VOCATIONAL AND TECHNICAL EDUCATION IN GEOSCIENCE WITH EMPHASIS ON GEOCHEMICAL EXPLORATION SKILLS

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ABSTRACT

Universities and colleges in three countries, Australia, Canada, and the United States, recognized the need to establish and reorganize geoscience programs at the vocational and technical 2-year levels. To accomplish these goals, a cooperative study with industry in one state or province from each country was initiated. These include: (1) Tasmania, Australia; (2) British Columbia, Canada; and (3) Alaska, United States. Over 100 mineral-industry organizations cooperated in the study by providing information regarding their specific training needs for support personnel. The data gathered have been used to identify training areas for semiskilled, skilled, and technical personnel in geochemical mineral exploration, including, but not limited to, geological skills, geochemical skills, environmental skills, and computer skills. With the areas of major educational need defined for geochemical exploration, an educational field-skills model has been developed for the three levels of training. The depth of each level of education and the training objectives for the work force at each level will be discussed.

INTRODUCTION

The objective of this work was to develop a diversified geoscience educational model at the 2-year technical, vocational, and continuing-education level that provides the source from which any nation can draw the proper educational tools to create a new geoscience program, modernize an existing program, or strengthen a weak program.

The international need for a study of this type was recognized as early as 1980, following numerous contacts from domestic and foreign geoscience educators regarding the structure and success of training within the University of Alaska Fairbanks Mining Extension Program, located in Fairbanks, Alaska, USA. Contacts, correspondence, and visits included, but were not limited to, educators from Australia, Brazil, Canada, Mozambique, and the conterminous United States. The need was magnified between 1985 and 1989 at the University of Alaska Fairbanks when an attempt to initiate and develop a 2-year geoscience vocational/technology program leading to an Associate of Science degree failed.

As a result of these experiences, it was recognized that many educational institutions had a need for information that would guide them in the development of new geoscience programs or the advancement and reformation of existing units.

Between 1989 and 1992, meetings with educators and members of the mining industry in three countries, Australia, Canada, and the United States, were initiated to determine the basic elements required of a strong posthigh school, 2-year geoscience vocational/technology program.

The study was conducted in appropriate states, provinces, and territories within the three countries. These included the Australian Capital Territory (ACT) and the state of Tasmania in Australia, the province of British Columbia in Canada, and the state of Alaska in the United States. The selection of these study areas was based on their geology, mineral industry, and educational institutions.

BASIC NEEDS ANALYSIS

Three basic areas of need were identified: (1) geoscience education for elementary and secondary school teachers, (2) geoscience education for the general public, and (3) vocational and technical education for the mineral industry.

Geoscience Education for Elementary and Secondary School Teachers

Teacher education was identified as the development of a 60-hour course of study designed specifically to prepare elementary and secondary school teachers to teach geoscience at their respective grade levels. This course was carefully combined with past experiences regarding teacher training techniques.

Geoscience Education for the General Public

Geoscience education for the general public was identified as the selection of a series of geoscience public service courses that were most appealing to the general public, that offered a potential avenue to the development of one or more cottage industries, and that simultaneously provided an understanding of geology and the mineral industry.

Vocational and Technical Education for the Mineral Industry

Geoscience education for the mineral industry is recognized as complex. The basic categories include geology, mineral exploration, mining, milling, smelting, refining, and environmental factors. Through this study it became clear that within these major groups exist scores of semiskilled, skilled, and geotechnical employment positions.

In an effort to identify the individual types of positions available, information was gathered through literary sources, professional meetings, and meetings with individual representatives of the mineral industry. The result of these fact-finding meetings was the development of a comprehensive questionnaire that was subsequently distributed to the appropriate organizations within the mineral industry. The corresponding data were used to determine the employment potential, to determine the relative value of each desired skill in a given program, and as guidance for an educational institution in developing a geoscience curriculum.

EDUCATIONAL LEVELS

Educational levels identified by representatives of the mineral industry and geoscience educators at the vocational technical level for field-related programs include, in the order of increasing complexity, semi-skilled, skilled, and technician levels. One common thread linked the educational levels. Representatives of industry stressed the need for a strong applied approach to courses over theoretical applications. Contributing members suggested that the content of the associated course or courses be divided into approximately three equal parts consisting of one-third theory, one-third laboratory practical, and one-third realistic field application. It was further suggested that, where possible, educational institutions organize their field work in cooperation with an exploration or mining company in their particular areas of geologic interest, thereby providing realistic field education for the students and beneficial information for the company. Discussions regarding the potential rewards to the participating geoscience department spanned the spectrum from financial gain to image development to placement of students in the workforce.

Semiskilled

Semiskilled suggests a basic understanding of equipment use and field methods required in a particular field-oriented program. This particular level of training is satisfied by a minimum of one introductory course that requires no prerequisite. Semiskilled field personnel should be able to work comfortably and grasp concepts easily on a supervised field project.

Skilled

Skilled field personnel were identified as those who have successfully completed 1 year of certified education that has provided an indepth understanding of equipment use and field methods associated with a particular field-oriented program. During discussions, mineral-industry representatives indicated that skilled field personnel should be able to understand concepts and work comfortably on a supervised field project.

Field Technicians

Field Technicians were identified as those who have successfully completed 2 years of geoscience education and have satisfied the requirements of an associate of science or technologist's diploma. They should have a broad understanding of the geosciences and a thorough understanding of the equipment and field methods used in one or more field-oriented programs.

It was also indicated that a technical level employee should be able, initially, to understand and perform field work with minimal supervision. In addition, it is held that following completion of one or two professionally guided field programs, technicians should be capable of organizing and directing similar programs with minimal supervision by the companies' professional geoscientist(s).

GEOCHEMICAL EXPLORATION FIELD SKILLS

With the general educational levels defined, focus was turned to the objective of analyzing the needs of companies involved in geochemical mineral exploration to determine whether or not it was worthwhile for an institution to develop the curriculum within a geoscience educational program.

The information of interest was the associated employment opportunities and also the type of training expected. The method for obtaining this information was through meetings and the distribution of questionnaires to appropriate organizations.

The data supplied by these potential employers provided information that identified the combined full- and part-time employment needs, estimates on numbers of positions available for annual hire, and nine field skills employers expected geochemical mineral-exploration field assistants to understand. These skills are shown in Table 1.

Table 1. Geochemical field skills and percent value for consideration in curriculum development.

Skill	In Percent Value
a. Plan and conduct surveys	13.09
b. Aerial photo. in site selection	11.55
c. Field sampling	15.40
d. Use of gold pan and sieves	9.63
e. Use of pH and specific ion meters	7.83
f. Simple field chem. tests of minerals	8.60
g. Field tests of water, silt, and soil	11.81
h. Care and repair of equipment	9.50
i. Interpret and plot data	12.58

THE TASMANIA, AUSTRALIA, STUDY

In the Australian portion of the study, geochemical mineral-exploration data were collected from exploration companies, mining companies, and appropriate government agencies serving the State of Tasmania.

Organization Size and Employment Needs

Fourteen companies and government agencies heavily engaged in geochemical mineral-exploration activities were polled. Variations in the size of the individual organizations are reflected in the number of full-time and part-time semiskilled and skilled (including technician) field-staff positions, which ranged between 0 and 50 full-time, and between 0 and 50 part-time employees. Data from questionnaires suggest that a total of 287 full-time and 221 part-time field assistants are employed by the 14 Tasmanian organizations. Based on a 5-percent availability of full-time positions and a 20-percent availability of part-time and seasonal positions for trainees, as expressed by participating members, the total number of full-time placements is 14 and the total number of part-time placements is 44.

Geochemical-Survey Skills

Based on a scale of one to five, Fig.1 shows the nine selected geochemical field skills and the magnitude of value collectively placed on each skill by the Tasmanian exploration organizations.

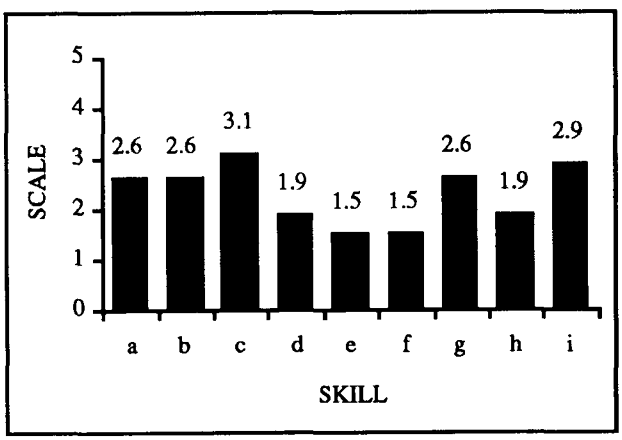

Fig.1. Tasmania. Relative value of geochemical exploration field skills: (a) planning and conducting a geochemical survey; (b) use of maps and aerial photos in selecting sample sites; (c) field sampling; (d) use of gold pan and sieves; (e) use of pH and specific ion meters; (f) simple field chemical tests for rocks and minerals; (g) field tests of water, silt, and soil; (h) care and repair of equipment; and (i) field interpretation and plotting of data.

Examination of the magnitude of value given each skill shows that the nine most favored field skills are, in decreasing value: (1) field sampling; (2) field interpretation and plotting of data; (3) planning and conducting a geochemical survey; (4) use of maps and aerial photographs in selecting sample sites; (5) field tests of water, silt, and soil; (6) use of gold pan and sieves; (7) care and repair of equipment; (8) use of pH and specific ion meters; and (9) simple field chemical tests for rocks and minerals.

Summary

In summary, the data suggest that approximately 14 full-time and 44 part-time and seasonal field positions become available annually in the 14 mineral-industry organizations polled. This suggests that a suitable number of field positions exist within the fabric of Tasmania's geochemical mineral-exploration industry to support training. In addition, the identification of the nine most important geochemical field skills and the detection of the relative value placed on each skill provide the focus on training needs as perceived by industry.

In terms of benefit to an associated educational institution, employment numbers provide confidence that students can be suitably placed within the fabric of Tasmanian exploration programs. In addition, the geochemical field-skills analysis serves as a guide for an institution in developing a curriculum that will meet the needs of students pursuing semiskilled, skilled, or technician-level field positions in Australian geochemical mineral exploration.

THE BRITISH COLUMBIA, CANADA, STUDY

In the Canadian portion of the study, geochemical mineral-exploration data were collected from exploration companies, mining companies, and appropriate government agencies serving the Province of British Columbia.

Organization Size and Employment Needs

Sixteen companies and government agencies heavily engaged in geochemical mineral exploration were polled. Variations in size of the individual organizations are reflected in the number of full-time and part-time semiskilled and skilled (including technician-level) field staff employed, which ranged between 0 and 50 full-time and between 0 and 50 part-time employees. Data from questionnaires suggest that a total of 256 full-time and 207 part-time field assistants are employed by the 16 British Columbia organizations. Based on a 5-percent availability of full-time positions and a 20-percent availability of part-time and seasonal positions for trainees, as expressed by participating members, the total number of full-time placements is 13 and the total number of part-time placements is 41.

Geochemical-Survey Skills

Based on a scale of one to five, Fig.2 shows the nine selected field skills and the magnitude of value collectively placed on each skill by the participating

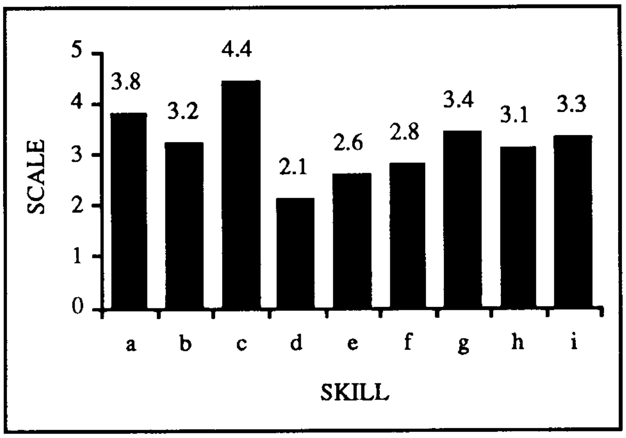

Fig.2. British Columbia. Relative value of geochemical exploration field skills: (a) planning and conducting a geochemical survey; (b) use of maps and aerial photos in selecting sample sites; (c) field sampling; (d) use of gold pan and sieves; (e) use of pH and specific ion meters; (f) simple field chemical tests for rocks and minerals; (g) field tests of water, silt, and soil; (h) care and repair of equipment; and (i) field interpretation and plotting of data.

British Columbia geochemical exploration organizations.

Examination of the magnitude of value given each skill indicates the nine most favored field-survey skills are, in decreasing value: (1) field sampling; (2) planning and conducting a geochemical survey; (3) field tests of water, silt, and soil; (4) field interpretation and plotting of data; (5) use of maps and aerial photographs in selecting sample sites; (6) care and repair of equipment; (7) simple field chemical tests of rocks and minerals; (8) use of pH and specific ion meters; and (9) use of gold pan and sieves.

Summary

In summary, the data suggest that approximately 13 full-time and 41 part-time and seasonal subprofessional field positions become available on an annual basis in the 16 mineral-industry organizations polled. This suggests that a suitable number of field positions exists within the fabric of the British Columbia geochemical mineral-exploration industry to support training. In addition, the identification of the nine most important geochemical field skills and the detection of the relative value placed on each skill provide the focus on training needs as perceived by industry.

In terms of benefit to an associated educational institution, employment information provides confidence that students can be suitably placed within the fabric of British Columbia's mineral-exploration programs. In addition, the geochemical field-skills analysis serves as a guide for an institution in developing a curriculum that will meet the needs of students pursuing semiskilled, skilled, or technician-level field positions in British Columbia geochemical mineral-exploration programs.

THE ALASKA, UNITED STATES, STUDY

In the United States portion of the study, geochemical exploration data were collected from mineral-exploration companies, mining companies, and appropriate government agencies serving the State of Alaska.

Organization Size and Employment Needs

Thirteen companies and government organizations heavily engaged in geochemical mineral-exploration activities were polled. Variations in size of the individual organizations are reflected in the number of full- and part-time semiskilled, skilled, and technician-level field-staff positions that ranged between 0 and 50 full-time and between 1 and 50 part-time employees. Data from questionnaires suggest that a total of 238 full-time and part-time field assistants are employed by the 13 Alaskan organizations. Based on a 5-percent availability of full-time positions and a 20-percent availability of part-time and seasonal positions for trainees, as expressed by participating members of the mineral industry, the total number of full-time placements is 12 and the total number of part-time placements is 36.

Geochemical-Survey Skills

Based on a scale of one to five, Fig.3 shows the nine selected geochemical field skills and the magnitude of value collectively placed on each skill by the participating Alaskan exploration organizations.

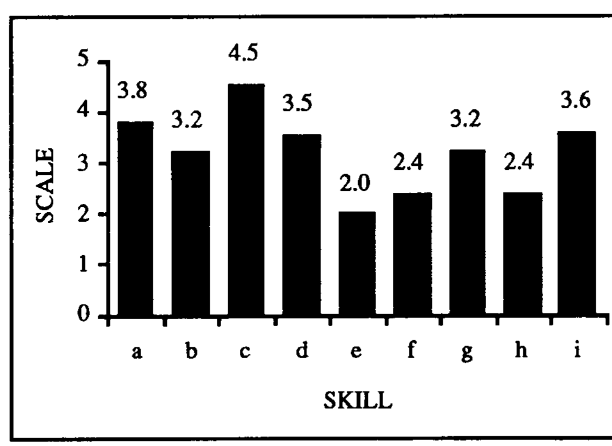

Fig.3. Alaska. Relative value of geochemical exploration field skills: (a) planning and conducting a geochemical survey; (b) use of maps and aerial photos in selecting sample sites; (c) field sampling; (d) use of gold pan and sieves; (e) use of pH and specific ion meters; (f) simple field chemical tests for rocks and minerals; (g) field tests of water, silt, and soil; (h) care and repair of equipment; and (i) field interpretation and plotting of data.

Examination of the magnitude of value given each skill shows that the nine most favored geochemical field-survey skills are, in decreasing value: (1) field sampling; (2) planning and conducting a geochemical field survey; (3) field interpretation and plotting of data; (4) use of gold pan and sieves; (5) use of maps and aerial photography in selecting sample sites; (6) field testing of water, silt, and soil; (7) care and repair of equipment; (8) simple field chemical tests for rocks and minerals; and (9) use of pH and specific ion meters.

Summary

In summary, the data suggest that approximately 12 full-time and 36 part-time and seasonal subprofessional field positions become available annually in the 13 mineral-industry organizations polled. This suggests that a suitable number of field positions exists within the fabric of Alaska's geochemical mineral-exploration industry to support training. In addition, the identification of the nine most important geochemical field skills and the detection of the relative value placed on each skill provide the focus on training needs as perceived by industry.

In terms of benefit to an associated educational institution, employment numbers provide confidence that students can be suitably placed within the fabric of Alaskan exploration programs. In addition, the geochemical field-skills analysis serves as a guide in the development of a curriculum that will meet the needs of students pursuing semiskilled, skilled, or technician-level field positions in Alaskan mineral-exploration programs.

THE MODEL PROGRAM

By combining the information gathered from the organizations in the three participating countries, it is possible to develop a field-skills-curriculum model for an educational institution in any country wishing to develop a new geoscience program, modernize an existing program, or strengthen a weak program.

Combined Organization's Employment Needs

The model, based on the information gathered from the 43 organizations located in the three countries studied, suggests a combined employment potential for semiskilled, skilled, and technician-level personnel of 781 full-time and 608 part-time field positions in mineral exploration. Based on the hiring level of 5-percent full-time and 20-percent part-time employees, as expressed by the mineral industry, the total number of full-time trainees that would be placed is approximately 39 and the total number of part-time and seasonal trainees is approximately 121.

Combined Geochemical Field Skills

The most valuable information that educational institutions can use after determining that employment opportunities are available in their areas of influence is that provided by the geochemical skills-analysis graphs.

By examining the graphs from the three participating countries, the relative values of the nine skills, as defined by the participating organizations, can be determined. In addition, by combining the data from the three figures, a model figure (Fig.4) is created that represents the value of each skill as perceived by the 43 organizations located in the three participating countries.

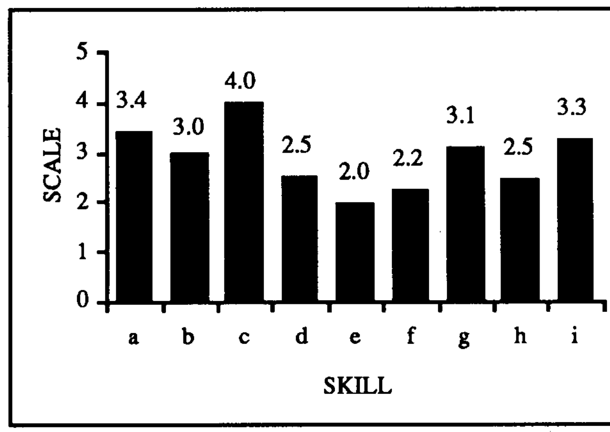

Fig.4. Model. Combined values of geochemical exploration field skills: (a) planning and conducting a geochemical survey; (b) use of maps and aerial photos in selecting sample sites; (c) field sampling; (d) use of gold pan and sieves; (e) use of pH and specific ion meters; (f) simple field chemical tests for rocks and minerals; (g) field tests of water, silt, and soil; (h) care and repair of equipment; and (i) field interpretation and plotting of data.

These relative values can be used effectively by an educational institution in any country in guiding the development of a course in geochemical field skills. In addition, by examining the value percentages represented in Fig.4, it is possible to determine just what level of effort should be devoted to teaching each skill.

CONCLUSION

In summary, 43 companies and organizations from three countries have provided information that suggests that suitable employment opportunities exist for semiskilled, skilled, and technician-level field personnel. In addition, these 43 organizations also have identified the nine most important geochemical field skills and the relative value of each skill.

With the knowledge and security that employment opportunities exist, an educational institution is in a position to use the skills analysis to meet the needs of industry by developing a curriculum structured both qualitatively and quantitatively to best serve students seeking employment in mineral exploration.

In conclusion, these 43 organizations, which are heavily engaged in geochemical mineral exploration, have supplied the source material from which any interested nation can draw the appropriate educational tools to aid in the development of a new vocational/technical geoscience program, modernize an existing program, or strengthen a weak program.

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