ISSUES IN CANADIAN GEOSCIENCE

Human Resources for Canadian Geoscience: Capacity Gaps and Skills Needs of the Next Decade

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INTRODUCTION

The world is changing rapidly: technology is accelerating our use of new tools for acquiring, integrating, processing, analyzing, and distributing geoscience data. Demands of users are increasing. Suppliers of geoscience knowledge have had to become lean and mean in response to economic pressures. Professional registration associations are grappling with minimum knowledge requirements and professional development credits. Demographics of geoscientists among larger geoscience employers show high amplitude swings, with under-supply a real possibility within a decade. Given this background, the Canadian Geoscience Council (CGC) held a one-day workshop on this theme in Vancouver in January 2000. It was attended by representatives of CGC member societies, federal and provincial geological surveys, other geoscience employers, the Committee of Chairs of Canadian Earth Science Departments, and the Canadian Council for Professional Geoscientists. While a few of those attending were self-employed, the rest were working for geotechnical and mining companies or associations, geological surveys, or universities. The meeting was facilitated by Chris Heath, a former oil company exploration executive and now an independent researcher who has undertaken a number of surveys of skills needs among geoscience employers in Britain, Canada, and elsewhere (Heath, this volume, p. 21-34; Heath, 1999, 2000a,b). This report will highlight key points that emerged, including recommendations for future action that have since been endorsed by CGC. The workshop was divided into employment areas, and this report is similarly structured.

The Mining Industry

Skills needs of Canadian-based mining companies were reviewed by Heath. Increased global competition for a declining number of top quality mineral deposits, unpredictable political and social attitudes, combined with the impact of recent low commodity prices and a recession, have traumatized the Canadian and international mining community. Companies have had to reinvent themselves in order to survive. Citing local opposition and greater opportunities elsewhere, many companies have moved out of Canada and now work in nations having large undeveloped reserves, and lower labor and operating costs. Restructuring has included a redefinition of each company's core businesses that resulted in the release of employees lacking skills needed in the firm's new business strategy. Based on a survey of 46 Canadian-based mining companies, Heath reaches several conclusions. Geoscience skills are regarded by employers as of equal importance as the totality of skills in computing, non-technical, and soft skills. An exception is the coal industry that tends to look for broader ranges of skills. Computer skills tend to be sought more by larger companies. In general, companies want geoscientists, rather than geologists or geophysicists, *etc.* The need for geophysical skills is increasingly important. Among the non-technical skills, the importance of an understanding of ethics and of effective contribution to teamwork were emphasized. Business awareness might also be higher among recruits. Poorly rated by employers were the needs for entrepreneurial flair, risk taking, and language ability.

After the ensuing discussion, the following views were expressed (although no rigorous attempt was made to achieve consensus).

- The recruiting trends for geoscientists follow the business trends in the mining sector, boom or bust. There seems to be very little demand for geologists for the next 5 years, but when depletion of reserves begins after this, opportunities will surface. However, an industry survey is needed for any estimate of capacity, or of gaps.
- Demand for environmental geoscientists in the mining sector is weak.
- The degree of B.Sc. is becoming regarded as a general degree and in the near future, geoscientists may require the degree of M.Sc. as a minimum for entry in the mining sector.
  There are some skills required by industry that are not taught in university and some that are taught that are not required (Heath, this volume, p. 21-34).
- There is a lack of mentoring of younger geoscientists by industry.
- There is poor communication between academia and industry.
- Industry wants youth plus experience, but this combination is difficult to achieve, except in rare co-operative education programs. Most skills that are lacking upon graduation are acquired

during work experience.
- Universities should teach core subjects (Heath, this volume, p. 21-34) and leave specialized training for work experience.
- The lack of earth science teaching in high schools is a problem when students reach university.
- The relevance of skills training in universities is illustrated by the importance of Quaternary geology and its role, for example, in the discovery of the diamond finds in Canada.
- The importance of economic geology training was cited, and expression of disappointment that it was not being taught as a core subject in many university programs.
- Universities have problems responding to industry needs because of, (a) economics (spending cuts in education), (b) retirees being replaced by sessional lecturers, (c) staff replacements hired by opportunity not planning, and (d) the system not allowing the hiring of people with the proper skill sets.
- University departments are often stuck with professors who are out-of-date, and universities cannot react quickly enough to changing requirements.
- Many jobs that geoscientists may have done in the past are now automated and completed on workstations.
- Comparison was made with the biological professions. In university, biology is often a route for a career path where students end up with biological skills but practice in a different field, while earth science is a destination, and most geoscientists end up in the geoscience job market.
- There is a dearth of information from industry regarding their skills requirements.
- Universities have not tracked where their graduates have gone.

The Oil and Gas Industry

Skills needs of oil companies were reviewed by Heath. Fluctuating oil prices, the demise of communism combined with the emergence of a global economy have created increased competition for the numerous investment opportunities now available to the hydrocarbon industry. These and other events have forced oil companies to restructure and develop new business strategies. While some skills became redundant the need for new skill mixes emerged. Employees lacking the technical and non-technical skills required in the new business environment were released. This has severely tightened the job market. Although their recruitment requirements are now modest, some companies have continued to recruit from a small pool of top quality graduates having the appropriate mix of technical and non-technical skills. To achieve this the search has become increasingly global, particularly for the larger international companies.

Recent surveys of major oil and service companies in Canada and elsewhere reveal some similarities with surveys of the mining industry. Broadly, companies rate geology and geophysics as important as computer and non-technical skills put together. However, the smaller companies tend to put a somewhat greater emphasis on computer and non-technical skills. Multidisciplinarity came out strongly, supporting the notion that "explorationists" are valued highly, whereas those with narrower skills may find suitable niches if they search diligently. Field training does not rank as highly as in the mining sector, but it is still very useful; biostratigraphy is rated more highly than general paleontology; geomorphology is rated lowly. Computer skills are rated highly (Heath, this volume, p. 21-34). Again in this sector, among non-technical skills, ethics and teamwork were highly rated; while language, international exposure, cultural sensitivity, risk taking and entrepreneurial flair were poorly rated. A Master's degree is becoming the minimum qualification for recruitment. Some business education is valued, particularly for project management, but also in planning and economics (reflecting the modern trend in exploration teams to include diverse skills in business and engineering as well as geoscience).

The Association of Professional Engineers, Geologists, and Geophysicists of Alberta has recently reviewed the demographics of geoscientists employed in the oil sector in Alberta, as part of a study of compliance undertaken by KPMG for a geoscience task force. Fifty percent of the sampled geoscientists were aged 40 to 50 years, 27% were 30-39; and 11% and 12%, respectively, were under 30 and over 50. The demographics of the geoscience population turn out to be very similar to those of the Canadian workforce, with the exception of the rather large spike in the 40-50 year category. This can be expected to lead to a supply problem within the next decade.

The following views were expressed during discussion.
- Within the Canadian oil and gas sector, there is a shift in the requirements of traditional skills as new finds are located offshore.
- Business skills are often developed at graduate school levels.
- Student are "over-taught" and, as a consequence, under achieve in learning.
- Core skill requirements have shifted.
- There is insufficient information on first employment of graduates in this sector.

The discussion gravitated toward "Public Awareness of Science," and here points were made that Earth sciences were not well understood and were not of interest to the public at large. Once again the comparison was made with biology and geography, where many students have taken these subjects in some depth during their career path to another final job market, while only those with a career destination in geoscience take geoscience in depth.

The Environmental and Geotechnical Industries

Grant Trump presented a survey of human resource requirements in the environmental industries in Canada. This includes geoscientists in a much broader spectrum of disciplinary expertise. About 100,000 people are employed in Canada as environmental practitioners with university degrees or college diplomas. More than 80% of the employers are small and medium size enterprises; municipal, provincial, and federal governments are also significant employers. Eighty percent of the companies surveyed are actively recruiting new environmental practitioners, and expectations are that there will be a continuing 5% growth rate in employment in this area. Eleven percent of the organizations surveyed reported hiring consultants because they could not find permanent employees with appropriate skills. Eighty percent of the organizations also indicated that their environmental practitioners

require training or skills upgrading, and the areas of concern were often non-technical/written communications, business/management skills, verbal communications, and computer skills. Several factors related to human resources were identified as having an impact on organizational growth. These included a lack of managerial skills among environmental practitioners, a lack of technical specialists with environmental skills, and difficulty recruiting experienced practitioners.

The following points were made during discussions:

- The environmental industry is still in its infancy, and 67% of the industry is in small businesses.
- The Prime Minister's Expert Panel on Skills has just released its report and concludes that there is not a shortage of technical skills but rather a shortage in the softer skills.
- The population is greying, and while young people are trained most, there is a lack of organized training for the middle aged.

Geological Surveys

Richard Grieve reported on the present situation with the federal and provincial surveys. Over the past 10 years, combined investment in geological surveying by both levels of government has decreased by about 50%. The accompanying loss of staff specialized in science and technology and the decline in capital investment have severely eroded science and technology (S&T) capacity (resources, skills, and infrastructure needed for program delivery). A significant proportion of scientific and technical staff will retire over the next 5-10 years, and there is a risk that their knowledge cannot be transferred to new staff if there is insufficient overlap for mentoring. Much of the Canadian land mass has not been adequately mapped geologically. Governments expect geological surveys to become more involved in areas that need geoscience input such as environmental protection, climate change, sustainable resource development, land use planning, and others. Also, advances in information technology have increased the potential for new geological survey products and information users. The combination of decreasing resources and increasing demands has caused an S&T capacity gap. Additional resources, effective partnerships, clearer definition of roles, decreased overlap in skill sets and tasks, and increased utilization of information technology can help bridge the gap.

Consider the demographic problem. Geological survey staff are getting older, and as many as 40% of scientific and technical staff may retire within the next 10 years. University enrolment statistics suggest that sufficient new recruits will be available to replace the retirees. However, it will be difficult to transfer knowledge to new personnel because recruitment can only start after present staff retire. At present, the lack of adequate field mapping training at the university level is profound: good young mappers are as rare as meteorites. Also, not all university geoscience programs pay sufficient attention to modern information technology; lack of knowledge of the principles of relational data bases and lack of attention to metadata on the part of government and other geologists have led to significant losses of information and time. Both field mapping and data management are crucial to government geological survey work. In some areas (*e.g.*, information technology), salary considerations and competition for new graduates can make recruitment difficult.

Dramatic advances in data management and communications technology over the past decade have transformed the ways in which geological surveys can manage, analyze, interpret, and visualize their data, information, and knowledge and disseminate their products. Geological surveys around the world are investing in initiatives to develop Internet access to their data, information and knowledge assets and integrate them into national and international geospatial data infrastructures. In each survey there are groups of people who are familiar with information technology who find creative ways to use it. Unfortunately, their effort to "spread the gospel" throughout the organization is in many cases hampered by one or more of the following factors: lack of resources; cultural differences within the organization; bad fit between information technology paradigm and scientific publishing paradigm; lack of agreement on standards, software and hardware selection; lack of understanding by management and the parent organization.

The skills that are currently under represented in the surveys' armoury to meet future program needs include: field mapping; multidisciplinary geology, geophysics and mineral deposits expertise; hydrogeology; climate change science, monitoring and modelling; environmental geoscience and geochemistry; natural hazards science; GIS and information management expertise; geography, sociology, and political science; application of Earth observation imagery to mapping; technology adaptation and transfer; and non-technical skills including communication, and understanding of organizational behaviour.

There are several strategies that can be, and are being, implemented to bridge the gaps. Infrastructure replacement should establish national and regional centres, in partnership with other stakeholders. Bridge funding is required to allow new recruitment before older staff retire. Redirect budgets to new, high-priority areas, especially in information technology. New and effective partnerships can solve many of the problems.

In discussion, the following points were raised:

- Five years is the learning time for a new graduate entering a geological survey;
- The Geological Survey of Canada (GSC) has started on the three Rs of Recruitment, Retention and Rejuvenation;
- There is a greying of the GSC workforce, and government has to determine and effect strategies for reducing this problem;
- There is new targeted money available for co-operative mapping programs;
- There must be a rationalization of skill sets required by federal government and provinces/territories;
- The GSC must do less academic survey work;
- It must be decided exactly what the GSC should be doing and how to do it in this changing world, not how to do it and then what to do;
- The Earth Sciences Sector of Natural Resources Canada (including the GSC) is forming new partnerships; there is a continuation of learning by staff, more flexible innovation, strategic hiring; and a change of cultural identities both in the GSC and the provincial surveys;
- The GSC should be doing things that

provinces cannot do; and developing geoscience policies;
- During the cold war, minerals and energy were of strategic importance, but there is not the same emphasis now;
- There is a dearth of young mappers (note that the United States Geological Survey pumps funding into student mapping theses);
- integration of activities of provincial-federal surveys is really important.

Academia

On behalf of the Council of Chairs of Canadian Earth Science Departments (CCCESD), Don Lawton summarized enrolments, diversity of course offerings, graduations, and staff.

Enrolment for bachelor students has reflected the economic cycles of the resource industries, reaching peaks in the mid-1980s and mid-1990s and now starting to climb again, with the present number of registrations at above 4000 students. Many B.Sc.s now take 4-6 years to complete because other things that take students' time. Registrations for M.Sc. and Ph.D. have remained fairly steady during the period from 1980 to 2000, with Masters' degree registrations at about 500. The community should track where graduates are first employed. Enrolment in earth science courses by non-geoscientists was generally flat from 1980 to 1990, at 10,000 students annually. From about 1990 onward, enrolment of non-geoscientists has increased substantially to around 20,000 students.

In 1985 there were about 1250 B.Sc. graduates in earth sciences per year. This number dropped to about 400 in the early 1990s and has risen to about 800 in 2000. Combined M.Sc. and Ph.D. graduations remained steady during these years at a little less than 200 per year.

Faculty numbers in earth sciences have fluctuated around the 500 level during 1980-2000. The number of postdoctoral fellows peaked in the mid 1990s and has dropped since then.

It was concluded that there probably is not a capacity gap in academia. There might be a mismatch between faculty expertise and employers' views of the university training of geoscience recruits. Differences may be attributable to two causes. First, the disciplinary spectrum of university faculty, by virtue of the natures of recruitment, promotion, and tenure, may not entirely reflect current status of the science. Second, there may be a difference of view as to what the prior aims of a university education are (*e.g.*, "how the Earth works" *versus* "how to explore it"). The earth science departments collectively have little control over their destinies, since higher education comes under provincial jurisdiction. Further, planning ahead is made difficult by the somewhat unpredictable nature of the cyclical demand for geoscientists that is driven by outside economic forces.

CONCLUSIONS AND RECOMMENDATIONS

The obvious conclusion of the workshop, transparent in this brief summary, is that we know far too little about this issue. Surveys of skills needs are partial, with some employment sectors not covered. Capacity has not been addressed in some sectors, to our knowledge, and in none, except the geological surveys, has there been any overt attempt to analyze the situation, define the problem and propose strategies for solution.

Capacity, long-term planning for earth sciences, and enhanced public awareness of geoscience were the subjects of the main recommendations agree upon by participants at the workshop. These recommendations have been debated at the Canadian Geoscience Council, and the following represent the position of CGC on these matters.

1. Before we can begin to address the issue of capacity gaps in earth sciences in Canada, we must first solve the information gap. There is probably a serious age-related gap, most apparent in the geological surveys and oil sectors, that will manifest itself within the next decade. However, in general, there is a paucity of information on both the supply and demand sides of the capacity and skills requirement equations. **A comprehensive survey of the supply/demand capacity gaps issue should be undertaken.** It was agreed that the CGC census of Canadian geoscientists will be a start.

2. **To facilitate understanding of the capacity issue, there must be better communications and collaboration between government, industry, and academia dealing with the capacity gaps issue.**

3. **A comprehensive strategic plan for the earth sciences across Canada should be developed.**

4. **There must be new initiatives by the profession in the area of public awareness of science and continued vigilance to ensure that earth sciences are taught in schools across Canada.**

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