Program Review there will likely be a re-definition of responsibilities for many agencies and perhaps the demise of others. At the provincial level, the Alberta Geological Survey, for example, has undergone significant restructuring in 1995-96. In such times of change leadership for the Canadian earth sciences is especially critical: the vision for future disciplinary change, commercial opportunities, environmental protection, public education, and public good must be articulated consistently and wisely. Such leadership must attempt to develop a common voice and message in many of the necessary pronouncements. Cooperation and shared funding for advancing such views must be forthcoming from agencies and individuals.

In past decades, such leadership commonly was provided by the largest, national, geoscientific agency – the Geological Survey of Canada – but now seriously eroded by budget cuts (with more to come), and having judged it necessary to respond to these by adopting a shorter-term vision and narrowing the focus of its activities, the GSC's ability to discharge its leadership role has become increasingly strained. The provincial geological surveys and academic sectors are too dispersed and appear to lack the organization and resources to fill the leadership vacuum. Geoscience industry is coordinated through organizations such as the Mining Association of Canada and the Canadian Association of Petroleum Producers but whose traditional roles have been primarily devoted to lobbying governments on behalf of their respective industries.

The potential for discipline leadership in the future remains in doubt. If its need is appreciated, there is a chance that existing or new groups will develop. For the foreseeable future, the Canadian Geoscience Council, at times working with the Royal Society of Canada (RSC), should strive to assume this responsibility. One small but significant example of imminent success is the establishment of a Canada Prize in the Earth and Environmental Sciences, potentially equivalent to a Nobel Prize. The multi-million dollar funding and the complex administrative arrangements are almost in place following splendid cooperation between a generous individual benefactor and the CGC and the RSC.

A current weakness in CGC is that it is representative of the Canadian Geoscience community through the membership of 14 geoscience societies and a number of associated agencies (Table 10.1). It has been able to marshal the support and opinion of senior leaders in the government and academic sectors, but less cohesively in the industrial sector. Given the present climate in government in which the voices of industrial leaders are welcomed, the CGC has been restructuring its operation, but must incorporate the leaders from all sectors. The CGC must also examine its own priorities and operations to focus on addressing the more critical issues in Canadian geoscience of today and the future and shed many of the routine coordinating functions it has assumed in the past. It must be recognized as the vehicle for visionary dialogue in the country to gain the necessary voluntary support, financing, and influence. If it cannot attract the Canadian Meteorological and Oceanographic Society (CMOS) to its membership, it should arrange a partnership to ensure a common strategy, message, and voice in representing the full spectrum of the Canadian earth sciences.

The strength of the CGC in being so broadly representative of the earth sciences community is also its weakness. There is considerable annual turnover in representation; member societies have been reluctant to increase fees; the funding base has not allowed for a strong permanent headquarters and secretariat.

In this report, several recommendations are addressed to the CGC in the hope that a reformed Council can undertake these charges. If the CGC cannot arrange a stronger funding base, a more effective administration, and a decisive agenda, then the earth science community should seek an alternative organization to implement the type of coordination and activities proposed in this report.

Table 10.1 Member Societies and Associate Members of the CGC

MEMBER SOCIETIES

- Association of Exploration Geochemists
- Canadian Geophysical Union
- International Association of Hydrogeologists, Canadian National Chapter
- Canadian Society of Petroleum Geologists
- Canadian Association of Geographers
- Canadian Geotechnical Society
- Canadian Quaternary Society
- Canadian Well Logging Society
- Mineralogical Society of Canada
- Canadian Exploration Geophysical Society
- Canadian Institute of Mining, Metallurgy and Petroleum
- Canadian Society of Exploration Geophysicists
- Geological Association of Canada

ASSOCIATE MEMBERS

- Council of Chairs of Canadian Earth Science Departments
- Committee of Provincial Geologists
- Geological Survey of Canada
- Royal Society of Canada (Earth, Ocean & Atmospheric Sciences Division)