Geoscience Canada

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N. Eyles

Volume 24, Number 2, June 1997

URI: https://id.erudit.org/iderudit/geocan24_2icg01

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Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

Explore this journal

Cite this article

Eyles, N. (1997). Geology on Campus: Crisis or Opportunity? *Geoscience Canada*, *24*(2), 108–111.

Issues in Canadian Geoscience

Geology on Campus: Crisis or Opportunity?

N. Eyles
Environmental Earth Sciences
University of Toronto at Scarborough
1265 Military Trail
Scarborough, Ontario M1C 1A4
E-mail: eyles@scar.utoronto.ca

INTRODUCTION

Geology, to quote Eldridge Moores, 1996 President of the Geological Society of America, "is in a crisis" (Moores, 1997). A similar conclusion was reached by the Barnes Report prepared for the Canadian Geoscience Council (Barnes *et al.*, 1995). Indeed, the discipline of geology, currently has only a tenuous hold on many North American university campuses and is clearly unwell. The underlying reasons for this sudden loss of tenure are many and complex but the symptoms (wastage, loss of vision) are clearly evident in terms of sporadic undergraduate interest and waning support from university administrators.

What are the options? An assisted death perhaps, or amputation of the more vital parts and rebuilding as an integral part of another more vital academic organism? What follows is an invited contribution describing recent experience at the Scarborough Campus of the University of Toronto where the former departments of geology and geography merged in 1993 to form a larger environmental science department supported by the appropriate resources and new faculty appointments. This evolution mirrors the international changes that these two disciplines are undergoing in response to broader societal concerns and economic trends and may be of interest to a wider audience.

CURRENT TRENDS ON CAMPUS

Geology has a long and honorable record as an academic discipline. Geologists have played a fundamental role in Canadian society and the nation's economic (and thus political) development. Currently, as a university discipline, however, Geology is struggling in the face of severe problems that, in combination, are likely to prove fatal to many Geology departments. First, has been the potent interest in environmental issues in society as a whole and especifically in high schools, and its translation into undergraduates seeking programs with greater breadth than normally offered by traditional Geology departments. Second, has been decreased traditional (oil and mining company) employment opportunities. Third, has been the 'greening' of geology itself involving the application of geological skills to broad ranging environmental problems (e.g., remediation, ecosystem-based planning) within multidisciplinary teams. As a result, there has been an irrevocable change in employer needs and job markets coincident with a dramatic decline in demand for geologists in the resource-based industries.

Collectively, the net result of the above mentioned changes has been a loss of interest in the discipline on many campuses, the erosion of traditional discipline boundaries and the emergence of Environmental Science as a powerful integrative discipline encompassing aspects of Geology (aka: Environmental Geology, Earth Science, Geoscience) together with Life Science and appropriate components drawn from the Social Sciences, including most appropriately, environmental law, assessment and planning. After all, the concern with the environment is based fundamentally on self-preservation and fears for our own habitat and future well being.

As a result of these and other local factors, there are now too many geology departments in North America trying to attract a steadily shrinking number of prospective students. Times are such that Eldridge Moores' 1996 Presidential Address to the Geological Society of America, originally intended as a "talk on pure science," instead focussed on a "call for action" in the face of an "ongoing crisis in geology" and the increasing "irrelevancy" of geology in the eyes of many University and college administrators. A severe reduction in the number of geology departments is inevitable; indeed, some have gone already.

The question being faced by many universities is how to reposition geology as a viable discipline within the university setting. Inevitably, such discussion commonly focusses on the merging of geology with geography departments into newly created schools or departments of environmental science or like-named units.

THE RISE OF ENVIRONMENTAL SCIENCE

The emergence of environmental science, in which planet Earth is seen as an integrated dynamic system instead of a collection of isolated components, is the beginning of the end for the continued existence of separate geo-disciplines

(geography, geology, geophysics) on many North American campuses (not all). The process of integration will lead, ultimately, to the creation of coherent teaching and research units all under one roof (intellectual "power shopping"). The needs of the environmental job market with its demand for scientific breadth, technological expertise and flexibility, is the principal stimulus and today's prospective graduate needs "one stop shopping" if his or her degree is to be a passport to a job.

The environmental sector is fast becoming a major Canadian employer of university and college graduates. In 1994, in the province of Ontario alone, the sector employed more than 38,000 people, working for 2200 companies, and generated $3.5 billion of annual revenue for the province, much of which comes from the export of environmental expertise and technologies outside Canada (Canadian Environmental Directory, 1994-1995). For comparison, in 1995 the provincial mining industry in Ontario employed directly and indirectly, about 106,000 people and generated $1.5 billion in government revenues (Canadian Mining Association, 1997). Thus, the environmental sector has grown very quickly to match that of the resource sector. Significantly, much of the growth of the environmental sector has been created by major expenditures on pollution prevention and environmental protection by the resource sector (see new journals such as *Mining Environmental Management*). Mining companies have spent well over $1 billion on environmental management since 1990 in Ontario alone. The same trend is evident in the United States. According to the annual survey carried out by the American Association of Petroleum Geologists, 55% of all 1994 geology graduates found employment in the environmental sector, which was identified as presenting "the best employment opportunities" (*Explorer* magazine, November 1994). That same survey revealed that out of 278 university geology departments in North America that responded to a questionnaire (about 38% of the total number of departments) few had more than 100 students enrolled in their program. Most face further erosion of their undergraduate enrollment and decreasing support from university administrations.

NEW INITIATIVES AT SCARBOROUGH CAMPUS

The University of Toronto at Scarborough has more than 5000 full-time and part-time undergraduate students (1996-1997) drawn predominantly from fast-growing suburban communities that make up the so-called "Area code 905" municipalities. The background of these students is extraordinarily broad. Many are "new" Canadians drawn from around the world. In 1993, Scarborough faculty within the disciplines of geology and geography mutually agreed to merge and form the department of environmental science (ES). This new discipline grouping was not imposed by the administration but was a collective decision. A great advantage was that the existing geology program was already environmentally focussed under the leadership of John Westgate and had a reputation of placing approximately a dozen high-quality graduates each year with environmental consulting companies and government agencies. The growing disenchantment of the physical geographers with their existing position in the social sciences (because of a preponderance of "human geography" colleagues), made a merger increasingly attractive. In fact, both groups shared a long history of joint graduate research and teaching interests in Earth history, surface processes, water and contamination. Existing faculty strengths of the new group lay in hydrogeology (Ken Howard), hydrology (Tony Price), glacial geology and urban geology (Nick Eyles), climate and ocean dynamics (Bill Gough), Quaternary paleoecology (Nancy Williams), soil erosion (Rorke Bryan), coastal sedimentology (Brian Greenwood), and the Quaternary (John Westgate). Administrative confidence in the program has since been translated into several faculty appointments in the fields of soil contamination (Kim Bolton) and surface water contamination and biology (Roberta Fulthorpe), and technical support. These permanent faculty are supported by adjunct professors such as Alex Mohajer (environmental geophysics and seismology), Adrian Scheidegger (neotectonics), sessional lecturers such as Rick Pybus (drilling technology) and cross-appointments with faculty in life sciences with interests in freshwater ecology (Dudley Williams, Czecia Nalewajko). Scarborough faculty members with interests in environmental chemistry, environmental law, environmental assessment, and urban forestry add futher breadth to the program, which is evolving rapidly. The program is able to draw on the very wide range of expertise available locally in industry, government and other educational institutions.

The success of any one academic program cannot be judged by enrolment numbers alone but they do at least provide an indication of how the undergraduate student body perceives the new initiative in providing a useful pathway to a career. The ES program at Scarborough currently has about 60 students specializing in such areas as coastal sedimentation, hydrogeology, Quaternary geology, urban geology, and others; about 80 majors and a first year enrolment of 150. Some 25 specialists graduate each year. Undergraduate courses stress real world applications and needs. Emphasis is given to fieldwork and includes two-week field camps to such places as Arizona, the Canadian Rockies, and Costa Rica where the students gain a half-course credit and invaluable field experience. A successful co-op program, in which students enjoy work terms outside the university with employers such as environmental consulting companies, was initiated in 1994 and is supported by a half-time co-ordinator. The co-op program currently has 15 students (30 is planned) and was highlighted in the 1997 *Macleans* "Guide to Canadian Universities." There are excellent links with the International Development Studies (IDS) co-op program at Scarborough; IDS students select a variety of courses within ES to help them prepare to face issues pertaining to the assessment and management of natural resources and the problems of environmental degradation in the developing world. In turn, ES courses are structured to reflect the international nature of environmental science.

There are about 20 ES M.Sc and Ph.D graduate students at Scarborough working on a wide range of interdisciplinary topics. The introduction of an M.Sc program, emphasizing the geological, hydrogeological and biological characterization of contaminated environments, and their remediation and management, is under discussion. Field research is being carried out in places such as Namibia, Uganda, Kenya, Mexico, Arctic Norway, Denmark, Antarctica, Australia and New Zealand. Local projects being conducted throughout the Greater Toronto Area include regional geological and hydrogeological studies, the development of geophysical techniques for high-resolution subsurface work, bio-monitoring of ground and surface waters, pesticide migration through the subsurface, and the application of paleo-ecological techniques for reconstructing recent climate change. Much local work is being conducted jointly with,

and is funded by, area munipalities and several Ontario Ministries (see Eyles, 1997, for examples).

The ES program at Scarborough is rooted in so-called "baseline studies" that focus on chemistry, calculus, dynamics of classical systems, physics and mathematics. A core first-year course on planet Earth is taught jointly by a geologist and a geographer and emphasizes hands-on teaching during the course of local field work in a variety of terrains and terranes (the Canadian Shield is just to the north). Field work is done early in the course to expose students to the "real world" and to establish a strong rapport between student and instructors. Subsequent years allow, but do not enforce, diversification into streams such as environmental earth science, environmental systems, conservation biology and environmental chemistry. With the emergence of environmental science, the discipline of geology has not been buried: far from it. Introductory "rocks for jocks" courses have long been popular at Scarborough, such as the geological hazards course that attracts up to 500 students annually, but enrolments in other courses that hitherto were directed at a narrow geological audience have more than doubled in the last two years with the creation of the environmental earth science stream.

OPPORTUNITIES FROM PROBLEMS?

The biggest problem we have faced as geologists working in the new ES group has been learning how to deliver laboratory practicals to much larger groups of students. To take one example, enrolments in second-year sedimentology and stratigraphy have gone from approximately 25 to 55, which requires new approaches to field work and laboratory training. Formerly separate courses such as mineralogy and petrology, have now been combined emphasizing the origin and properties of a wider range of "Earth materials." Engineering and structural behavior of earth materials is also handled in a new integrated course. As a result of these intiatives, the discipline of geology is now highly visible as a key core discipline on campus, whereas formerly, existing as a separate "stand alone" discipline, it never enjoyed this much interest. Furthermore, geology courses are now mandatory for undergraduates enrolled in life sciences, chemistry and physics who are now routinely exposed to a dynamic Earth history and the wide range of geological techniques with which this record is deciphered by geologists. Some students enter the ES program in the second year as refugees from other programs, seeking a broader scientific base from which to pursue employment opportunities. The Scarborough route, together with parallel developments elsewhere in North America, does provide a working model for geological teaching and research into the next century. Naturally, it is not the only model and future directions will vary from institution to institution. Some schools will undoubtedly manage to maintain strong geology departments but many will not. Within broadly based environmentally focussed programs, founded on large enrolments, there is ample opportunity for more specialist, resource-based geology courses to survive. Given the background of a burgeoning growth in global population and the probability of major resource shortages and environmental catastrophes, such environmentally based programs can only prosper. The need for integrated approaches to local and global environmental problems has recently been emphasized both by the National Research Council in the United States and by the Canadian Global Change Program. Today's environmental scientist needs to be part geologist, biologist, chemist, physicist, computer technician and increasingly, part planner and lawyer.

PROFESSIONAL REGISTRATION OF "GEOSCIENTISTS": AIMING AT A MOVING TARGET?

The Scarborough model has demonstrated that geology can prosper in an environmental science department. We still do the same teaching (albeit to a different and larger audience) and we still conduct geological research and graduate student training. To some extent what we call ourselves is irrelevant; except in one very important respect. Ontario now has a Joint Task force (JTF) on geoscientists established by the Association of Geoscientists of Ontario (AGO) and the Professional Engineers of Ontario (PEO). A recommendation from the JTF that geoscientists have a licensing body in parallel with that of the engineering profession has been agreed to by PEO and now requires modification of the relevant Government of Ontario Acts. Key areas of ongoing discussion are academic degree course contents that a trainee professional geoscientist should fulfill, and the type and duration of postgraduate experience required. Professional registration is essential in an increasingly litigious world and industry has the right to expect that certain standards are met.

Most debate so far has been based on the premise that the only way of delivering a geoscience eduation is *via* departments of geology and geophysics; accreditation of only such departments is advocated. This is a dated viewpoint promoted largely by those outside academia. Indeed, we face the very disturbing prospect in which future professional registration criteria may be dictated by professionals unfamiliar with current trends in science, society and the resulting rapid pace of change in universities. This would be at strong variance with the evolving trends on campus in which "geoscience" is increasingly being delivered by environmental science departments, as noted above. As "classical" geology and geophysics departments decrease in numbers, funneling "professionals" through a very specific four-year geoscience undergraduate program will likely become unworkable. Universities must remain places of innovation and cross-fertilization in research; programs must be sufficiently flexible to facilitate their immediate translation into undergraduate and graduate teaching. Major postwar innovations in such areas as geochemistry, plate tectonics and hydrogeology were initiated in universities before their wider acceptance and use by industry.

At last count, almost all of the 13 Geology Departments in Ontario were currently in discussion with geography or other departments regarding mergers to form larger, environmentally focussed groupings. Some mergers have already been completed. There is increasing recognition of the need to move away from the teaching of specific topical courses to more modular courses dealing with surface systems, deep earth systems and plate tectonics which act as umbrellas under which specific "core" components (*e.g.*, mineralogy, petrology, structure) can be taught. These concerns are nationwide and subject to ongoing debate in many provinces; the Canadian Council of Professional Geoscientists (CCPG) is currently in the process of working toward a national standardized syllabus. Not too standardized one hopes; what sells in southern Ontario, for example, won't necessarily be academically attractive to prospective students in Newfoundland or Alberta, which are provinces with very different experiences and expectations of

what "geoscience" contributes to the provincial economy. There has to be room for local specialization and interests within the broader education of undergraduates; universities would be failing in their duty if education were seen merely as "training" for a particular profession.

LOCAL NEEDS AND "SPECIALIZED MISSIONS"

A key reason why environmental science is successful at Scarborough is that the campus is located in one of Canada's largest urban areas (16% of the national population) where the interaction between the natural environment and expansive urban growth are daily topics in the media and the subject of much public debate and activity in schools. Urban environmental problems of the Toronto region are the bread and butter of many local consulting companies and a good source of full-time and co-op employment. The environmental degradation associated with global urbanization increasingly will be seen as the most immediate environmental problem facing us in the 21st century; many Scarborough students are familiar with such global environmental problems at first hand. Many have found positions with North American consulting companies working in Asia, and elsewhere, where the ability to speak local languages is an asset. The Scarborough ES program provides an example of the "specialized mission" discussed by Barnes *et al.* (1995) in the context of future goals for Ontario's universities.

As a final comment, it seems ironic perhaps, that a focus of much research in the last 10 years has been extinctions in the geologic record. As a discipline, geology is facing its own extinction event but, as we know from the past, the future is one of diversification and the growth of new life forms. Geology will undoubtedly disappear from many universities (not all I hasten to add) but basic geological skills in understanding the history and structure of planet Earth are increasingly seen as a core component in the training of environmental scientists and a fundamental part of a young persons education. There are great opportunities here. We may no longer call ourselves geologists but the value of what we do is now being amplified and transmitted to a much larger audience who, ultimately, pay the bills. The environmental sector, like any other, is subject to the ups and downs of cyclic market forces but environmental concerns are here to stay on campus, as they are in the world at large.

ACKNOWLEDGMENTS

I thank John Westgate, Ken Howard, and Carolyn Eyles for reading earlier drafts of the manuscript and many other colleagues and students for discussions; additional comments by Roger Macqueen are much appreciated. It is stressed that the views contained here relate to Scarborough Campus of the University of Toronto only, are intended to stimulate discussion, and are not intended to be seen as prescriptive.

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