PRESIDENTIAL ADDRESS

Geoscience in Canada: The Best of Times, the Worst of Times

Richard J. Wardle

12 Rigolet Crescent, St. John's
Newfoundland and Labrador
Canada, A1A 3S2
Email: richwardle@nl.rogers.com

INTRODUCTION

As a former, now retired, government executive I thought that I would take advantage of the opportunity offered by the presidential address to review the current state of the geosciences in Canada from the perspective of someone who left the field of geoscience in 2006 and returned in 2013–14 as vice president and then president of the Geological Association of Canada (GAC). What has changed in the interim, how did geoscience benefit from the commodity boom and how well prepared is it for the future? The title of the talk is shamelessly borrowed from Charles Dickens's *Tale of Two Cities* and is used to describe the mixed set of circumstances that prevail in our current economic climate and the opportunities and pitfalls that exist for the geosciences as we move into the future. This address will move through three parts; starting with a review of the current economic environment and the demand for resources, which is the overall direct and indirect driver for geoscience demand; then look at a personal assessment of the current state of the geosciences in Canada; and thirdly examine some thoughts on how we can improve our visibility and influence as geoscientists.

THE PRESENT ECONOMIC ENVIRONMENT AND THE DEMAND FOR RESOURCES

The demand for geoscience, in Canada at least, is very broadly a function of the demand for resources, which in turn is dependent on the overall state of the global economy. The demand for resources has both a direct effect on geoscience, for example through employment in the extractive industries, but also indirectly through basic and applied research, including the environmental and geological engineering disciplines. Canada is still very much a resource economy in which natural resources account for 18% of gross domestic product (GDP) and some 50% of exports. It was the resource economy that pulled Canada through the financial crisis and subsequent recession of 2007–09 more or less unscathed and it is the resource economy that will continue to be a significant driver of growth in future years.

In terms of the global economic environment, the United States and the United Kingdom are seeing significant growth in both GDP and employment following the recession. Canada's economy has also been recovering, but is now being weighed down by the post-2011 decline in commodity prices and may see stalled growth due to the recent crash in oil prices. The Eurozone's growth has slowed to the point that its main economic engine, Germany, is hovering on the edge of recession and the zone as a whole is threatened by deflation. Japan is also struggling to escape two decades or so of deflation and recently seems to have moved back into recession. China's economy, all important from the perspective of resource demand, has slowed but GDP growth is around 7%, which is still a robust level compared to the 3 to 4% levels of the UK and US, and the anemic <1% levels of the Eurozone. Overall, this picture is mildly encouraging, especially the recent surge in US growth that has been considerably aided by falling oil and gas prices resulting from the fracking revolution. A lot can still go wrong; however, the hope is that the US will lead the global economy into a period of renewed growth and increase the demand for raw materials, including petroleum and minerals, and in turn increase the demand for geoscientists and geoscience.

A critical factor in any recovery will be the performance of the Chinese economy, which drove the commodity boom during the period 2005–2011 and which still has a huge impact on commodity markets. Since 2011, the Chinese economy has been transitioning from one led by exports, to one driven more by internal consumer-led growth. This has resulted in slower growth; however, due to the enormous increase in size of the Chinese economy, recent growth rates of around 7.5% are equivalent in terms of their economic impact to 12% growth in 2008 (Wright 2013). Even as it slows, China still generates over a quarter of the world's growth (The Economist 2014); for example, China accounts for 47% of world steel pro-

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duction (World Steel Association 2014) and 44% of copper consumption (Keen 2104).

The commodity boom resulting from China's explosive growth is reflected in Figure 1, which is a chart of some selected historical metal prices (World Bank 2015) in constant US dollars and thus corrected for the effects of inflation. Price is a function of supply *vs.* demand and therefore generally acts as a proxy for resource demand. The curves for iron ore, nickel, zinc and gold in Figure 1 outline the commodity boom that developed *circa* 2005, when Chinese demand for natural resources burst onto the world stage, and which lasted until 2008–09 when it was sharply curtailed by the financial crisis and ensuing great recession. Prices (and demand) rebounded in 2010 and reached a peak in 2011, but in this period demand was largely led by Chinese fiscal stimulus that poured 4 trillion yuan (US$ 586 billion) into an effort, ultimately a successful one, to keep China out of recession. This stimulus began to unwind in 2011, and coupled with efforts to cool the Chinese economy, resulted in lower resource demand and a fall in metal prices. This marked the end of the commodity boom and the start of a general price decline that has produced recessionary conditions in the metals and mining business. The commodity price decline is also being abetted by new resource production coming on stream, notably for crude oil and iron ore, which is forcing prices down further.

Crude oil prices have shown a similar pattern of growth to that of metals but escaped the effects of the commodity downturn until mid-2014 when a combination of surging US production and slowing global demand instigated a steep decline in prices that continues to the present day. The decrease in oil prices may have a negative impact on Canada's economy, which in part is still a petro-economy, but may be positive for global growth through its action as a form of fiscal stimulus.

With respect to metals, there is a sign of hope in that the World Bank's price forecasts as of January 2015 (World Bank 2015; Fig. 1) indicate that over the next ten years or so

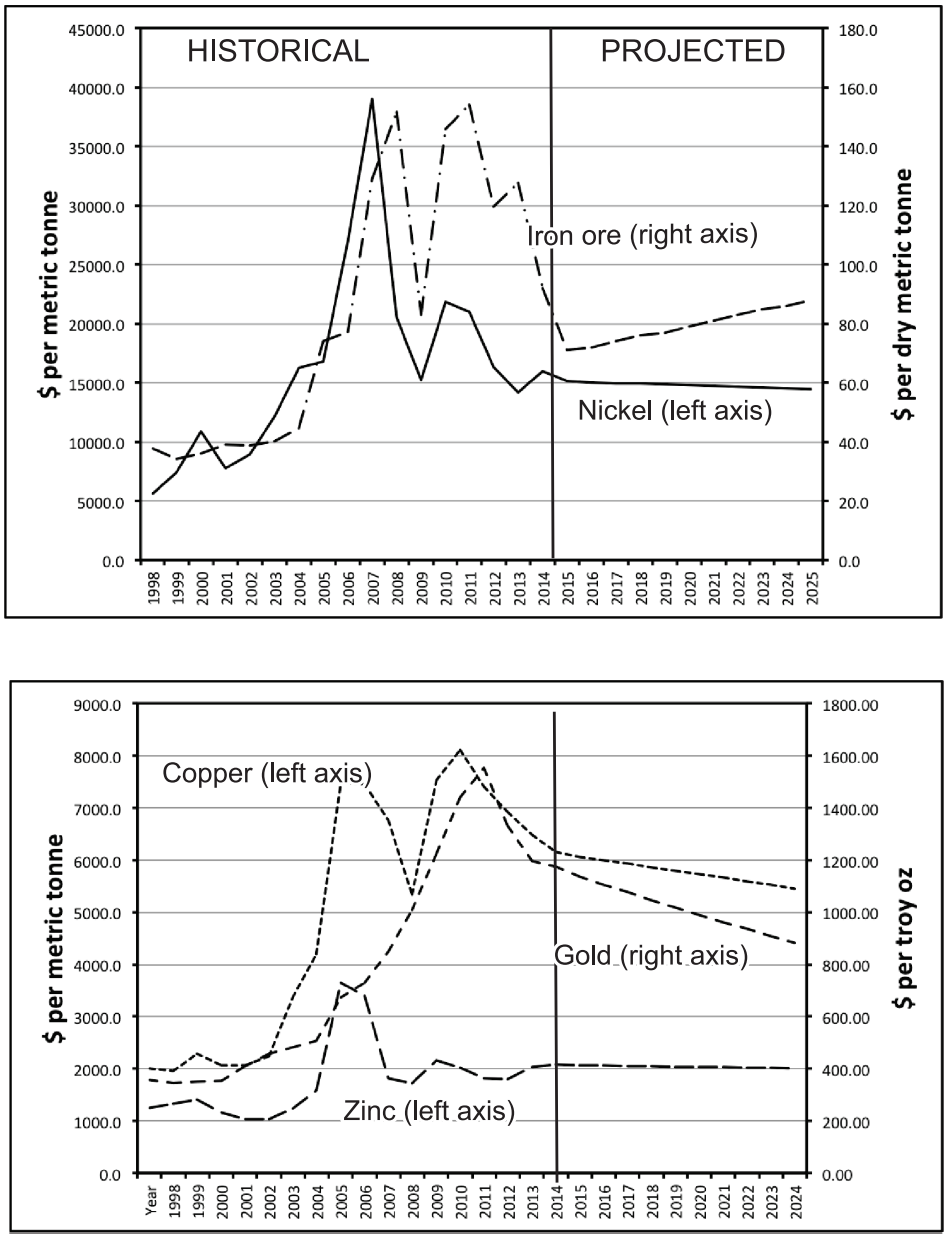

Figure 1. The history of the commodity boom and subsequent decline as revealed by selected metal prices in constant US dollars. Prices to the right of the vertical line are projected. Source World Bank (2015).

metal prices (in constant dollars) will remain well above their pre-boom (pre-2005) levels. This in large part is due to the continuation of relatively high levels of growth of the Chinese economy, and accelerating US demand.

Turning now to the impact of growth on geoscience, two questions arise. Did Canada's geoscience sector expand during the commodities boom, and secondly is the sector well positioned to meet the demands of the next upturn in the economic cycle when it eventually arrives?

GEOSCIENCE IN CANADA – ARE WE MEETING THE CHALLENGE?

In order to assess the above questions I looked at four metrics for which public data are readily available, namely: Research Spending, Student and Highly Qualified Personnel Training, Geological Survey Spending and Professional Geoscientist Registration. This to a large extent involves an assessment of how government funding is utilized. Significant geoscience is undertaken by the private sector but the data is more difficult to acquire; hence, this aspect is beyond the scope of the review.

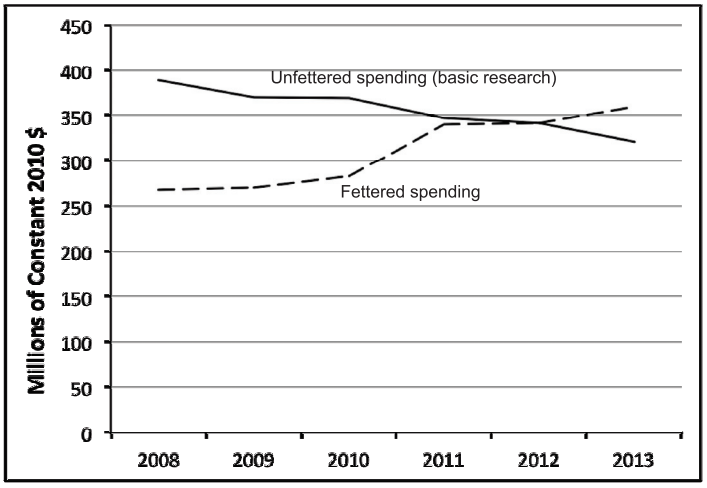

Figure 2. Fettered vs. unfettered research funding in millions of constant dollars. CAUT (2013).

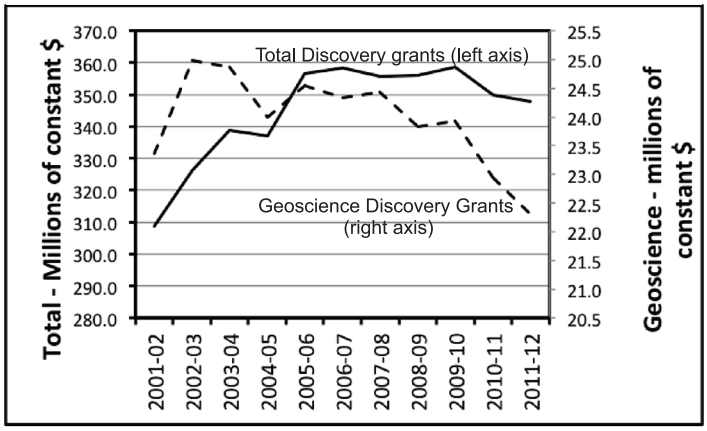

Figure 3. Geoscience (left axis) *vs.* total Discovery Grant awards (right axis) in millions of constant dollars. NSERC (2013).

Research Spending

To most GAC members, research-spending means funding provided by the Natural Sciences and Engineering Research Council (NSERC), especially its Discovery Grant program. Overall NSERC funding, as measured in constant dollars, has seen a decline of about 6.4% since 2007–2008, probably due to efforts to reduce the federal deficit and consequent across-the-board cuts to government programs. Of more interest, however, has been the recent implementation of a policy that has seen funding diverted from basic research, as represented mainly by the Discovery Grant program, towards research with greater perceived commercial value. This is shown in Figure 2, taken from data published by the Canadian Association of University Teachers (CAUT 2013) showing the concomitant decline in spending on basic research (described as unfettered spending by CAUT) versus that on research projects with strong industry links and which, from the NSERC perspective, represents a greater chance of economic success (labeled fettered). Spending is shown in constant dollars. CAUT (2013) also reported that the success rates for Discovery Grants have fallen from 71% in 2008–09 to 62% in 2011–12, indicating that funding is being concentrated in a progressively smaller number of hands. Whether these trends in Discovery Grant spending are good or bad depends on the perspective of the researcher. Those involved in basic research understandably perceive this as a threat to curiosity-driven research and to university-based research as it has traditionally been carried out. This view also received support from Nature (2012). However, there is an alternative view, which is based on the argument that Canada is a resource-dependent country and perhaps needs a greater focus on industry-related research. Regardless of the benefits of attracting industry participation, the concentration of funds into an increasingly smaller number of research hands appears to be leaving many basic researchers either without funds or with budgets reduced to the point that they can longer do effective research or fund graduate students. There is a concern, therefore, as to what these changes may eventually do to earth science departments across the country and to the supply of graduate students and highly qualified personnel that is essential to the future of Canadian earth science research.

Focusing on earth science as a component of the Discovery Grant program there is evidence that other factors are also at work. Figure 3 plots the total Discovery Grant awards against awards to the geosciences sector alone in terms of constant dollars (NSERC 2013; expenditures converted by author to constant dollars using the Consumer Price Index (CPI)). From this it is clear that while total grants increased up to 2006 and then remained more or less flat, earth sciences awards have been in steady decline since 2002 and in steeper decline since 2009. Overall this represents a decade-long decline in earth science research funding of about 10%. There is also evidence from NSERC data that over the same interval of 2002–12 the number of Discovery grants awarded to the geoscience sector has remained essentially flat compared to a gradual increase in the total number of grants awarded. Note that it would be interesting to know what has happened since 2012 but unfortunately the relevant data on the NSERC web site have not been updated for this period.

Why the decline? I am not an academic but anecdotal suggestions from colleagues in academia indicate that some of the more obvious causes may be: i) demographic change, earth sciences being an aging profession in which many researchers are gradually winding down programs as they approach retirement; ii) the reportedly low profile that many earth science departments seem to have within their universities (perhaps running up against the view that earth science is 'not really a science'); and iii) perhaps a failure by us as geoscientists to organize ourselves and promote the importance of geoscience. Most likely the decline is due to a combination of all these and perhaps other factors, but in any case predates any effect that recent NSERC policy changes may have had.

Student Graduation

The overall picture of student gradua-

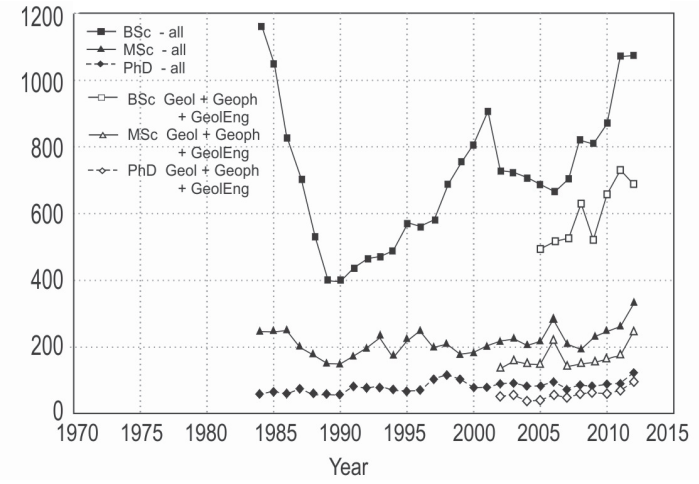

Figure 4. Student graduations. CCCESD (2014).

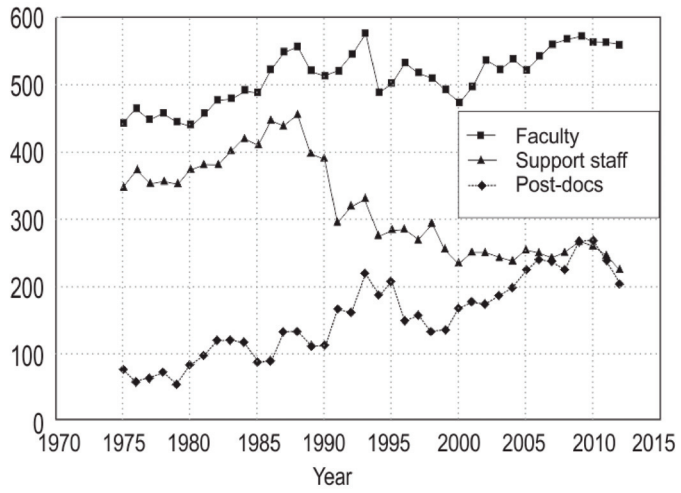

Figure 5. Faculty, support staff, post-graduate and post-doctoral numbers. CCCESD (2014).

tion is captured in Figure 4, supplied by the Council of Chairs of Canadian Earth Science Departments (CCCESD 2014). For undergraduate students, the graph shows a strong upward trend since 2005, which interestingly coincides with the onset of the commodity boom and which continues an overall pattern established *circa* 1990 and which is approaching the previous high, set in the mid-1980s. The recent upward trend was not affected by the financial crisis and to date does not appear to have been disturbed by the post-2011 downturn in the commodity markets; however, this may change in 2015. The supply of graduate students shows a slight upward trend since 2005 but there has been a downturn in the past year that is as yet of uncertain significance.

Data from the same source (Fig. 5) also show that faculty numbers have been flat over the past few years following a gradual increase in numbers since 2000 (CCCESD 2014). Support staff numbers have dropped precipitously since the late 1980s, which combined with minimal growth in faculty numbers must create interesting problems for faculty attempting to handle the undergraduate boom. Finally, post-doctorate fellow numbers show a pattern of erratic growth since 2000 interrupted by a steep downturn in 2010 that was only partly reversed by early 2014. It will be interesting to see if this reversal is maintained.

Geological Surveys

The metric chosen to represent trends in public geoscience is funding in the form of federal and provincial government appropriations. This is summarized in Figure 6, which is based on nominal dollar figures provided by Duke (2010) and the Committee of Provincial and Territorial Geologists (CPTG 2013) but converted into constant dollars by the author using the CPI. The figure shows spending for the Geological Survey of Canada (GSC) and collective provincial and territorial surveys over the period 1983 to 2011. The data show a peak of funding in the mid-1980s that was followed by a decline of about 50% to 1990. Since then the trend has been erratic but overall essentially flat. Spending by the GSC has declined by a proportionately greater amount than the provincial-territorial surveys. Significantly, there was no increase in real funding during the commodity boom, suggesting that the surveys had difficulty in convincing their respective governments that there was a need for greater investment in public geoscience during this period. In the post-2011 period, survey budgets have probably also come under increased pressure due to deficit-fighting measures.

Professional Geoscientist Registration

Geoscientists Canada (O. Bonham, personal communication 2014) has reported a steady increase in professional geoscientists registration since the inception of the system in 1970 with a growth of 50% between 2003 and 2014. There is a caution that these numbers represent registrations, not individual memberships; some individuals being registered in more than one province. Nevertheless, the strong growth is an encouraging sign that professional geoscience is becoming more entrenched in our society and is keeping pace with a growing economy.

Summary

The good news emerging from this brief review is that BSc graduation is surging and probably adequate for present and future needs, also that professional registrations are rising. Both components of the geoscience sector have grown through the commodity boom and have survived – to date at least – the subsequent downturn.

The not-so-good news is that NSERC research funding is in decline in constant dollar terms and that success rates and numbers of Discovery Grant awards for geosciences are dropping at a faster rate than in the remainder of the science sector. Geoscience faculty numbers are static in the face of increased undergraduate enrollment. Post-graduate student numbers have shown a slight increase since 2000. Post-doctorate numbers have also shown growth but have fallen off in recent years. Geological survey spending has also been static, in constant dollar terms, since the early 1990s.

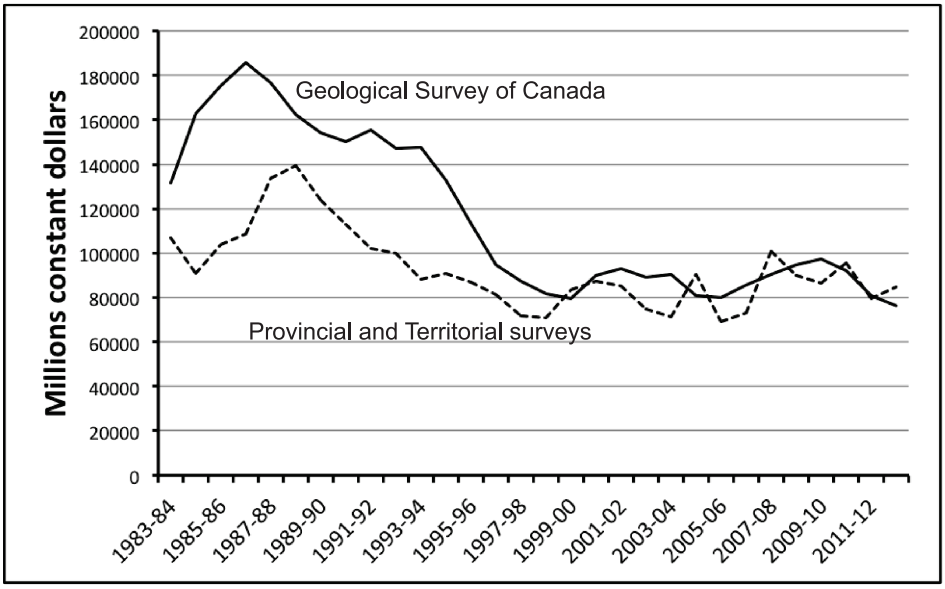

Figure 6. Funding for federal and provincial-territorial geological surveys in millions of constant dollars. After CPTG (2013) and (for pre-2003–04 data) Duke (2010).

Returning to the question posed at the beginning of this address, namely what has changed since I left geoscience in 2006 and returned in recent years, the answer is not much. Many of the problems that existed in earlier times are still there, suggesting that we have a structural problem and that geoscience, particularly its research capability, did not benefit from the commodity boom and is not as well prepared for the future as it should be. What is the root cause of the inadequacy and what can be done to fix it?

GEOSCIENCE AND COMMUNICATION

As they appear to me, the principal problems that afflict the geoscience sector are:

- Poor perception of geoscience by the public and by governments, which translates to a poor brand image
- Poor awareness of geoscience and its merits at senior government levels
- Failure by geoscientists to get their message across effectively – especially to governments

The result has been systemic underfunding and underutilization of the geoscience sector. There is nothing new here and many minds other than mine have likely contemplated the problem and pondered how to fix it. Suffice it to say that identifying the problem is a lot easier than finding the cure. Also, it is not a uniquely Canadian problem; for example UNESCO has recently slashed its geoscience budget, imperiling the well-established International Geological Correlation Program. Public geoscience in the USA has also come under pressure. As well, geoscience may be caught up in a general skeptical view of the value of basic science that seems to colour attitudes at some government levels.

A fundamental part of this problem is that we as geoscientists do not communicate effectively, especially with governments. In 2012, then President of the GAC, Stephen Rowins, gave a presidential address titled *"Geoscientists and Rodney Dangerfield: Neither gets any respect."* He was absolutely correct. We are perhaps better at communicating with the public – many Canadian geoscientists having a strong interest in outreach – but much less effective when it comes to communicating with governments. Communication with the public is important but that with government is essential because this ultimately is where much of our funding comes from. My experience, gained from working for several years in the executive levels of a provincial government, is that geoscience is an especially hard sell. Governments as a whole tend to have selective hearing and dwell on items that are of significance for the three- to four-year political cycle, especially things related to job creation, revenue and cost-cutting. Many geoscience outcomes of the type that matter to the political levels are by their very nature long term. For example, it may take several economic cycles before a geological mapping project yields anything significant in economic terms. Unfortunately, attempts to explain why funds should be invested in long-term outcomes often meet with glazed eyes, especially in the pressurized environment of budget approval. The problem becomes worse during periodic budget reduction exercises, which invariably categorize expenditure in terms of "essential," "nice to have" and "not essential." Unfortunately for geoscience, it tends to fall in the middle category and thus soaks up more than its fair share of the cuts.

Can we do a better job? There are reportedly some 20,000 geoscientists in Canada so the numbers should be there to support some effective communication. The problem though is that as a profession we are highly fragmented and tend to isolate ourselves in discipline silos. This problem has long been recognized and was the driving force in 2006 when the Canadian Federation of Earth Sciences (CFES) was formed out of the ashes of the previous Canadian Geoscience Council. A major purpose of CFES was to defragment the Canadian geoscience community, and undertake advocacy and outreach activities that would promote the values of geoscience to both public and government alike. Although it got off to a strong start, in later years CFES struggled to get the full support of the geoscience community, and in 2012 underwent somewhat of an existential crisis. Since then the federation has been reactivated with a new set of strategic priorities, namely:

- Provide a coordinating role and common voice for member societies and the Earth Science community in Canada
- Coordinate public policy advocacy on behalf of Earth Sciences
- Facilitate public awareness of Earth Science and Earth Science literacy
- Represent Canadian Earth Sci-

ences internationally
- Provide service to member societies in particular and to the Earth Science community in general

The federation has been very successful in its public outreach programs; for example, the Canadian Geoscience Education Network (CGEN), the EdGEO teacher workshops, which are a staple feature of GAC-MAC meetings, the Geoparks program, and through publications such as the recently published *Four Billion Years and Counting: Canada's Geological Heritage* and its French language equivalent *Quatre millards d'années d'histoire: Le patrimoine géologique du Canada*. It has been less successful in its advocacy and common voice programs, mainly due to the continued reluctance of a significant part of the geoscience community to get behind the effort, and due to a decline in the financial support necessary to further its agenda (effective advocacy does not come cheap). However, from the perspective of the author, CFES is at present the only common voice that we have for geoscience in Canada and it has to receive more support.

If there is a vision as to what we might aspire to, it is the American Geosciences Institute (AGI), which manages to combine public outreach, professional interests such as workforce surveys news, and government advocacy. Individual United States geoscience associations may have their own unique policy interests but they are, to at least some extent, coordinated and promoted in Washington through AGI. We can perhaps dream that one day we will have something comparable.

SUMMARY

Economic recovery, led by the United States, appears to be real (although the potential for some financial disaster triggering a return to recession can never be discounted) and will hopefully energize the global economy and resurrect the demand for Canada's mineral and petroleum resources. Canada remains a predominantly resource-based economy and needs a vibrant geoscience community to support not just resource exploration and extraction but also to assist with the environmental mitigation and remediation issues that come with resource development. Unfortunately, geoscience in Canada is underfunded and we have done a poor job of persuading governments of its importance. We have to do better at communication and need to develop a better brand image for our science. To this end we need a coordinated voice for Canadian geoscience, which at the moment only CFES can provide. If there is a take-away message from this address it is that CFES needs the support, not just of GAC but of ALL Canadian geoscience associations.

ACKNOWLEDGEMENTS

It was a pleasure to serve as president of GAC and to have the opportunity to give this address. I extend sincere thanks to my colleagues on GAC council and the staff at GAC headquarters for their support and forbearance during my term as president. I leave knowing that GAC is in supremely capable hands.

Thanks are due to Sandra Barr for critical review of an initial draft of this address. The opinions expressed are my own, and do not represent the views of the GAC or other organizations in any way. In the same spirit, any errors or omissions are the sole fault of the author.

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