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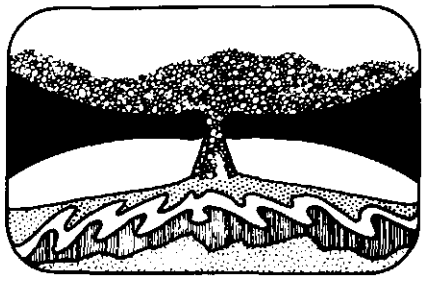
# Features



## Geological Education

### Undergraduate Geology - The Co-operative Way

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**Summary**
Advances in geology in the last decade involving radical new concepts, methods of surveys, large scale projects, and new sophisticated techniques have been difficult to assimilate into the regular undergraduate geology programmes. Increased numbers of geology majors, together with the economic turndown, reduced exploration and field work, have resulted in applied experience now being difficult to secure for many geology students. In order to provide more relevant instruction and to introduce more and varied applied experience to undergraduates, a unique cooperative programme in geology has been established at the University of Waterloo. With the programme streamlined, and the first co-op graduates due in the Spring of 1977, a discussion of this programme and its philosophy is now appropriate. Whereas it may not be the only way to respond to the new challenges and demands in geology, it certainly is a radical departure from more traditional programmes.

**Introduction**
The discipline and teaching of geology have, in general, been conservative. From its pre-eminence among the sciences a century ago when theories ranging from the origin of the earth to the nature of ancient giant reptiles challenged the imagination and philosophies of both scientists and laymen, geology has become constipated through its own descriptive nature. Advances in the last decade, involving the plate tectonic trinity and the increasing use of analytical and computation techniques, have rightly led to talk of the "revolution" in geology. After a century in the scientific wilderness, geologists have welcomed this spirit of rejuvenation; at last their messiah has come.

While the nature of the subject has thus changed dramatically, it can be questioned that university undergraduate programmes have adequately responded in terms of curricula. Examination of university calendars is not necessarily instructive since the brief course descriptions scarcely reveal the true scope and depth of the content. Some repackaging may have been ventured: some years ago our department added a fourth-year course called Crustal Evolution, a title that appeared too presumptuous at the time but now seems appropriate. Some courses may have been retitled: Invertebrate Paleontology to Paleobiology. Others may simply have had the course content progressively updated. Thus, while universities may have responded in aspects of course content, it is debateable that they have been able to respond to changing style, techniques, and employment patterns of geology.

In terms of style, we have witnessed marked increases in scale of geological operations: aircraft-assisted mapping; regional geochemical and airborne geophysical surveys; immense civil engineering and environmental projects such as James Bay, Arctic pipelines, urban waste and water problems; and broad integrated field projects by the Department of Energy, Mines and Resources. Thus, opportunities for students to participate in small summer mapping parties have both diminished and become somewhat less relevant and instructive.

Increased use of analytical and computation equipment has not been easy to assimilate by students. Geology departments have a variable proportion of such equipment in their own labs, but by no means the full array, and much of it may be restricted to graduate level instruction. Undergraduates who come into contact with, or operate such tools in their summer work commonly lack a basic understanding of the equipment itself or its role and limitations in solving geological problems. Frequently, they are not privy to the assessment and interpretation of the data produced.

These new developments have resulted in summer field work playing less of a key role in the life of most practising geologists, especially those in the petroleum industry. Companies and surveys have consequently provided fewer opportunities for summer work and this work becomes less of a true reflection of what will concern the student after graduation. A further problem related to employment is that with the increase in the number of Canadian geology departments, and consequently undergraduate students, even the better students may fail to find

relevant summer work or be restricted to repeating the dominant employment sector (e.g., petroleum, mining) of his geographic region. The economic recession has generally played havoc with the summer employment modes that were more stable and successful in past decades.

**A Solution—Co-operative Geology**

These current problems have been felt more acutely in other disciplines where appropriate summer work was restricted or unavailable. A solution lies in co-operative undergraduate programmes - those where the students alternate terms of academic and extra-University work experience. The external work is formally arranged and partially structured; its injection into the programme necessitates lengthening the total programme from four to five years. Such work is arranged with industry, consulting companies, municipal, provincial and federal government agencies. These co-operative programmes have been instituted in Europe, the U. S. and elsewhere with success. In Canada, it has been pioneered by the University of Waterloo for over a decade and in more recent years it has been attempted on a more limited scale, for example, by Memorial University and the Université de Québec at Sherbrooke.

At Waterloo, 45 per cent of the 13,500 undergraduate students are in some form of co-operative programme (e.g., in Earth Sciences, Physics, Chemistry, the Mathematics Faculty, Architecture, Geography, Planning, Economics, Political Science, Psychology, Recreation, and all of the Engineering Faculty). Their work terms are arranged through a separate department (Placement and Coordination) comprising 20 specialists who also act as liaison between students away from campus and their departments. They arrange work with over 1200 companies across Canada as well as a few abroad.

The decision to develop a co-operative programme at the University of Waterloo in addition to the regular programme, was taken in 1972. The first "wave" of students in the programme is just entering its final year to graduate next Spring. The three years that they have taken to complete the academic Years 2 and 3 have included five four-month work terms. We are now in a position to begin to assess the merits of the programme.

The co-op programme starts after the students have taken a common, regular first year. No official work term is planned after their first year since their specialist knowledge is still limited. However, this year about half of those 50 or so planning to enter geology were placed in geological jobs. The second and third academic years are fully semesterized and the courses and work terms taken are arranged as shown in Table I. Note that students return for course work in the summer of their second calendar year and still retain two summers for field work at the end of their second and third academic years. The eight month, double work term at the end of their third academic year may be taken with a single agency over the whole period which allows for work abroad, and also allows excellent opportunities for gathering data for their B.Sc. thesis of their final year. After this eight-month work spell, the students return to campus for two campus terms, that is a "regular" final academic year.

F – Fall W – Winter S – Spring Wk Tm – Work Term

| 1976-7 | | | 1977-8 | | | 1978-9 | | | 1979-80 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F | W | S | F | W | S | F | W | S | F | W | S |
| 2A | Wk Tm 1 | 2B | Wk Tm 2 | 3A | Wk Tm 3 | 3B | Wk Tm 4 | Wk Tm 5 | 4A | 4B | |

**Table I**

*University of Waterloo co-operative programme. The normal progress of a student entering Co-operative Earth Sciences in his second academic year in the Fall of 1976 is shown in the table above. Completion of this course requires a total of 23½ course-credits (including year one). Of these at least 19 must be from courses in the Faculties of Science and Mathematics, including all required courses, and two must be from courses in the Faculty of Arts. In addition, attendance is required on two third year field trips.*

**Advantages**

Few would deny that applied on-site experience is an invaluable complement to academic instruction. The co-op system provides by virtually ensuring the student of five, and sometimes six, formal work terms taken at all seasons of the year, that both field and lab experience are assured. Further, by offering companies student employment at times other than the summer, it becomes possible for most students to have diversified work experience: mining, petroleum, consulting, field mapping, geophysical-geochemical surveys, etc. The types of work undertaken by the students in the winter term (half way through their second academic year) and those in the summer term (following the end of their third year) are summarized in Table II. So far, all our students have been placed in geological jobs in all their work terms.

Another feature of the program is that from the five work terms, each student must prepare four formal work reports, detailing the work or a related project that was undertaken. Many companies provide specific projects and the reports commonly develop into mini-theses. Such report writing, which has to be approved by a faculty member, provides excellent experience in this aspect.

For the students, a further important facet is that by extending the total length of the programme, by more regular alternation of work and academic terms, and by virtual assurance of employment in these terms, they are more able to finance their undergraduate education. Thus, students receive much more applied experience, of a diversified nature in type and geographic area than just summer work, come into a closer contact with the work of practising geologists, develop greater report writing skills, and more readily finance their education. Faculty members have added information of assessment from their work terms and also find that this experience improves performance in later academic courses.

**Disadvantages**

On the negative side, it must be noted that not all students desire to take an extra year in university and some do not have to contend with serious financial concerns. Most of the disadvantages fall to the faculty, since it is necessary to offer courses for second year students

in the summer. With a large department, this is not necessarily a major problem. However, while we still retain the regular programme, some repetition of courses is necessary since the regular and co-op students become out-of-phase midway through the second year.

Added costs are incurred in requiring a geology coordinator for the programme. With such a large committment by Waterloo to this type of programme, a streamlined operation with the involvement of over 1200 companies has evolved. Further, no single department can effectively introduce such a programme in isolation. For example, science, math and arts electives must be available for students when they return to campus for the summer term. Few universities have such a selection so it is difficult to predict that this unique programme at Waterloo will easily be adopted by other geology departments without greater co-op commitments by their own universities.

**The Employers Viewpoint**

The growth and success of all the co-op programmes at Waterloo has reflected the general satisfaction with the system by the various employers. They are able to employ partially-trained personnel for short-term projects. They are now able to provide assistants to their professional staff in the fall and winter as well as in the summer terms. Copies of the work reports are provided to the employer. For those with an eye to hiring future geologists, a better opportunity to preview students capabilities is provided - a feature also to the benefit of the student.

Initially, some companies need to make some adjustments to add this type of assistant into their programmes. Companies are expected to provide a relevant work experience for the students reflecting their general academic maturity. With the possibility of short-term changes in projects, students do not necessarily receive challenging work for their full work terms - perhaps a better reflection of the real work anyway.

**The Future**

From the enthusiasm and quality of the students presently in the programme, the Waterloo faculty are convinced that this unique programme in undergraduate geology is destined to produce a more mature, experienced and professional future geologist than the traditional regular programme. Adjustments in course content, work term employment, etc., are to be expected as the programme evolves and feedback is obtained from the employers and the students. At present, one third of our current undergraduate students still opts for the regular programme. In the future, should this number decline it is conceivable that only the co-op programme would be offered, as in the Engineering Faculty which is the largest in Canada.

In summary, we feel that this unique programme in undergraduate geology provides a remarkable mix of the normal academic content with a high proportion of varied work experience in applied geology. Through the injection of this work experience, students develop a greater awareness and maturity of the applied discipline of geology, they come into contact with the many techniques and types of equipment not available in universities, and they work with practising geologists not only in the field but also in the lab and office. Industry often levels the criticism at universities that their work, teachings, and concepts are not always relevant to the "real world". While we still provide this academic side, the co-op programme allows students to learn current thinking, practice and techniques of those who apply the discipline.

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**Table II**

*Type and location of work term employment for co-operative for the winter term (Year 2 students) and summer term (Year 3 students).*

| | Percentage of Students | | | Percentage of Students | |
|---|---|---|---|---|---|
| **Type of Employment** | **Winter 2A Term** | **Summer 3B Term** | **Location of Employment** | **Winter 2A Term** | **Summer 3B Term** |
| **Engineering Geology** | 5 | 5 | | | |
| **Environmental Geology** | 10 | 10 | **Maritimes** | 20 | 5 |
| **Field Mapping** | — | 20 | **Quebec** | 15 | 20 |
| **Geophysics** | 50 | 20 | **Ontario** | 40 | 45 |
| **Geochemistry** | — | 10 | **Prairie Provinces** | 15 | 20 |
| **Hydrogeology** | 10 | 10 | **B.C.** | 5 | 5 |
| **Mining Geology** | 15 | 15 | **Yukon & N.W. Terr.** | 5 | 5 |
| **Petroleum Geology** | 10 | 10 | | | |