S.88-22

SIMON FRASER UNIVERSITY

MEMORANDUM

TO: Senate

FROM: W. Wattamaniuk
Secretary, SCAP

SUBJECT: Proposal for a Department of Earth Sciences

DATE: April 20, 1988

Action undertaken by the Senate Committee on Academic Planning at its meeting of April 13, 1988 gives rise to the following motion:

> "that Senate approve and recommend approval to the Board of Governors, the proposal for a Department of Earth Sciences, as set out in S.88-22"

Note: For the information of Senate, this proposal is part of a process of continual academic planning of new programs at SFU. There is no intention of proceeding with the program unless new designated funding is made available. The new courses outlined in the proposal are conceptual in nature and would not be available for offering until specifically brought forward on course proposal forms and approved by SCUS, SCAP and Senate.

SCAP 88-2

SIMON FRASER UNIVERSITY

MEMORANDUM

To: SCAP

From: W. R. Heath, Secretary SCUS

Subject: Proposal for a Department of Earth Sciences

Date: March 2, 1988

SCUS recommends

MOTION: that SCAP approve the proposal for a Department of Earth Sciences.

This matter has been reviewed in the past by both SCUS and SCAP and we draw your attention to the following changes in content introduced since the last consideration of the proposal:

P. 9
(a) In accordance with recent calendar changes, CHEM 102-3, CHEM 103-3 and CHEM 119-3 have been substituted for CHEM 104-3, CHEM 105-3 and CHEM 118-3 respectively.
(b) In accordance with recent calendar changes, GEOG 213-3 has been substituted for GEOG 313 and GEOG 311 has been eliminated (on p. 10 of the proposal).
(c) The status of CMPT 102-3 has been changed from required to recommended in order to reduce the number of lower-level required hours imposed by changes in (b).

P.10
(a) In accordance with recent calendar changes, GEOG 312-3, GEOG 313-3 and 317-3 changed to GEOG 212-3, GEOG 313-4 and 317-4.

P.11
(a) In accordance with recent calendar changes, MATH 272-3, 302-3, 372-3 and 375-3 have been changed to STAT 270-3, 302-3, 330-3 and 375-3.
(b) Wording in Section 3.5 changed to conform precisely with Faculty of Science entry in the calendar.

P.16
(a) MAEA 408-3 (Geostatistics) changed to STAT 408-3 on recommendation of Department of Mathematics and Statistics Chairman.

SIMON FRASER UNIVERSITY

MEMORANDUM

To. Senate Committee on Academic Planning	From. Office of the Dean of Graduate Studies
Subject. Proposed Graduate Program in Earth Sciences	Date. March 30, 1988

The Senate Graduate Studies Committee, at its Meeting on March 28, 1988, approved the proposed Master's program in Earth Sciences and it is now being forwarded to the Senate Committee on Academic Planning for approval.

B.P. Clayman
Dean of Graduate Studies.

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A DEPARTMENT OF EARTH SCIENCES AT SIMON FRASER UNIVERSITY

A Proposal

TABLE OF CONTENTS

1. PREAMBLE

Simon Fraser University was established in 1965 without a geology program and remains without one. A fundamental argument of this proposal is that the absence of geology in the academic program of the University is a basic deficiency in the University curriculum limiting the quality of science at S.F.U.. We fully endorse the concern expressed in a recent major review of Canadian geoscience that a small group of Canadian universities, including S.F.U., has no geology program. In the words of these reviewers, "it is inconceivable that a modern university would not offer some of the basic courses in geology so necessary for understanding Earth resources and their conservation" (Neale, E.R.W. and Armstrong, J.E., 1981, Canadian Geoscience Council Report: *Geological Survey of Canada*, Paper 80-6, p. 25). In this regard, Science at Simon Fraser University in 1987 remains significantly incomplete and inconceivably limited and idiosyncratic.

Furthermore, we believe that geological training facilities in British Columbia are in need of strengthening, particularly in the areas of industrial-mineral resources and environmental geoscience. Even though this Province relies upon the mineral and hydrocarbon base for so much of its wealth, only one of the Provincial universities offers a developed program in geology. The establishment of a program at Simon Fraser University would provide additional educational resources in such fields as industrial-mineral exploration and extraction, modelling of contaminant dispersal in geological systems, terrain analysis, the application of expert systems to geological problems, and geotechnical assessment of alpine resource conflicts.

The provision of Earth Science courses in the University currently is the responsibility of the Department of Geography. Courses in geology, geomorphology, sedimentology, soils, meteorology and hydrology are taught under the rubric of the physical geography program. Student response to these Earth Science courses has been strong and sustained.

Further development of the Earth Sciences at Simon Fraser must be built on a core of geology courses. The introduction of such subjects as stratigraphy, petrology, mineralogy, paleontology and structures is a necessary prerequisite to the expansion of Earth Science in the University. Although a short-term fix might be achieved by strengthening the Earth Science core in the Department of Geography, such a bridge eventually would also threaten the primary mandate of that Department to provide a balanced and integrated view of Earth environment and the

geography of human activity within it.

The establishment of an independent Earth Science program would not only fill a void in the science offerings to Simon Fraser University students, but it would strengthen other academic programs. The absence of systematic Earth Science has been an important limiting factor, for example, in the development of the physical geography and Quaternary Science programs. But Geography is not the only department that would benefit greatly by the presence of an Earth Science program; Archaeology, Biology, Chemistry, Physics and the Natural Resource Management Program, in particular, also are natural partners in such an endeavour.

It must be emphasized that this proposal is not a new departure for the University, but simply a logical development of ongoing scholarly effort and present University investment in existing but limited programs involving several faculty, Earth Science courses, and equipment. Thus, although approval of this proposal will create a completely new teaching and research structure at S.F.U., it will rest firmly on a foundation of existing resources.

The proposed Earth Science program at S.F.U. obviously and properly will duplicate core elements of the geoscience program at U.B.C. but the program on this campus, from the start, will be focussed on Quaternary studies, sedimentology, geostatistics and environmental geoscience, rather than attempting to 'cover the field'. Concentration of the S.F.U. resources in this manner will not only put in place a strongly complementary set of S.F.U./U.B.C. undergraduate and graduate academic opportunities for British Columbians, but it will assure for the S.F.U. program the immediate opportunity of becoming a centre of excellence in the field. Furthermore, the S.F.U. graduate program will be designed to accommodate a limited number of part-time students, a group presently not served by the University of British Columbia.

The economic returns from such an academic program are clear. This Province is a resource-based and development-oriented community in which a full and varied appreciation of the potential and limitation of the geological environment is absolutely vital to the success of many mining, engineering, and development ventures. Nowhere is this more apparent than in the important alpine regions of the Province where mountainous terrain poses environmental problems best solved by scientists and engineers trained in such Earth Science core disciplines as surficial geology, geomorphology, hydrology, and other geotechnical skills such as slope stability analysis. Planning at all levels in such environments involves the

assessment of geological hazards and an important role of the S.F.U. graduate in the Earth Sciences will be to develop just that particular expertise.

The location and exploitation of industrial minerals lacks the glamour of copper and gold mining yet it is a crucial part of the province's mining industry. Graduates of this program are expected to play an active role in the industrial-mineral and related industries.

2. CHARACTER OF AN EARTH SCIENCE PROGRAM AT S.F.U.

It is proposed that a Department of *Earth Science* rather than *Geology* be established at Simon Fraser University because the former title implies a broader and more integrated view of planet Earth than that characterizing traditional geology programs which typically are strongly focussed on the needs of the local mining-industry. The program outlined here attempts to create an academic unit which will have both academic credibility and identity in the professional geological community while at the same time avoiding unnecessary duplication of the geology offerings at the University of British Columbia. It also is designed to fit the circumstances of this University with respect to the availability of existing Earth-science courses, the trimester organization of the year, and the functioning of the cooperative education program.

2.1: An Explicit Interdisciplinary Approach

One of the themes of the Canadian Geoscience Council Report is the need to strengthen the interdisciplinary component of Canadian Earth-science. It strongly recommends that, in order "to promote interdisciplinary research, teaching and other interaction between departments, university administrators are urged to encourage joint appointments between separate departments of geology and geophysics and also with such departments as chemistry, geography, civil engineering, physics and biology" (Neale and Armstrong, 1981, p.8).

It is proposed that the new Department be founded in part on joint appointments with existing departments, including Geography and possibly Biological Sciences and Mathematics. Possibilities for joint or associate positions also exist in Chemistry, Physics and Engineering Science. Obviously the particular

nature of the joint appointments must be agreed between the departments involved.

The interdisciplinary nature of the program will be reinforced by the incorporation of both undergraduate and graduate courses from outside the Earth Science Department within its core requirements (for example, hydrology and geomorphology from Geography).

2.2: Appointment of Adjunct and Visiting Professors

Vancouver is a major centre for consulting, governmental and industrial geoscience. This pool of manpower will be tapped for people willing to teach courses, give workshops or lectures in the Earth Science program. Such a policy will have the benefit of insuring that the S.F.U. Earth Science program maintains close contact with the non-academic world of geoscience; feedback from such interactions will keep the faculty aware of trends, needs and new thrusts in the applied fields.

The use of adjunct professors has proven successful in several departments of the University, most notably, the Resource Management Program. The experience gathered there clearly demonstrates the benefits of having professionals who give advice to the department, offer the occasional lecture and advise students. It is an effective way of insuring that contact with the government and industrial sectors of geoscience is routinely maintained.

2.3: Cooperative Education

Over the past five years the University has increased the number of departments taking part in the work-study programs of cooperative education. Students have responded positively to the opportunity of spending part of the academic year in a supervised work situation. The application of their theoretical skills in the work-place has attracted large numbers of students, and the selection process for these positions is highly competitive.

The lead time necessary for making the contacts with employers, formulating the departmental regulations, and fully informing students, necessitates that planning for co-op should start in the second year of the Department's operation. The number of students involved in the co-op endeavour will be small, although the actual number will reflect the interests of students and employers.

2.4: Academic Emphases of the Department

It is proposed that the academic emphasis of the Department will be, to use a popular term, in the area of soft-rock geology. This emphasis reflects the existing Earth Science strength on the campus: fluvial geomorphology, geochronology, palynology, hydrology, sedimentology and Quaternary studies. The following areas will be the major thrusts of the Earth Science program:

i Quaternary geology and geomorphology
ii Sedimentology and sedimentary petrology
iii Geostatistics
iv Environmental geoscience

Complementing these academic thrusts of the department is a three-course fieldwork requirement. This reflects the conviction of the Earth Science Program Committee that fieldwork should be a major and integral part of the second, third, and fourth years of a B.Sc. program. The formal field courses (EASC 206, EASC 304, EASC 412) will be supplemented by one and two-day field excursions in the other Earth Science courses.

2.5: The Undergraduate Program (B.Sc.)

The undergraduate program is designed to provide a broad education in Earth Science with sufficient emphasis on traditional fields of geology to allow graduates to meet potential Provincial certification as a professional geologist and the entry requirements to graduate schools of geology in Canada and elsewhere. The program outlined below in Section 3 is a revised version of an earlier proposal that was reviewed by a number of distinguished geologists across North America (see Appendix 2). Their reactions to that proposal were very positive and most of their suggestions for improvements have been incorporated into the present document.

2.6: The Graduate Program (M.Sc.)

The graduate program is designed to provide research opportunities and training for both full-time and part-time students in several areas of the Earth Sciences including Quaternary studies, sedimentology, geostatistics and environmental geoscience. The part-time program will provide Earth scientists in local geoscience companies with an opportunity to upgrade their qualifications in

selected areas of the Earth Sciences while maintaining their employment.

This program represents a direct extension of the proposed undergraduate program in Earth Sciences with the concordant aim of correcting a long-standing weakness of the University to provide full and balanced teaching and research opportunities in the Earth Sciences. Furthermore, an M.Sc. program in the Earth Sciences will help to provide for the research needs and aspirations of newly-appointed faculty in the Department of Earth Sciences and of existing faculty presently working in the Earth Sciences in established departments. Thus, an S.F.U. graduate program in the Earth Sciences would recognize in name both the ongoing activities in the University as well as introducing the new coordinated program. The lively activity and commitment to Earth Sciences at S.F.U. already is evident by:

- the variety of graduate research programs with Earth Science components (particularly in Archaeology, Biological Sciences, Geography and Physics);
- the recently established Institute for Quaternary Research;
- the availability of such facilities as the ^{14}C radiocarbon dating and X-ray fluorescence laboratories;
- the University investment in field and laboratory equipment (for example, petrographic microscopes; seismic recorders; drilling rig; survey boats etc);
- the University's internal funding of a select number of geology courses.

The only institution in British Columbia offering a graduate degree in Earth Sciences (geological sciences) is the University of British Columbia. In contrast with that program, and indeed with most others in Canada, the proposed M.Sc. program at S.F.U. will exploit and build on existing strength in areas directly related to Quaternary geoscience. The closest programs to the model being proposed here are those at the Universities of Alberta and at Waterloo in Quaternary studies.

The program outlined below in Section 4 is a revised version of an earlier proposal reviewed, modified and approved by the S.F.U. Graduate Studies Committee. An important part of this process was the accommodation of concerns expressed by the Earth Sciences Committee (Geological Sciences, Geophysics, and Geography) at U.B.C. (see Appendix 3).

3. ACADEMIC REQUIREMENTS FOR THE UNDERGRADUATE PROGRAM (B.Sc.)

Requirements for the B.Sc. (Major) and B.Sc. (Honours.) program in the Faculty of Science are listed on p. 95-96 in the University Calendar.

3.1: Lower Division Core

All students majoring in Earth Sciences are expected to complete the following courses, or their equivalent, within the first 60 hours (4 semesters) of their program.

Courses in Earth Science			Semester Hours
EASC	101-3	Physical Geology	3
	102-3	Historical Geology	3
	201-3	Stratigraphy and Sedimentation	3
	202-3	Crystallography and Optical Mineralogy	3
	203-3	Paleontology	3
	204-3	Structural Geology I	3
	205-3	Mineralogy and Petrology	3
	206-1	Field Geology I	1
			22

Courses in Other Science Departments			Semester Hours
CHEM	102-3	General Chemistry I for Physical Sciences	3
	103-3	General Chemistry II for Physical Sciences	3
	115-2	General Chemistry Laboratory I	2
	119-2	General Chemistry Laboratory II for Physical Sciences	2
PHYS	120-3	General Physics I	3
	121-3	General Physics II	3
	131-2	General Physics Laboratory	2
BISC	102-4	Introduction to Biology	4
MATH	102-3	Introduction to Statistics	3
	151-3	Calculus I	3
	152-3	Calculus II	3
GEOG	213-3	Geomorphology I	3
			34

3.2: Upper Division Core

All Earth Science majors will be expected to take the following upper division courses:

Courses in Earth Science			Semester Hours
EASC	301-3	Igneous and Metamorphic Petrology	3
	302-3	Sedimentary Petrology	3
	304-3	Geophysics	3
	306-2	Field Geology II	2
GEOG	313-4	Geomorphology II	4
	317-4	Soil Geography	4
EASC	401-3	Regional Geology of Western Canada	3
	402-3	Sedimentology	3
	403-3	Quaternary Geology and Geomorphology	3
	404-3	Biostratigraphy	3
	405-3	Basin Analysis	3
	406-2	Field Geology III	2
	407-3	Structural Geology II	3
	410-3	Fluvial Systems	3
	490-0	Undergraduate Seminar	0
			42

3.3: Recommended Courses from other Departments

The following courses are ones that Earth Science majors might find useful to add as electives:

ARCH	410-5	Advanced Archeometry
	411-5	Archaeological Dating
	438-5	Geoarchaeology
BISC	204-3	Introduction to Ecology
	337-3	Comparative Morphology, Distribution & Evolution of Vascular Plants
	434-3	Paleoecology and Palynology
CHEM	218-3	Introduction to Analytical Chemistry
	232-3	The Chemistry of Non-Transition Elements
	251-3	Organic Chemistry I

	371-3	Chemistry of the Environment
	416-3	Modern Methods of Analytical Chemistry
CMPT	102-3	Introduction to Programming for Science Students
	104-1	Introduction to High Programming Language II
	187-1	Computing Project - Earth Science
GEOG	353-4	Aerial Photographic Interpretation
	212-4	Geography of Natural Hazards
	413-4	Advanced Geomorphology
	416-4	Pleistocene Geography
	418-4	Terrain Evaluation
MATH	251-3	Calculus III
	262-4	Engineering Mechanics I
	263-4	Engineering Mechanics II
STAT	270-3	Introduction to Probability & Statistics
	302-3	Analysis of Experimental and Observational Data
	330-3	linear Models in Applied Statistics
	460-3	Decision Analysis and Bayesian Inference
PHYS	211-3	Intermediate Mechanics

3.4: **The Honours Program**

Departmental approval is required for entry into the Honours Program. All students applying for entry must have completed 30 semester hours at Simon Fraser University in the Major Program in Earth Science. The requirements for honours are the same as previously listed for the major but, in addition, the following must be completed:

(a) an additional **12** semester hours for a minimum total of **132** for graduation;

(b) an Honours Thesis (EASC 499-9).

3.5: **Electives from beyond the Faculty of Science**

All majors and honours in Earth Science must take a minimum of **6** semester hours of electives in subjects taken outside the Faculty of Science (excluding EDUC 401, 402, 405, and 406).

EASC

101-3 Physical Geology
102-3 Historical Geology
201-3 Stratigraphy & Sedimentation
202-3 Crystallography and Optical Mineralogy
203-3 Paleontology
204-3 Structural Geology I
205-3 Mineralogy and Petrology
206-1 Field Geology I

301-3 Igneous and Metamorphic Petrology
302-3 Sedimentary Petrology
303-3 Geochronology
304-3 Geophysics
305-3 X-Ray Mineralogy
306-2 Field Geology II
307-3 Geotechnical Problems in Alpine Areas
308-3 Environmental Geoscience

401-3 Regional Geology of Western Canada
402-3 Sedimentology
403-3 Quaternary Geology and Geomorphology
404-3 Biostratigraphy
405-3 Basin Analysis
406-2 Field Geology III
407-3 Structural Geology II
409-3 Low Temperature Geochemistry
410-3 Fluvial Systems
490-3 Undergraduate Seminar
491-3 Directed Readings
492-3 Directed Readings
493-3 Directed Readings
499-9 Honours Thesis

STAT

408-3 Geostatistics (requires new course proposal from Department of Mathematics and Statistics)

3.7: Course Descriptions

EASC 101-3 PHYSICAL GEOLOGY

An introduction to rocks and minerals and the processes of their formation. The structure of the Earth, plate tectonics and the evolution of the surface features of the Earth.

EASC 102-3 HISTORICAL GEOLOGY

The study of the evolution of the Earth; the geological time scale, fossils and evolution; introductory stratigraphic concepts; geological history of Western Canada.

EASC 201-3 STRATIGRAPHY AND SEDIMENTATION

An introduction to the nature, origin and interpretation of stratified Earth materials. Principles of lithostratigraphy, biostratigraphy and chrono-stratigraphy. The facies concept.

Prerequisites: EASC 101 or GEOG 111; and EASC 102

EASC 202-3 CRYSTALLOGRAPHY AND OPTICAL MINERALOGY

Introduction to crystallography, crystal chemistry and chemical properties and chemical principles necessary for the study of minerals.

Prerequisite: EASC 101

EASC 203-3 PALEONTOLOGY

Principles of classification, morphology and development of the major groups of animals and plants in the geological record. The paleoecologic significance of fossils.

Prerequisite: EASC 102

EASC 204-3 STRUCTURAL GEOLOGY I

Description, classification and interpretation of Earth structures: folds, faults, joints, cleavage and lineations. Elementary rock mechanics.

Prerequisites: EASC 101 and EASC 102

EASC 205-3 MINERALOGY AND PETROLOGY

Optical phenomena related to the use of the polarizing microscope in the identification of minerals in the thin section. Petrogenesis and classification of igneous, sedimentary and metamorphic rocks. Hand specimen and thin section identification of rocks and minerals.

Prerequisites: EASC 202. Can be taken concurrently.

EASC 206-1 FIELD GEOLOGY I

Seven day excursion at the end of the spring semester to demonstrate the geology of British Columbia.

Prerequisites: EASC 101 and EASC 102

EASC 301-3 IGNEOUS AND METAMORPHIC PETROLOGY

Mineralogy, phase relations, origin and occurrence of igneous rocks. The classification of igneous rocks. Mineralogy and textures of metamorphic rocks. The study of hand specimen and thin section.

Prerequisite: EASC 205

EASC 302-3 SEDIMENTARY PETROLOGY

The study of the composition, fabric, origin and environments of sedimentary rocks. Hand specimen and thin section will be used for the identification and interpretation of sediments.

Prerequisite: EASC 205

EASC 303-3 GEOCHRONOLOGY

The application of various dating techniques to the geologic record including C14, thermoluminescence, fission track, potassium argon and others.

Prerequisites: PHYS 101 and PHYS 102, or PHYS 120 and PHYS 121

EASC 304-3 GEOPHYSICS

An introduction to geophysics utilizing seismic, magnetic and gravimetric observations of the Earth. A brief review of logging techniques.

Prerequisites: PHYS 120 and PHYS 121

EASC 305-3 X-RAY MINERALOGY

Fundamentals of X-ray diffraction techniques with emphasis on clay mineralogy.

Prerequisite: EASC 205

EASC 306-2 FIELD GEOLOGY II

A twelve day field camp held after the final week in the Spring Semester. The camp will emphasize the study of sedimentary rocks.

Prerequisite: The completion of the required 3rd year Earth Science courses.

EASC 307-3 GEOTECHNICAL PROBLEMS IN ALPINE AREAS

The role of geology and geological engineering in man's use of Alpine areas for settlement. Case studies from British Columbia and the European Alps will be used.

Prerequisite: 75 credit hours

EASC 308-3 ENVIRONMENTAL GEOSCIENCE

Environmental geology is a branch of ecology which deals with the relationship of man to his geological habitat. Topics covered will include environmental impact of mineral extraction and logging; erosion and sedimentation in rural and urban environments; mass movement.

Prerequisites: 75 credit hours including 6 hours in Earth Science

EASC 401-3 REGIONAL GEOLOGY OF WESTERN CANADA

The stratigraphy, structure and historical geology of western Canada. Important mineral and fossil sites will be discussed.

Prerequisites: EASC 201 and EASC 204

EASC 402-3 SEDIMENTOLOGY

The physics of sediment transport in fluids, the formation, character and classification of internal structures in sediments, and palaeoenviromental analysis.

Prerequisites: EASC 302

EASC 403-3 QUATERNARY GEOLOGY AND GEOMORPHOLOGY

Stratigraphy and history of the Quaternary Period with emphases on glaciation and Holocene alluvial fills. Several field trips in the Fraser Lowlands.

Prerequisite: GEOG 313

EASC 404-3 BIOSTRATIGRAPHY

The use of fossil evidence in the solving of stratigraphic problems, and the reconstruction of the conditions of deposition of ancient sediments.

Prerequisites: EASC 201 and EASC 203

ASC 405-3 BASIN ANALYSIS

The study of major depositional systems. Methods of analyzing basin geometry, depositional and tectonic history; basin classification; basin models; basin characteristics. Extensive use of Canadian examples.

Prerequisites: EASC 201 and EASC 204

EASC 406-2 FIELD GEOLOGY III

The study of deformed sedimentary, igneous and metamorphic rocks in the field. Twelve days of field work preceded by reading and laboratory studies.

Prerequisites: EASC 305 and EASC 412

EASC 407-3 STRUCTURAL GEOLOGY II

Rheological behaviour of rock; theories of stress distribution; failure criteria for rock; the evaluation of bulk rock properties.

Prerequisite: 75 credit hours including EASC 204

EASC 409-3 LOW TEMPERATURE GEOCHEMISTRY

Low temperature aqueous solution geochemistry. Geochemical problems in sedimentary and diagenetic environments.

Prerequisites: EASC 205, EASC 302, CHEM 232

EASC 410-3 FLUVIAL SYSTEMS

Stream processes and the evolution of drainage systems. Modern environments of fluvial sedimentation with applications to the ancient record.

Prerequisites: EASC 201 and GEOG 313

EASC 490-0 UNDERGRADUATE SEMINAR

A seminar for students in their last year of study. Visiting speakers. Site visits to mines, drilling locations. Discussions of the applications of Earth Science in the industrial and commercial world.

Prerequisites: 105 credit hours and majoring in Earth Sciences

EASC 491-1 DIRECTED READINGS

A course in which reading and research, and/or field work will be supervised by faculty members.

Prerequisite: 75 credit hours including 30 hours of courses in Earth Sciences, and permission of the department

EASC 492-2 DIRECTED READINGS

A course in which reading and research, and/or field work will be supervised by faculty members.

Prerequisite: 75 credit hours including 30 hours of courses in Earth Sciences, and permission of the department.

EASC 493-3 DIRECTED READINGS

A course in which reading and research, and/or field work will be supervised by faculty members.

Prerequisites: 75 credit hours including 30 hours of courses in Earth Sciences, and permission of the department.

EASC 499-9 HONOURS THESIS

An in-depth investigation of a topic in the Earth Sciences.

Prerequisites: 105 credit hours and consent of the supervisor

STAT 408-3 GEOSTATISTICS (It is suggested that this new course proposal would come forward from the Department of Mathematics and Statistics)

The theory of spatially correlated random variables applied to geological problems. Topics include variograms for analysis of spatial continuity, kriging, nonparametric and parametric geostatistics.

Prerequisites: MATH 272 or MATH 302

4. ACADEMIC REQUIREMENTS FOR THE GRADUATE PROGRAM (M.Sc.)

4.1: Admission and General Requirements

The D The Department of Earth Sciences offers a program leading to the M.Sc. degree in Earth Sciences, with emphases on Earth surface processes, geomorphology, surficial and Quaternary geology and sedimentology.

Admission: For admission requirements, refer to the General Regulations, pp. 199-200. Students should normally have a B.Sc. degree, or equivalent, in an honours program with at least a good second-class standing (3.0 GPA) in the Earth Sciences (for example: geology, geological engineering, geophysics, geomorphology, soil science, physical geography).

Degree Requirements: All students in the program will be required to take EASC 600 (Introduction to Graduate Studies) and five courses from the list below. In addition a thesis is required for the degree. The actual course selection will be a reflection of the student's research interest and guidance from the senior supervisor.

4.2: Graduate Courses

Because of the interdisciplinary nature of the Earth Science program, students are encouraged to undertake graduate courses in other Departments related to their particular research interests.

New Courses

EASC 600-0 **Introduction to Graduate Studies**
A required course designed to acquaint new graduate students with the research strengths of the Department, research facilities in the University and its vicinity and with the methodologies of the main fields of the Earth Sciences.

EASC 610-3 **Statistical Analysis of Earth Science Data**
Statistical methods and their use in geology and hydrogeology.

EASC 620-3 **Clastic Sedimentology**
Description and analysis of clastic sediments including, textures, fabrics, sedimentary structures,and facies associations in a variety of deposisional settings; diagenesis and geochemistry.

EASC 621-3 **Physical Sedimentology**
Physical processes of sedimentation in modern depositional environments

EASC 630-3 **Stratigraphy I**
The historical development of the concepts and principles of stratigraphy and the relative geological time scale; classification of stratigraphic units using various stratigraphic codes; international problems in stratigraphic classification and correlation.

EASC 631-3 **Stratigraphy II**
Selected problems in the application of stratigraphic techniques including seismic stratigraphy.

EASC 640-3 **Techniques for Quaternary Geology**
Field and analytical techniques in the description and interpretation of Quaternary sediments; field studies.

EASC 641-3 **Geochronology**
Principles and problems of dating surficial materials; Canadian case studies in Quaternary geology.

EASC 650-3 **Fluvial Sedimentary Systems**
Fluvial geomorphology and sedimentology of single and multichanneled river systems.

EASC 660-3 **Hydrometeorology**
Principles of dynamic meteorology with emphasis on near-surface energy-balance models as a component of the hydrologic cycle.

EASC 661-3 **Groundwater Hydrology**
Semi-steady state flow, leakage and recharge, effects of consolidation, analysis of pump tests, and other selected topics from the theory of groundwater movement.

EASC 680-2 **Subsurface Techniques**
Field course in the application of drilling methods (including core recovery and lithologic logging) and geophysical well logging.

EASC 690-3 **Applied Geophysics**
Recent advances in exploration geophysics; topics will include seismic stratigraphy, airborne survey systems, and well-logging techniques for the detection of hydrocarbons.

EASC 700-1 **Special Topics in Earth Sciences I**
Advanced study of selected topics, the focus of which will vary from semester to semester.

EASC 701-2 **Special Topics in Earth Sciences II**
Advanced study of selected topics, the focus of which will vary from semester to semester.

EASC 702-3 **Special Topics in Earth Sciences III**
Advanced study of selected topics, the focus of which will vary from semester to semester.

EASC 703-4 **Special Topics in Earth Sciences IV**
Advanced study of selected topics, the focus of which will vary from semester to semester.

EASC 704-5 **Special Topics in Earth Sciences V**
Advanced study of selected topics, the focus of which will vary from semester to semester.

EASC 800 **M.Sc. Thesis (Earth Science)**

Existing Courses

MRM 631 Applied Geomorphology and Hydrology

GEOG 717 Digital Processing of Remote Sensing Data

GEOG 726 Fluvial Geomorphology*

GEOG 728 Quaternary Geology and Geomorphology*

GEOG 730 Fossil Landforms

* these courses would be renumbered as EASC or GEEA (joint GEOG and EASC offerings) once the program is established.

Undergraduate courses with graduate sections:

ARC 411 Archaeological Dating

ARC 438 Geoarchaeology

BISC 434 Paleoecology and Palynology

4.2: The M.Sc. Thesis

Graduates of this program will be required to conduct original research and report their results in a thesis.

5. FACULTY AND STAFF REQUIREMENTS: FIVE YEAR PLAN

Faculty Requirements

Sedimentary petrologist

Igneous or metamorphic petrologist

Biostratigrapher or paleontologist

Stratigrapher

Structural geologist

Initial joint appointments: Geography (1.0 FTE)

Off Campus Visiting Appointments: 1.0 FTE (involvement of non-University geoscience professionals as visiting professors.)

Staff Requirements

Departmental Assistant

One secretary and one part-time secretary

Two technicians

Teaching Assistants

Initially two teaching assistants will be required, subsequently increasing to ten assistants in the fourth year of the Department's operation.

See the flow chart for the hiring sequence in Table 1.

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR	TOTAL COMPLEMENT IN THE FIFTH YEAR
Stratigrapher	Sedimentary Petrologist	Structural Geologist		
Igneous/Metam. Petrologist	Biostratigrapher	Visiting Appointment (0.5)	Visiting Appointment (0.5)	**Seven Faculty Positions**
Joint Appointments with Geography (1.0)				
Secretary	Departmental Assistant	Part-time Secretary		**One Departmental Assistant**
Technician		Technician		**1.5 Secretaries** **2 Technicians**
2 Teaching Assistants	2 Teaching Assistants	2 Teaching Assistants	4 Teaching Assistants	**10 Teaching Assistants**

Table 1: Flow Chart of Faculty and Staff Hiring by Year

6. SPACE REQUIREMENTS: FIVE YEAR PLAN

The following office and laboratory space requirements will need to come on stream in accordance with the progressive hiring of faculty and staff outlined in the 5-Year Plan (Section 5).

Office and Laboratory Space

The Department of Earth Science will require the following office and laboratory space:

eight faculty offices
Chairman's office and associated meeting room (seminar room)
two teaching assistant offices (each holding six desk spaces)
office for the secretarial staff
room for office equipment
office for the departmental assistant
storage room for equipment
two offices for technicians
undergraduate teaching space (see below)
research laboratories (see below)

Undergraduate Teaching Space

laboratory (handling 25 students) for the introductory geology courses
laboratory designed for the crystallography and the introductory course in mineralogy and petrology
laboratory for paleontology and palynology
laboratory for the advanced petrology courses
general purpose laboratories

Research Laboratories

laboratory for stratigraphical research
laboratory for petrology research
laboratory for Quaternary research
sedimentological laboratory
coal geology research laboratory

7. LIBRARY RESOURCES

Preamble

A core collection in the Earth Sciences had already been established to support ongoing research and teaching. The QE section of the Library is growing each year, especially in the areas supportive of geomorphology and sedimentology. The start date for many journals is 1965/66, reflecting the date of the University's inauguration. Retrospective purchasing has extended the available length of the major geology journals (e.g., Bulletin of Geological Society of America now begins in 1946; Journal of Geology begins in 1893; American Journal of Science begins in 1950).

The publications of the Geological Survey of Canada and those of the U.S. Geological Survey are taken and the back holdings are close to being complete. The weakness of the present collection is in the limited holdings of provincial and state geological surveys, departments of mines and other governmental agencies involved in the Earth Sciences.

The University's Map Library has a complete collection of Canadian topographic maps; a limited collection of U.S. topographic maps and a scattered holding of topographic maps from other countries. The limited collection of geological maps will need strengthening.

Selected Journals and Serials from the S.F.U. Library Involving Earth Sciences

Advances in Hydroscience
American Assoc. Petrol. Geolog., Bulletin
American Congress on Surveying & Mapping: Annual Proceedings
American Geophysical Union: Transactions
American Meteorolog. Soc., Bulletin
American Meteorolog. Soc., Meteorolog. Monographs
American Journal of Science
American Soc. Civil Engineers
Urban Planning Division
Geotechnical Engineering Division
Hydraulics
Soil Mechanics and Foundations
American Water Works Assoc., Journal
Antarctic Oceanology
Antarctic Snow & Ice Studies
Archives for Meteorology, Geophysics and Bioclimatology
Arctic
Arctic and Alpine Research
Atmosphere - Ocean
Bibliography of Alaskan Geology
British Geomorphological Research Group Technical Bulletin
Current Research
Bulletin of Canadian Petroleum Geology

Canadian Alpine Journal
Canadian Cartographer
Canadian Geographer
Canadian Geophysical Bulletin
Canadian Geotechnical Journal
Canadian Journal of Earth Sciences
Canadian Mining and Metallurgical

Bulletin
Canadian Mining Journal
Canadian Statistical Journal
Canadian Surveyor
Canadian Weather Review
Cartographer
Cartographic Journal
Cartographica
Catena
Climate Perspectives
Coastal Studies series
Colorado, State Univ., Hydrology Papers
Comments on Earth Sciences, Geophysics

Developments in Sedimentology
Earth and Planetary Science Letters
Earth Surface Processes
Earthquake Info. Bulletin
Ecological Modelling
Economic Geology
Environment
Environment Abstracts
Environment and Planning
Environmental Comment
Environmental Geology
Environmental Planning
Erde
Exploration Geophysics

Fennia

GeoAbstracts
GeoForum
Geografiska Annaler (A)
Geographical Bulletin (EMR, Canada)
Geographical Journal
Geographical Review
Geographie Physique et Quaternaire
Geological Abstracts
Geological Fieldwork
Geological Magazine
Geological Society of American
has all publications (Bulletin, Memoirs, Papers, etc.)
Geological Society of London, Journal
Quarterly Review
Geologist's Association, Proceedings
Geology
Geomorphological Abstracts
Geomorphology Symposia Series
Geophysical Abstracts
Geophysical Journal
Geophysical Monographs
Geos
Geoscience Canada
Geotechnique
Geotimes

GB. Institute of Geological Sciences

Habitat
Hydrology Symposium, Proceedings

Ice
Iceabikigt
Industrial Water Engineering
Institute of British Geographers, Transactions

Journal of Applied Meteorology
Journal of Environmental Management
Journal of Geology
Journal of Geophysical Research
Journal of Glaciology
Journal of Hydrology (both NZ and the Netherlands)
Journal of Meteorology
Journal of Petrology
Journal of Range Management
Journal of Sedimentary Petrology
Journal of Soil and Water Conservation
Journal of Atmospheric Sciences

Land and Water Law Review
Land Economics
Land Research Series, Australia
Land Use Abstracts
Landscape
Landscape Planning
Lund Series in Geography, Physical Geography

McGill, Sub-Artic Research Lab., publications
Marine Geology
Marine Technology Society
Meddelelser om Gronland
Marine Geophysical Researches
Meteorological and Geoastrophysical Abstracts
Meteorological Magazine
Meterological Translations
Meteorologische Rundschan
Methods in Geochemistry and Geophysics
Mineral Sciences Investigations
Mining Technology

Natural Hazards Observer
Natural Resources Forum
Natural Resources Journal
New Zealand Geographer
Norsk Geografish Tidsskrift

Offshore Exploration
Ontario Geography
Ozone Data for the World

Palaeogeography, Palaeoclimatology, Palaeoecology
Parks and Recreation
Photogrammetric Engineering and Remote Sensing
Plan Canada
Polar Record
Pollen et Spores
PreCambrian
Progress in Physical Geography

Quaternaria
Quaternary Science Reviews
Quaternary Research

Radiocarbon
Remote Sensing in Canada
Research on Urban Hydrology
Review of Paleobotany & Palynology
Reviews in Engineering Geology
Reviews of Geophysics
Revista Geografica
Revue de Geomorphologie Dynamique

Sedimentary Geology
Sedimentology
Seismological Bulletin
Seismological Society of America, Bulletin
Snow Cover Data, Canada
Snow Survey Bulletin, B.C.
Societe de Geographie de Quebec
Soil Science
Soil Science Society of America, Journal
Spill Technology Newsletter
Storm Data
Studies and Reports in Hydrology, Paris
Surveying and Mapping

Tellus
Terra
Town and Country Planning
Town Planning Review

WMO Bulletin
Water Resources Bulletin
Water Resources Research
Water Spectrum
Weather
Weatherwise
World Survey of Climatology

Zeitschrift für Geomorphologie

The University has access to GEOREF and other computer-based library data bases.

Mike Roberts

Jack Corse

Collection supporting Earth Sciences Department

30 November 1981

This is a brief review of the SFU Library resources in the area of Earth Sciences. Professor Mike Roberts of the Geography Department requested us to review the adequacy of the collection as far as supporting a Department of Earth Sciences was concerned. At present, various courses in the Earth Sciences area are taught in a variety of departments with no overall coordination.

In general terms are are reasonably well placed to support such a proposal. A basic subject heading search of our collection disclosed holdings in every major sub-division of earth Sciencews. This means that we have a good basis on which to build. It is entirely possible that specific weaknesses would be disclosed as faculty members develop courses but these problems would be dealt with at the time. My understanding of this proposal is that its main thrust is to gather existing courses under a new umbrella rather than branching our in totally new directions.

The establishment of a new department may result in more courses being offered in this arae which would, in turn, place more pressures on the collection. Without specific course prposals it is impossible to be more definitive. On the understanding that courses would be offered in some areas of Earth Science that are barely covered by our existing programs, it would be essential to expand our coverage of these areas in our approval plans.

The journal collection which supports our present program of Geology and Geomorphology is being reviewed by Professor Mike Roberts. This is an area where budget constraints render it difficult to subscribe to many new journals, however, we already have a reasonably good collection of journals for this area.

The implications of these proposals for the Library are minimized because courses in this area have always formed part of the program at SFU It should be emphasized that any move towards increasing the number of courses taught and their general thrust (i.e. more emphasis on civil engineering and soil mechanics) would result in a corresponding increase in Library expenditure. This would need to be funded as a new program.

JC:vk

8. BUDGET

The budget outlined in Table 2 provides estimates of the various components of the operating costs of the Department of Earth Sciences. It excludes costs of the reallocation of existing space and equipment to this new program.

ASSUMPTIONS FOR TABLE 2 (1985):

		Salary	Salary & Benefits (13%)
Faculty Positions		$40,000	$45,200
Technicians	(a)	20,000	22,600
	(b)	25,000	28,250
Departmental Assistant		22,000	24,860
Secretary		17,000	19,210
Secretary (part-time)		8,000	9,040
Teaching Assistants		5,000	5,000

Table 2: Budget (Five Year Plan)

	Year 1			Year 2			Year 3			Year 4			Year 5		
Faculty	1.	(7/12)	26,352	1.	Continuing Positions	135,000	1.	Continuing Positions	226,000	1.	Continuing Positions	297,552	1.	Continuing Positions	
	2.	(7/12)	26,352	2.	(7/12)	26,352	2.	7/12 of .25 FTE	6,588	2.	7/12 of .5 FTE	13,176		(7 FTE)	
	3.	(12/12)	45,200	3.	(7/12)	26,352	3.	7/12 of .25 FTE	6,588			———			———
			97,904			188,304			239,176			310,728			316,400
STAFF	1.	Secretary (12/12)	19,210	1.	Continuing Positions	47,460	1.	Continuing Positions	47,460	1.	Continuing Positions	56,500	1.	Continuing Positions	56,500
	2.	Technician (8/12)	18,815			———	2.	Part-Time Secretary	9,040			———			———
			38,025			47,460			56,500			56,500			56,500
TEACHING ASSISTANTS	1.	2 T.A.'s	10,000	1.	Continuing Positions	10,000	1.	Continuing Positions	20,000	1.	Continuing Positions	30,000	1.	Continuing Positions	50,000
			———	2.	2 T.A.'s	10,000	2.	2 T.A.'s	10,000	2.	4 T.A.'s	20,000			———
			10,000			20,000			30,000			50,000			50,000
EQUIPMENT			100,000			60,000			40,000			40,000			40,000
OPERATING			20,000			25,000			30,000			35,000			40,000
50% OVERHEAD ON ABOVE ITEMS		Total of Above 50%	132,964		Total of Above 50%	340,764 170,382		Total of Above 50%	395,676 197,838		Total of Above 50%	492,228 246,114		Total of Above 50%	502,900 251,450
			398,893			511,146			593,514			738,342			754,350
LIBRARY			15,000			15,000			15,000			15,000			15,000
TOTAL:			**$413,893**			**$526,146**			**$608,514**			**$753,342**			**$769,350**

A1. Appendix I

The Present Status of Earth Sciences at S.F.U..

This section will provide a review of the present teaching and research capabilities of the University in the field of Earth Sciences. The listing of publications is not intended to be comprehensive but an overview; a similar caveat applies to the listing of equipment.

Geography

Faculty teaching Earth Science courses:

Bailey	(meteorology, climatology, hydrology)
Crampton	(soils, geology, permafrost)
Hickin	(fluvial geomorphology, geology,sedimentology)
Roberts	(fluvial geomorphology, Quaternary alluvial sedimentation)
Sagar	(meterology, climatology, glaciology)
Hutchinson	(deltaic ecology and sedimentation)

Earth Science and related courses:

GEOG 111	Physical Geography
	Introductory Geology
	Cartography I
	Hydrology
	Geography of Natural Hazards
	Geomorphology I
	Climatology I
	Biogeography I
	Soil Geography
	Sedimentology
	Cartography II
	Aerial Photographic Interpretation
	Quaternary Geology and Geomorphology
	Geomorphology II
	Climatology II
	Biogeography II

Pleistocene Geography

Terrain Evolution

Theoretical and Computer Cartography

Selected Research Publications: **W.G. Bailey**

An analysis of errors in the calculation of evapotranspiration by the Bowen ration and combination model methods. NRG PUBLICATION 79-11, 10 p.

With J.A. Davies. Estimating evapotranspiration from soybeans. Preprint Volume: Fourteenth Conference on Agriculture and Forest Meteorology and Fourth Conference on Biometeorology, Am. Meteorol. Soc., 158-160.

With P.F. Mills. Climatology research at the Beaverlodge Research Station. Proceedings of the 1980 Annual Meeting of the Alberta Climatological Association. Alberta Energy and Natural Resources, Technical Report T/10-1980, 35 p.

Agricultural climate resources for northwestern Canada. Preprint Volume of Extended Abstracts for 15th Conference on Agriculture and Forest Meteorology and 5th Conference on Biometeorology, Am. Meteorol. Soc., 139-140.

With H. Lerer, and P.F. Mills. Pollination activity of Megachile rotundata. Preprint Volume of Extended Abstracts for 15th Conference on Agriculture and Forest Meteorology and 5th Conference on Biometeorology, Am. Meteorol. Soc., 13-15.

The climate resources for agriculture in northwestern Canada. Agriculture and Forestry Bulletin, 4, 11-17.

With J.A. Davies. Bulk stomatal resistance control on evaporation. Boundary-Layer Meteorol., 20, 401-415.

With J.A. Davies. Evaporation from soybeans. Boundary-Layer Meteorol., 20, 417-428.

With J.A. Davies. The effect of uncertainty in aerodynamic resistance on evaporation estimates from the combination model. Boundary-Layer Meteorol., 20, 187-199.

With A.L. Darwent. Soil moisture and temperature response to shallow tillage in the early spring. Can. J. Soil Sc., 61, 455-460.

With H. Lerer and P.F. Mills. Pollination activity of the alfalfa leafcutting bee. Presentation for the 16th Annual Congress of the Canadian Meteorological and Oceanographic Society, May 26-28, 1982, 3 p.

With R.B. Stewart. A method for assessing leaf area. Can. J. Plant Sci., 62, 211-214.

With P.F. Mills. Humidity and the pollination activity of Megachile rotunda. Env. Ent., 11, 1063-1066.

With H. Lerer, P.F. Mills and P. Pankiw. Pollination activity of Megachile rotundata. Evn. Ent., 11, 997-1000.

With H.N. Hayhoe, and G.C. Topp. Estimation of spring thaw water movement and freeze-thaw processes using time-domain reflectometry. Atmosphere-Ocean. In press.

Selected Research Publications: **C.B. Crampton**

Structural petrology and problems of the Caledonides. The Adv. of Sci., 12, 574-575.

Loch Shin Limestone: comparison of dolomite and calcite fabrics. Trans. Edin. Geol. Soc., 16, 334-337.

Structural petrology of Cambro-Ordovician limestones of the Northwest Highlands of Scotland.

Amer. J. Sci., 256, 145-158.

Heavy minerals in the Magnesian Limestone of Yorkshire. Proc. Yorks. Geolo. Soc., 31, 383-390.

Petrography of the Mesozoic succession of South Wales. Geol. Mag., 97, 215-228.

Quartz fabric reorientation in the region of Benmore Assynt, Northwest Highlands of Scotland, Geol. Mag., 100, 361-370.

Contrasting vegetational histories of certain soils in South Wales: in interpretation of their pollen content. J. Ecol., 51, 453-459.

The development and morphology of iron pan podzols in mid and South Wales. J. Soil Sci., 14, 282-302.

Analysis of pollen in soils on the peaks of South Wales. Scot. Geogr. Mag., 82, 46-52.

Certain effects of glacial events in the Vale of Glamorgan, South Wales. J. Glaciol., 6, 261-266.

With J.A. Taylor. Solifluction terraces in South Wales. Biul. Perygl., 16, 15-36.

Soil development on tips in South Wales. Sylva, 47, 12-14.

With T.F. Finch. A comparison of soils on Coal Measures in S.W. Ireland and S.E. Wales. Sci. Proc. Roy. Dublin Soc., 3, 87-99.

The distribution and possible genesis of some organic terrain patterns in the southern Mackenzie River Valley. Can. J. Earth Sci., 10, 432-438.

A landscape zonation for the southern and central Mackenzie River Valley based on terrain permafrost characteristics. Can. J. Earth Sci., 10, 1843-1854.

With N.W. Rutter. A geo-ecological terrain analysis of discontinuously frozen ground in the Upper Mackenzie River Valley, Canada. Proc. 2nd. Int. Conf. Permafrost, Permafrost Inst., Acad. Sic. U.S.S.R., Yakutsk. The North American Contribution, Nat. Acad. Sci., Washington, 101-105.

Micro-shear fabrics in soils of the Canadian North. Proc. 4th Int. Work. Meeting Soil Micromorphology, Department of Geography, Queen's University, Kingston, Ontario, 655-664.

A bisequal, periglacial section of the Miramichi Valley, Eastern Canada. Can. J. Soil Sci., 54, 111-113.

Linear-patterned slopes in the Discontinuous Permafrost Zone of the central Mackenzie River Valley, Artic, 27, 265-272.

Landscape mapping in the Mackenzie River Valley. Artic, 28, 284-294.

Landscape mapping and classification in the southern and central Mackenzie River Valley, N.W.T., Canada. Proc. Can. Assoc. Geogr., Vancouver, Session 8, Biogeography and Soils, 156-163.

Shearing of Gleysols and Luvisols with wetting, and Cryosols with freezing. Proc. Can. Soc. Soil Sci., Brandon, Manitoba, 20 p.

Patterned ground in the Maritimes, Canada. Biul. Perygl., 26, 199-204.

Changes in permafrost distribution in northeastern British Columbia. Artic, 30, 61-62.

A note on asymmetric valleys in the Central Mackenzie River Catchment, Canada. Earth Surface Processes, 2, 427-429.

The distribution and thickness of icy permafrost in northeastern British Columbia. Can. J. Earth Sci., 15, 655-659.

Rapid changes in the distribution of soil drainage classes on Burnaby Mountain, British Columbia. Can. J. Soil Sci., 59, 215-219.

Variations of pH with annual cumulative precipitation in acid forest soils. Can. J. Soil Sci., 60, 385-387.

Terraced deposits in The Upper Blackstone River catchment, the Yukon. Musk-Ox, 26, 82-84.

Analysis of synergistic systems for evaluating terrain sensitivity to disturbance of icy permafrost in the Mackenzie River Valley, Canada. Geoderma, 28, 57-61.

Podzolization of soils under individual tree canopies in southwestern B.C., Canada. Geoderma, 28, 57-61.

Some observations of volcanic ash soils in the southern Yukon. Musk-Ox, 31.

Variations of pH with annual precipitation in loamy forest soils. Can. J. Soil Sci., 64, (in press).

Selected Research Publications: **E.J. Hickin**

Channel morphology, bankfull stage, and bankfull discharge of streams near Sydney: The Australian Journal of Science, 1968, Vol. 30, No. 7, p. 274-275.

A newly identified process of point bar formation in natural streams: American Journal of Science, 1969,Vol. 267, p. 999-1010.

The terraces of the Lower Colo and Hawkesbury drainage basins, New South Wales: The Australian Geographer, 1970, Vol. XI, No. 3, p. 278-287.

with Page, K. J., The age of valley fills in the Sydney Basin: Search, 1971,Vol. 2, No.10, p. 383-384.

Pseudomeanders and point dunes - a flume study: American Journal of Science, 1972, Vol. 272, p. 762-799.

The development of meanders in natural river channels: American Journal of Science, 1974, Vol. 274, p. 414-442.

with Nanson, G.C., The character of channel migration on the Beatton River, Northeast British Columbia, Canada, Geological Society of America Bulletin, 1975, Vol. 86, p. 487-494.

The analysis of river planform responses to changes in discharge: In K.J. Gregory (editor), River Channel Changes, John Wiley & Sons, New York, 1977, p. 249-263.

Hydraulic factors controlling channel migration: In R. E. Davidson - Arnott & W. Nickling (editors), Research into Fluvial Systems, 1977, GeoAbstracts, Norwich, p. 59-66.

Mean flow-structure in meanders of the Squamish River, British Columbia: Canadian Journal of Earth Sciences, 1978, Vol. 15, No. 11, p. 1833-1849.

Concave-bank benches on the Squamish River, British Columbia, Canada: Canadian Journal of Earth Sciences, 1979,Vol 16, No. 1, p. 200-203.

Hickin, E. J., 1980, Seismic Velocities of unconsolidated sediments in the Vancouver area of British Columbia: The Canadian Geographer, 1980, Vol. XXIV, No. 4, p. 411-416.

River channel changes: retrospect and prospect: International Association of Sedimentologists Special Publication, Vol. 6, p. 61-83.

with Nanson, G. C., Channel migration and incision on the Beatton River: Journal of the Hydraulic Engineering, American Society of Civil Engineers, 1983, Vol. 109, No.3, p. 327-337.

with Nanson, G. C., Closure to discussion of "Channel migration and incision on the Beatton River", Journal of Hydraulic Engineering, American Society of Civil Engineers, 1984, Vol.110, No. 11, p. 1683-1684.

with Nanson, G. C., Lateral migration rates of river bends: Journal of Hydraulic Engineering, American Society of Civil Engineers, 1984, Vol. 110, No. 11, p. 1557-1567.

Vegetation and river channel dynamics: The Canadian Geographer, 1984 Vol. XXVIII, No. 2, p. 111-126.

with Brierley, G., The downstream gradation of particle sizes in the Squamish River, British Columbia: Earth Surface Processes and Landforms, 1985, Vol. 10, p. 597-606.

Concave-Bank Benches in the Floodplains of Muskwa and Fort Nelson Rivers, British Columbia: The Canadian Geographer, 1986,Vol 30, No2, p. 111-122.

with Nanson, G.C., A statistical analysis of bank erosion and channel migration in western Canada: Geological Society of America Bulletin, 1986, Vol. 97, p. 497-504.

Lateral migration rates of river bends: In P.N. Cheremisinoff, N.P. Cheremisinoff, and S.L.

Cheng (editors), Handbook of Civil Engineering,1987, Technomic Publishing, Hasbrouck Heights, N.J.,Vol.4, 57 p., in press.

with Sichingabula, H.M.,The geomorphic impact of the catastrophic October 1984 flood on the planform of Squamish River, southwestern British Columbia: Canadian Journal of Earth Sciences, 1987, in press.

Selected Research Publications: **I. Hutchinson**

The Pleistocene Period and Plant Evolution in the Amazon Basin. Int'l. Geogr. Union, Montreal.

Geographical Context of Field Work in British Honduras. In Pines of Central America. Organization for Tropical Studies, Costa Rica.

Ecological Modelling and the Stand Dynamics of Caribbean pine. Can. Assoc. Geogr., Vancouver.

With M.C. Roberts. Vertical variation in stemflow generation. J. Applied Ecology, 18, 521-527.

Vegetation-environment in relations in a brackish marsh, Lulu Island, Richmond, B.C. Can. J. Bot., 60, 452-462.

Selected Research Publications: **M.C. Roberts**

With D. Mark. The Use of Trend Surfaces in Till Fabric Analysis. Can. J. Earth Sci., 7, 4, 1179-1184.

With P.C. Klingeman. The Influence of Landform and Precipitation Parameters on Flood Hydrography. J. Hydrol., 11, 393-411.

With D.M. Mark. The Use of Trend Surfaces in Till Fabric Analysis: A Reply. Can. J. Earth Sci., 8, 9, 1167-1169.

Streamflow and Drainage Density. Seminar in Water Resources, Technical Report No. 21, Hydromechanics Laboratory, School of Civil Engineering, Purdue University, 10 p.

With P.C. Klingeman. The Relationship of Drainage Net Fluctuation and Discharge. Int'l. Geog., 1, 189-191, 22nd Int'l. Geographical Congress, Montreal.

Watershed in the Rural-Urban Fringe. National Symposium on Watersheds in Transition, 300-306. American Water Resources Association Conference, Fort Collins, Colorado.

With D.W. Waldrip. Slopes in Indiana. Proc. Ind. Acad. Sci., 81, 251-257.

Geohydrologic Factors Involved in the Location of Sanitary Landfill Sites. B.C. Geog. Ser., 17 (Tantulus Research Ltd., Vancouver), 113-118.

With D.A. Cobb. Horton's 1945 Study: A cartobibliography. Bulletin Geol. Soc. Am., 84, 2733-2736.

With J.R. Chiesa, J.C. Randolph and R.S. Howe. A Land Capability Model for the Lower Lake Monroe Watershed. Purdue University Water Resources Research Center, Technical Report #66, 27 p.

With H.H. Gray, R.S. Howe, J.C. Randolph and N.L. White. Lake Monroe Land Suitability Study: A Technical Report on a Selected Portion of the Lake Monroe Watershed. School of Public and Environmental Affairs, Indiana University, Bloomington, 406 p.

Variations of Drainage Density in a Small British Columbia Watershed. Water Res. Bull., 14, 2, 470-476.

Drainage Density Variations of the Morainic Landscapes of Northeastern Indiana. Zeitschrift für Geomorphologie, 22, 262-471.

The Use of Computer Graphics in the Evaluation of Sanitary Landfill Sites. Comp. & Graphics, 3,

167-169.

With J.J. Hidore. A Laboratory Manual for Physical Geography. Burgess Publishing Co., Minneapolis, 220 p. (2nd edition).

With J.A. Randolph and J.R. Chiesa. A Land Suitability Model for the Evaluation of Land-Use Change. Envir. Mgnt., 3, 4, 339-352.

With I. Hutchinson. Vertical variation in stemflow generation. J. Applied Ecology, 18, 521-527.

With D.R. Whitehead. The palynology of non-marine Neogene deposit in the Williamette Valley, Oregon. Review of Palaeobotany and Palynology, 41, 1-12.

With K.M. Rood. The role of ice contributing area in the morphology of transverse fjords, British Columbia. Geografiska Annaler, 66A(4), in press.

The late Cenozoic geomorphology and stratigraphy of the southern Williamette Valley, Oregon. In W.C. Mahaney (ed.), Correlation of Quaternary Chronologies, GeoBooks, Norwich.

The geomorphology and stratigraphy of the Lizard Loess in south Cornwall, England. Boreas, 14, 75-82.

Selected Research Publications: **R.B. Sagar**

Meteorological and Glaciological Observations on the Gilman Glacier, Northern Ellesmere Island, 1961. Geog. Bull., 22, 13-57.

Glaciological and Climatological Studies on the Barnes Ice Cap, 1962-64. Geog. Bull., 8, 1, 3-47.

O.H. Loken, Mass Balance Observations on the Barnes Ice Cap. Proc. Berne Symposium 1968, September. Int'l. Assoc. Scientific Hydrology, 79, 282-291.

Biological Sciences

Faculty teaching Earth Science courses:

Mathewes (palynology, paleoecology)

Courses with paleontological leanings:

BISC 337 Comparative morphology, distribution and evolution of vascular plants.
BISC 400 Evolution
BISC 434 Paleoecology and Palynology

Selected Research Publications: **R.W. Mathewes**

With R.C. Brooke. Fossil Taxodiaceae and new angiosperm macrofossils from Quilchena, British Columbia. Syesis, 4, 209-216.

With C.E. Borden and G.E. Rouse. New radiocarbon dates from the Yale area of the lower Fraser River Canyon, British Columbia. Can. J. Earth Sci., 9, 1055-1057.

A palynological study of postglacial vegetation changes in the University Research Forest, southwestern British Columbia. Can. J. Bot., 51, 2085-2103.

With G.E. Rouse. Palynology and paleoecology of post-glacial sediments from the lower Fraser Canyon of British Columbia. Can. J. Earth Sci., 12, 745-756.

Pollen analysis at Glenrose. In: The Glenrose Cannery Site. (R.G. Matson, ed.). National Museum of Man Mercury Series, Archaeological Survey of Canada, Paper No. 52, 98-103.

The environment and biotic resources of the Lillooet area. In: Reports of the Lillooet

Archaeological Project No. 1, Introduction and Setting. (A.H. Stryd and S. Lawhead, eds.). National Museum of Man Mercury Series, Archaeological Survey of Canada, Paper No. 73, 68-99.

Pollen morphology of some western Canadian Myriophyllum species in relation to taxonomy. Can. J. Bot., 56, 1372-1380.

With H.H. Birks. Studies in vegetational history of Scotland. V. Late Devensian and early Flandrian pollen and macro-fossil stratigraphy at Abernethy Forest, Inverness-Shire. New Phytol., 80, 455-484.

A paleoecological analysis of Quadra Sand at Point Grey, British Columbia, based on indicator pollen. Can. J. Earth Sci., 16, 847-858.

Pollen morphology of Pacific Northwestern Polemonium species in relation to paleocology and taxonomy. Can. J. Earth Sci., 57, 2428-2442.

With J.M. White, R.W. Mathewes and W.H. Mathews. Radiocarbon dates from Boone Lake and their relation to the 'Ice-free Coridor' in the Peace River District of Alberta, Canada. Can. J. Earth Sci., 16, 1870-1874.

Pollen evidence for the presence of Tall Jocob's-Ladder (Polemonium caeruleum L.) on the Queen Charlotte Islands during late-glacial time. Syesis. (In press.)

With J.W. Westgate. Bridge River tephra: revised distribution and significance for detecting old carbon errors in radiocarbon dates of limnic sediments in southern British Columbia. Can. J. Earth Sci., 17, 1454-1461.

With L.E. Heusser. A 12,000 year palynological record of temperature and precipitation trends in southwestern British Columbia. Can. J. Bot., 59, 707-710.

With J.J. Clague. Stratigraphic relationships and paleoecology of late-glacial peat bed from the Queen Charlotte Islands, British Columbia. Can. J. Earth Sci., 19, 6, 1185-1195.

With J.A. White. Holocene vegetation and climatic change in the Peace River District, Canada. Can. J. Earth Sci., 19, 3, 555-570.

With J.J. Clague, R.W. Mathewes and B.G. Warner. Late Quaternary geology of eastern Graham Island, Queen Charlotte Islands, British Columbia. Can. J. Earth Sci., 19, 9, 1786-1795.

With J.M. D'Auria. Historic changes in an urban watershed determined by pollen and geochemical analyses of lake sediment. Can. J. Earth Sci., 19, 11, 2114-2125.

With B.G. Warner and J.J. Clague. Ice-free conditions on the Queen Charlotte Islands, British Columbia, at the height of Lake Wisconsin Glaciation. Science, 218, 675-677.

With B.G. Warner and J.J. Clague. Geology and paleoecology of a mid-Wisconsin peat from the Queen Charlotte Islands, British Columbia, Canada. Quat. Res., 21, 337-350.

With R.J. Hebda. Holocene history of cedar and native Indian cultures of the North American Pacific Coast. Science, 225, 711-713.

With D.S. McLennan. Pollen transport and representation in the Coast Mountains of British Columbia. I. Flowering phenology and aerial deposition. Can. J. Bot., 62, 2154-2164.

Physics

Faculty teaching Earth Science courses:

Huntley (archaeometry, thermoluminescence dating)

Courses with partial Earth Science content:

PHYS 181 Introduction to physical science in archaeology

Selected Research Publications: **D.J. Huntley**

With D.E. Nelson. On Radiation and Thermoluminescence, Current Anthropology, 16, 670-671.

With H.P. Johnson. Thermoluminescence as a Potential Means of Dating Siliceous Ocean Sediments. Can. J. Earth Sci., 13, 593-596.

Experiences with an Alpha Counter. Ancient TL, 1, 3-6.

With D.C. Bailey. Obsidian Source Identification by Thermoluminescence. Archaeometry, 20, 159-170.

The Effect of Sample Reflectance in Alpha Counting. Ancient TL, 4, 2-3.

With A.G. Wintle. Some Aspects of Alpha Counting. Council of Europe PACT Journal, 2, 115-119.

With F.J. diSalva and T.M. Rice. Effect of Electron-Phonon Scattering on Charge Density Wave Transitions. J. Phys. C., 11, L767-L770.

With A.G. Wintle. Thermoluminescence Dating of Ocean Sediments. Council of Europe PACT Journal, 3, 373-380.

With A.G. Wintle. Thermoluminescence Dating of a Deep-Sea Sediment Core. Nature, 279, 5715, 710-712.

With A.G. Wintle. Thermoluminescence Dating of Ocean Sediments. Can. J. Earth Sci., 17, 348-360.

With G.W. Berger, P.J. Mulhern. Isolation of Silt-Sized Quartz Grains from Sediments. Ancient TL, 11, 8-9.

With G.W. Berger. Thermoluminescence Dating of Terrigenous Sediments. Council of Europe PACT Journal (proceeding of a specialist seminar on thermoluminescence dating, Oxford, September). In Press.

With A.B. Cormie, D.E. Nelson. X-ray Fluorescence as a Practical Instrumental Technique for Finger-Printing Tephra Samples Found in Archaeological Deposits. Proceedings of the NATO Advanced Study Institute, "Tephra Studies as a Tool in Quaternary Research," Lavgarvatn, Iceland, June 18-29.

With A.G. Wintle. The Use of Alpha Scintillation Counting for Measuring Th-230 and Pa-231 Contents of Ocean Sediments. Can. J. Earth Sci., 18, 419-432.

With P.J. Mulhern and G.W. Berger. A Technique for the Magnetic Separation of Silt-Sized Sediments. J. Sedimentary Petrology, June, 672-674.

With A.B. Cormie and D.E. Nelson. Identifying Tephras by Alpha Counting. Can. J. Earth Sci., 19, 662-665.

With A.G. Wintle. Thermoluminescence Dating of Sediments - A Review. Quaternary Sci. Reviews. In Press.

Archaeology

Faculty teaching Earth Science related courses:

Fladmark

Nelson

Courses with partial Earth Science content:

ARCH	410	Advanced archaeometry

ARCH	411	Archaeological dating
ARCH	438	Geoarchaeology

Selected Research Publications: **K.R. Fladmark**

A Paleoecological Model for Northwest Coast Prehistory. Mercury Series 43, Archaeological Survey of Canada, Ottawa, 319 pp.

Routes: Alternate migration corridors for early man in North America. American Antiquity, 44(1): 55-69.

Valentine, K.W., Fladmark, K.R. and B.E. Spurling. The description chronology and correlation of buried soils and cultural layers in a terrace section, Peace River Valley, B.C. Canadian Journal of Soil Science, 60: 185-197.

Microdebitage: Initial Considerations. Journal of Archaeological Science, 9(2): 205-220.

Times and Places: Environmental correlates of Mid-to-Late Wisconsinan human population expansion in North America. In: Early Man in the New World, R. Shutler, editor, Sage Publications, Beverly Hills-London, pp. 13-42.

Selected Research Publications: **D.E. Nelson**

"A study of sand movement in Western Lake Ontario using neutron-activable glass sand." J.P. Coakley, R.W. Durham, D.E. Nelson and R.W. Goble. Proceedings of the International Symposium on Interrelationships of Estuarine and Continental Shelf Sedimentation, Bordeaux. Published in Memoires de l'Institute de Geologie du Bassin d'Aquitaine, 7, 363-368.

"Techniques for tracing sediment movement." D.E. Nelson and J.P. Coakley, Scientific Series No. 32, Inland Waters Directorate, Canadian Centre for Inland Waters, Burlington, Ontario, 40 p.

"Characterization of Pacific Northwest Coast obsidian by X-ray fluorescence analysis." D.E. Nelson, J.M. D'Auria and R.B. Bennett. Archaeometry, 17, 1, 85-97.

"Uses of x-ray fluorescence analysis in Archaeology." Erle Nelson, Syesis, 8, 91-95.

"A criticism of 'Hazards of radiography and high-energy light exposure for thermoluminescence analysis' by H.M. Rowlett." D.E. Nelson and D.J. Huntley. Current Anthropology, 16, 4, 670-671.

"Obsidian sources in the Anahim Peak area." D.E. Nelson and George Will. Current Research Reports, Dept. of Archaeology, Simon Fraser University, Publication No. 3, 151-154.

"Carbon-14: Direct detection at natural concentrations." D.E. Nelson, R.G. Korteling and W.R. Stott. Science, 198, 507.

"Report of a preliminary reconnaissance of a portion of Mt. Edziza Provincial Park." K.R. Fladmark and D.E. Nelson, submitted to the provincial Heritage Advisory Board, Nov.

"Results from the Simon Fraser-McMaster Universities carbon dating Project." D.E. Nelson, R.G. Korteling, D.G. Burke, J.W. McKay and W.R. Stott. Proceedings of the First Conference on Radiocarbon Dating with Accelerators. University of Rochester, April 20. Editor, H.E. Gove.

"Report on the analysis of obsidian artifacts." D.E. Nelson, submitted to G. Macdonald, National Museum of Man, Ottawa, Jan. 5.

"Techniques for the direct measurement of natural ^{10}Be and ^{14}C with a tandem accelerator." J.R. Southon, D.E. Nelson, R.G. Korteling, I. Nowikow, E. Hammaren, J. McKay and D. Burke. Accepted for publication in an American Chemical Society Monograph series, July 21.

"Pacific Northwest tephra identification using XES, NAA and alpha-counting analysis." A.B. Cormie, D.E. Nelson and D.J. Huntley. In "Tephra as a tool in Quaternary Research." Editor D. Reidel. Hingham Press.

"An ion injection system for use in tandem accelerator radio-isotope dating devices." D.E. Lobb, J.R. Southon, D.E. Nelson, W. Wiesehahn and R.G. Korteling. Nuclear Instruments and Methods, 179, 171-180.

"Dietary information from d ^{13}C and d ^{15}N measurements on human bone." B.S. Chisholm, D.E. Nelson and H.P. Schwarcz. Proceedings, Symposium on C-14 and Archaeology, Groningen, (in press).

"The preparation of a ^{10}Be standard." J. Southon, J. Thorson, D.E. Nelson, R. Korteling, J.S. Vogel, T.L. Ku, J.L. Reyss and I. Nowikow. Proceedings, Symposium on accelerator Mass Spectrometry. Argonne National Laboratory (in press).

"Identifying tephras by alpha-counting." A.B. Cormie, D.J. Huntley and D.E. Nelson. Canadian J. of Earth Phys., 19, 662-665.

Mathematics

Faculty with research interests in Earth Science:

Shoemaker

Stephens

Courses with potential Earth Science content:

MATH	362	Fluid Mechanics I
MATH	361	Mechanics of deformable media
MATH	462	Fluid Mechanics II

Selected Research Publications: **E.M. Shoemaker**

Creep rupture of rotating disks and thin shells of revolution. Trans. Amer. Soc. Mechanical Engineers, Ser. E, 32, 607-610.

Creep slump in glacier reservoirs - theory and experiment. J. Glaciology, 27, 393-406.

With L.W. Morland. Ice Shelf balances. Cold Regions Science and Technology, 5, 235-251.

A glacier flow model incorporating deviation stresses. J. Glaciology, 30, 334-340.

Selected Research Publications: **M.A. Stephens**

Multi-sample tests for the Fisher distribution for directions. Biometrika, 56, 169-183.

EDF statistics for goodness-of-fit and some comparisons. J. Amer. Stat. Ass., 69, 730-737.

Axial and biomodal data on the sphere, in "Applied Statistics" (R.P. Gupta, ed.), N.Y., North-Holland Publ. Co.

Vector correlation. Biometrika, 66, 41-48.

Use of the von Mises distribution to analyse continuous proportions. Biometrika, 69, 197-203.

Chemistry

Faculty with research interests in Earth Science:

D'Auria

Course with Earth Science interest:

CHEM 371 Chemistry of the Environment

Selected Research Publications: **J.M. D'Auria**

With R. Bennett. The Application of Energy Dispersive X-ray Fluorescence Spectroscopy to Determining the Provenience of Obsidian. International Journal of Applied Radiation and Isotopes, 25, 361-371.

With D.E. Nelson and R. Bennett. Characterization of Pacific Northwest Coast Obsidian by X-ray Fluorescence Analysis. Archaeometry, 17, 85-97.

With I.G. Stump, J.D. Popham and J. Kearney. Monitoring Trace Elements in the Mussel, Mytilus edulis, Using XES. Marine Poll. Bull., 10, 270-274.

J.A. McCleen, I.G. Stump and J. Holman. Monitoring Trace Elements in Diets and Life Stages of the Onion Maggot, Hylemya antiqua, with X-ray Energy Spectroscopy. The Canadian Entomologist, 111, 1293-1298.

With J.D. Popham and D.C. Johnson. Mussels (Mytilus edulis) as Point Source Indicators of Trace Metal Pollution. Marine Poll. Bull., 11, 261-263.

With J.D. Popham. Arion Ater as an Indicator of Terrestrial Environmental Pollution. Water, Air & Soil Poll., 14, 115-124.

With T.E. Ward, P.P. Singh, D.L. Friesel, A. Yavin, A. Doron, G. Sheffer and M. Dillig. Radiochemical Study of the Combined (r,p^0) and (r,g) Reactions on Bismuth with Proton from 62 to 480 MeV. Phys. Rev. C24, 588-598.

With C. Nichols. Seam and Location Differentiation of Coal Specimens Using Trace Element Concentrations. The Analyst, 106, 874-882.

With J.D. Popham. Statistical Models for Estimating Seawater Metal Concentrations from Metal Concentrations in Mussels (Mytilus edulis). Bull. Environm. Contam. Toxicol., 27, 660-670.

With J.D. Popham. A New Sentinel Organism for Vanadium and Titanium. Marine Poll. Bull., 13, 25-27.

With J.D. Popham. Effects of Season and Seawater Concentrations on Trace Metal Concentrations in the Organs of Mytilus edulis. Arch. Environm. Contam. Toxicol., 11, 273-282.

With R.W. Mathewes. Historic Changes in an Urban Watershed Determined by Pollen and Geochemical Analysis of Lake Sediment. Can. Jour. Earth Sci., 19, 2114-2125.

With J. Wolley. Geranium in an Ancient Tree Using X-ray Fluorescence Spectroscopy. The Analyst, 107, 1279-1282.

With J.D. Popham. Combined Effects of Body Size, Season and Location on Trace Element Levels in Mytilus edulis. Arch. Environm. Contam. Toxicol., 12, 1-14.

With B.E. Snow, R. Shutler, Jr., and J. Payne. Archaeological Ceramic Differentiation Using Trace Element Patterns. Can. J. Chem. (In Press.)

With J.D. Popham. A Statistical Approach for Deciding if Mussels (Mytilus edulis) have been collected from a water body polluted with trace metals. Environm. Sci. and Tech. (submit.)

Specialized Laboratories and Equipment

Department of Geography

Geomorphology Laboratory: a teaching and research facility with sediment analysis equipment (several rhotap mechanical analysis vibrators, visual accumulation tube, automatic fine sediment analyser, thin-sectioning instruments, balances, microscopes and general laboratory facilities).

Biogeography Laboratory: a teaching and research facility with a variety of bioanalytical equipment (computerized spectrophotometer, incubators, facilities for palynological and dendrochronological analyses) and general laboratory facilities.

Remote Sensing and Computer Cartography Laboratory: a teaching and research facility housing advanced electronic instrumentation for photogammetry, surveying and automated cartography (computer terminals, G-2 stereocord, plotters and microprocessors.

Field Equipment: Equipment presently used for Earth Science research includes -- 4-wheel drive vehicle, several survey boats and outboard motors, heavy-duty mounted drilling rig, portable refraction seismography, surveying instruments, high-resolution recording depth sounder, a variety of portable testing instruments (pH, soil strength, specific ion meters, etc.), field camp equipment (tents, generators, stoves, etc.).

Department of Archaeology Laboratories and Equipment

Radiocarbon Laboratory: A fully equipped and functioning radiocarbon dating facility in operation since October 1979 (see Radiocarbon 24(3), pp. 344-351, 1982). Samples are processed in a Phonon Mark IV combustion bomb and converted to benzene, and counted in a Packard model 3255 Liquid Scintillation counter, or a LKB Liquid Scintillation Counter, in a sub-basement room shielded with 6 m of sand.

Zooarchaeology Laboratory and Collection: The laboratory includes research space, microscopes and basic analytical equipment, for a collection of more than 900 complete fish, mammal and bird skeletons from the Quaternary of North America.

Geoarchaeology Laboratory: A research and teaching space including equipment for basic granulometry and soil chemistry. Special equipment includes a Nikon Labphot-Pol petrographic microscope with automated camera

and epilluminator; a Nikon Sk-T polarizing research microscope; a Sartorius 2007 MP analytical balance; motorized diamond saw and thin-section polishing apparatus, and a Bausch and Lomb Spectronic 20 photospectrometer.

Physical Anthropology and Forensic Laboratories: These research and teaching spaces include a large collection of human osteological remains and analytical equipment, including X-ray apparatus.

Field Equipment: A wide array of camping and surveying equipment including a variety of optical transits, levels and alidades, cameras, soil augers, generators, pumps, chainsaws, etc. The department also operates a 4x4 crewcab truck, miscellaneous outboard boats, and a 40' diesel-powered research vessel (MV Sisiutl).

Department of Biological Sciences

The Biological Sciences Department at Simon Fraser maintains a variety of services and equipment that would be valuable for a variety of Earth Sciences research and teaching efforts. Of particular importance is the scanning electron microscope (SEM), Carbon/Nitrogen analyzer usable for sediments, and the palynology/paleoecology research laboratory which houses coring equipment, preparation and analytical areas, reference collections of pollen and spores, and reprint collections.

Department of Physics

A modest investment in Earth Science research has been made in the Physics Department by D.J. Huntley. The main thrust of the research effort here has been the development of a technique of dating sediments using the thermoluminescence of their minerals. As an aid to this a technique has been developed for determining the uranium and thorium contents of samples by alpha counting. In turn this last has led to a new method of determining Th-230 and Pa-231 excess contents in ocean sediments and hence the determination of sedimentation rates. Relevant important equipment includes two thermoluminescence measuring apparatuses, two alpha counters, a magnetic separator, and radioactive sources. The Department also has an X-ray diffraction analyzer which can be used for mineral analyses. A small X-ray fluorescence apparatus is currently being assembled and this can be used for elemental analysis and also for 'fingerprinting' (by trace-element analysis) such things as volcanic ash and obsidian.

A2. Appendix 2

External Referee Reports on the B.Sc. Program

The Earth Science Program Committee decided that once a proposal had been developed it would be sent to a group of distinguished Earth scientists for their review. This was done in May 1984.
The reviewers were:

Dr. R.N. Farvolden
Department of Earth Sciences
University of Waterloo

Dr. E.R.W. Neale
Academic Vice-President
Memorial University, Newfoundland

Dr. N.W. Rutter, Chairman
Department of Geology
University of Alberta

Dr. E.A. Keller
Department of Environmental &
Geological Sciences
University of California
Santa Barbara

Dr. N.D. Smith
Department of Geological Sciences
University of Illinois at Chicago

Dr. D. Tempelman-Kluit
Geological Survey of Canada
Vancouver, B.C.

These reviews were positive and very supportive of the proposal. The reader should be aware in reading these letters that *the present proposal is the result of a series of changes that were made in response to the reviewers' comments.* In several letters reference is made to options in the final year of the major but these have now been removed. The options were modest degrees of specialization in the final year but the reviewers strongly supported the notion that the degree should be one that offers a rounded geological education. In addition, the present proposal includes a stronger foundation of practical fieldwork than was proposed originally.

University of Waterloo

Waterloo, Ontario, Canada
N2L 3G1

Faculty of Science
Department of Earth Sciences
519/885-1211

Telex Number
069-55259

May 28, 1984

Professor M. C. Roberts, Chairman
Earth Sciences Committee
Department of Geography
Simon Fraser University
Burnaby, B.C.
V5A 1S6

Dear Professor Roberts:

I have examined your proposal for a Department of Earth Sciences at Simon Fraser University. Indeed, a strong case can be made for a Department of Geology as an essential academic component of any modern major university because of the importance of "understanding Earth resources and their conservation". This is especially applicable to British Columbia because of the unique geological setting of the province.

On the other hand, a case can be made that this is already being done at SFU through courses taught by the Department of Geography. More faculty and courses could be added to augment this activity without establishing a new department.

But the main purpose of establishing a new Department of Earth Sciences is to ensure that SFU has a place in this sector of science and society. Again, British Columbia is a special place in this regard, and the field is too important to you to be served by anything less than a regular department.

The question then arises as to what kind of department should it be. I agree fully with your position that above all, the new department not duplicate what is now being done by way of teaching and research at UBC. You will find that some duplication is unavoidable, but that should be accepted. The whole exercise should be regarded as a wonderful opportunity to do something new - to create an undergraduate program and a research program that is truly innovative and different, taking advantage of past experience in Canadian universities without the burden of traditions and inertia.

I would focus the program a little more sharply than is done in the proposal. At the beginning at least, the theme of the new department should be clearly defined. What about environmental geology as a main theme? This would include your 1) Quaternary geology and geomorphology, 2) Sedimentology and sedimentary petrology (emphasize Quaternary and modern sediments and present-day erosion), as well as hydrology, "geotechnique" and terrain analysis. Geostatistics is an excellent supporting theme and computer modelling should be included. My suggestion would be to emphasize the effects of extraction of coal (or other minerals) rather than the geology of coal.

Of course this reflects my strong bias which stems from my belief that we all want to have department and courses just like those we knew so well as students, and also that almost all geology undergraduate programs in Canada today include the same courses as they did in 1930! Some of them are even taught the same way, I suspect.

Comments directed at more specific details of the curriculum are listed below.

1) The emphasis is reasonable and appropriate and the criticism above is based on personal interests.

2) I believe you are attempting too much for a new department. Five new options is too much to start. It may dilute your efforts and resources.

3) I believe you are proposing too many courses. Invariably, new departments go through a period of constant changes in courses. It's easier to start out with a minimum of core courses and then add new courses or divide old courses as required.

4) I am surprised to find that computer science is not a requirement in the first or second year. Use of computers should be a requirement for most of the courses in third and fourth year.

Yours very truly,

R. N. Farvolden
Professor

RNF:cm

DEPARTMENT OF GEOLOGY

THE UNIVERSITY OF ALBERTA
EDMONTON, CANADA
T6G 2E3

June 20, 1984

Dr. M.C. Roberts
Earth Sciences Committee
Dept. of Geography
Simon Fraser University
Burnaby, B.C.
V5A 1S6

Dear Mike:

Re: Earth Sciences Department Proposal

Thanks for sending me your proposal for an Earth Sciences Department at Simon Fraser. Needless to say, I'm all for it. I was surprised that a department was not established at the very beginning of the University.

All in all, your program looks reasonable. You have included most core courses but one could argue that there is not enough of some and none of others. For example, there is no principles of geological mapping (2nd structure course), geotectonics (plate tectonics), no separate course in petroleum geology, ore deposits, or clay mineralogy. Probably one semester of geophysics is not enough and there is certainly not enough geochemistry. For your information, I have enclosed our course requirements for specialization and honors and the course descriptions. As you can see, we require a strong general background with only a few options in the fourth year. This way we can protect our students from over-specialization that may limit their employment opportunities. This, I think, is your biggest weakness. The student has too many options without being totally grounded in basic geology.

I feel that our graduates, even though they have some options, say in petroleum geology, could still qualify as a coal or economic geologist, etc. Having been in the business since 1912, our graduates in industry say we should keep our program fairly general - they (industry) can teach special skills that they may need for a specific job. I should add that 80% of our graduates go into industry at the B.Sc. level.

Specifically on your options - I find that Quaternary geologists are only employed at the graduate level. If they get proper grounding in geology at the undergraduate level, they have no time for the number of subjects and courses (many from other departments) that a Quaternary geologist needs today. I would say that my students in the Master's or Ph.D. level would

.../2

qualify as both Quaternary geologists and environmental geologists. In other words, they get a dosage of natural science subjects as well as engineering subjects (from the geotechnical engineering department). This way they could work for an engineering firm, exploration company (boulder tracing) or a research outfit (government or university).

Your geostatistics option has me a little confused. We consider geostatistics a tool in solving geological problems. We require a course in geostatistics (Geol 580) which isn't enough, but really leave it up to the student to get more statistics through options if he or she is inclined that way. We do not sacrifice basic geology.

So my message is to concentrate on geology and minimize specialization. On the undergraduate level you really can't have a "soft rock" leaning - remember "hard rocks" produce the "soft rocks". Of course, on the graduate level this philosophy is entirely different.

One minor point, joint appointments can be a real pain. You may find with some that dual loyalties are an excuse not to satisfy either program.

I hope I have added a bit to your deliberations. Good luck on your proposal. Please keep me informed on what is happening.

Sincerely,

N.W. Rutter
Professor and Chairman

NWR/ean
Encl.

Rec'd June 6, 1984

7 copies

THE UNIVERSITY OF ILLINOIS AT CHICAGO

College of Liberal Arts and Sciences
Department of Geological Sciences
Box 4348, Chicago, Illinois 60680
(312) 996-3154

May 29, 1984

Dr. E. J. Hickin, Chairman
Department of Geography
Simon Fraser University
Burnaby, B.C.
Canada U5A 1S6

Dear Ted:

I am pleased to learn that your university is considering the establishment of an earth sciences department, and am glad to offer some opinions requested in your letter.

First of all, being a product and participant of the American university system, certain operational and philosophical differences with the Canadian view of university education exist at the outset. There is probably no point in my addressing these differences, but they certainly do affect my opinion of what is and is not an "appropriate" course structure for an undergraduate geology ("earth science") program. I taught at the University of Alberta for one year, so I have at least a minimal understanding of how your system works.

I have wondered for a long time why Simon Fraser doesn't have a geology department already. I would venture to guess that it is the largest and most established university in Canada without one. This is especially surprising given the role of geology (and geologists) in Canada's economy. According to Bailly's recent discussion (Geol. Soc. Amer. Bull, 1984, p. 257-264), Canada has the largest ratio of geologists to population of all the major western countries (twice that of the U.S.A.), and falls behind only the Soviet Union and Iceland for the rest of the world. Has the presence of nearby UBC been a deterrent? One must look hard in the U.S.A. to find a university even approaching "major" status that lacks a geology or earth science department. Clemson is the only one that comes to mind.

Two of the principles/guidelines put forth by your Senate committee, b and d in your letter, press me to comment. Why should there be a "soft rock" emphasis? If this is a temporary situation dictated by present faculty specialities, then fine, but I don't see it to be a wise long-term strategy mainly because I don't think undergraduate degrees should be so confined and specialized. How many 18-year-old high school graduates are mature enough to pick Simon Fraser over say UBC because of its "soft rock emphasis"? And what about the third-year student who decides he likes mineralogy or geophysics better? For much of the same reason, I don't understand why you should worry about duplicating the UBC program. It's hard enough to find a high school graduate who is convinced he/she wants to study "geology" at a university, let alone this specialty or that. Perhaps this specialty emphasis and nonduplication principle is a tactic designed to enhance approval of the new department from university and/or provincial administrators. If so, then your programmatic choices may be constrained for the time being, but I think a long term goal for the BS major and honours degrees should be better balance, with no particular concern for duplicating UBC.

Turning to your specific questions:

1. Is the basic science core sufficient? Yes, I think so. The year each of chemistry, physics, and math through calculus is similar to the requirements of most undergraduate geology programs, and the biology and statistics requirements are good additions though not generally required elsewhere (at least not in the USA). On the other hand, at least one semester of computer programming could be required instead of just recommended. Perhaps you could consider two semesters of programming (CMPT 101-4, 104-1) or one programming plus an additional semester of statistics as an <u>elected</u> alternative to the two semesters of biology. The chemistry, physics, and calculus requirements should be sacred.

2. Are there any important omissions in the geology core? No; in fact I think there are too many required upper division core courses, but this may reflect my "American university" bias. Aside from Field Camp, Geophysics, and possibly Sedimentary Petrology and a combined Igneous/Metamorphic Petrology course, I would not <u>require</u> any of the other upper division core courses listed on p. 7 of the proposal. Soil Geography seems particularly unnecessary as a requirement. On the other hand, if the remaining core courses were electives for which courses in other departments could be substituted, more flexibility could be built into the program without necessarily losing quality. Bright undergraduates might be better served by allowing (encouraging) them to take additional advanced coursework in mathematics, computer science, physics, chemistry

Dr. E. J. Hickin, Chairman

or engineering than to be loaded down with unneeded geology courses. I note that neither physical chemistry, differential equations, nor fluid mechanics are listed among the "recommended" courses from other departments. Many of our sharper undergraduates take one or more of these in preparation for graduate school later on.

3. Are the options sufficient in number? If I believed these were desirable at all in an undergraduate program, I would say no because I don't agree with the soft-rock emphasis (or any other "emphasis"). There should be more breadth (e.g., "hard-rock", geophysics, paleontology), assuming there are faculty to teach the necessary courses. My answer, I guess, is a double-no: no, because there are too many specialized options (meaning more than zero), and no there aren't enough options if we're hell-bent on having them! Again, my institutional bias shows. I have no opinion on an Economic Geology option.

4. Given the range of options proposed, are there any advanced course that should be added? They look reasonable, though the inclusion of economic geology and rock mechanics in the Geostatistics Option seems arbitrary. Advanced sedimentology would seem to be as suitable as biostratigraphy in the Coal Geology option. I'm not sure what coal geologists do these days anyway. Is there a real demand for graduates from such a specialty? I would bet that graduates from a "geophysics option" would have an easier time finding employment, which I assume is a principal goal of such an intensely specialized undergraduate program.

I hope these comments are of some use, and that your proposal meets smooth sailing. An earth sciences department at Simon Fraser is long overdue.

No doubt we'll cross paths, but may our next mutual field trip be less sodden than the Scottish one!

Best wishes,

Norman D. Smith
Professor of Geological Sciences

NDS:ms

MEMORIAL UNIVERSITY OF NEWFOUNDLAND
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July 25, 1984

Professor M. C. Roberts
Chairman, Earth Sciences Committee
Simon Fraser University
Burnaby, B.C.
V5A 1S6

Dear Mike:

Belated congratulations on your proposal to establish a Department of Earth Sciences at S.F.U. Your letter came at the beginning of two months of meetings and holidays, was placed in a briefcase for answering en route, disappeared in a briefcase shuffle, only to resurface a few days ago. Sorry!

I am very impressed with your plans. The idea of a rather different, in fact almost unique department of earth sciences will not only be a great asset to S.F.U. but will be welcomed by students and professionals across the country. It complements the UBC program and, I imagine, will draw students who seek a different approach just as Waterloo's innovative emphasis drew undergraduates who wanted a different emphasis from the traditional offerings of Ontario universities.

Academically your Lower Division core looks very sound and very rigorous. I have one query -- the semester hours add up to 60 (24 + 36) out of the first 60 which doesn't allow much flexibility for the student who wishes to work a few Arts courses in with his/her Science courses in order to impart some balance to university education. Also, one must remember the criticism from all segments of government and industry of the students who couldn't write or speak intelligibly. Could you not combine sedimentology and stratigraphy and drop one of the biology courses at that level in order to broaden the student?

The Upper Division core courses provide a solid background in geoscience. I wonder, however, if you are not offering too wide a variety of final year options, each with requirements that are rather too precise. Why not two broad options: one in geomorphology/ sedimentology and the other in economic geology, with the possibility of taking lashings of statistics and computer science or digging further

into chemistry and geochemistry? At the undergraduate level, a course in directed reading or an honours thesis surely would be ample to emphasize coal geology, environmental geology, geostatistics, or whatever.

The minimum of 6 semester hours in Arts, etc. seems low but, I imagine, that is an unfortunate University regulation -- just as is the minimum of one Science (or Math) course for Arts students in most Canadian Universities. Come the Revolution and we'll return to the good old days when Science majors took masses of languages, economics, political science, etc. and Arts majors took chemistry, physics and geology!

I naturally like the interdisciplinary emphasis and hope that your joint appointments will be genuinely active in teaching, e.g. chemists teaching parts of the geochemistry courses and physicists looking after wind blown sand and parts of hydraulics. It is a great education for those in our sister sciences to become involved in earth science courses. In time it opens up whole new vistas to the better ones.

You are wise indeed to draw upon the wealth of government and industrial geoscientists in the Vancouver area as adjunct professors. You are lucky to have so many first rate people in your backyard. I presume you are forming a Dean's Advisory Committee or something of the sort that will involve such people from the start so that they feel they have helped shape it. Such a committee, with rotating membership from government, industry, and another university, is a guarantee of good health to any department in the sciences.

I hope you will set up the M.Sc. program at the same time that you establish the B.Sc. in earth sciences. Having a few good graduate students around to act as counsellors to the undergrads and as catalysts to faculty research is essential to a flying start.

Best wishes for the success of a great enterprise.

Sincerely yours,

Ward

E. R. W. Neale
Vice-President (Academic)

ERWN/gw

UNIVERSITY OF CALIFORNIA, SANTA BARBARA

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO

SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF GEOLOGICAL SCIENCES

SANTA BARBARA, CALIFORNIA 93106

June 8, 1984

Dr. E. J. Hickin, Chairman
Department of Geography
Simon Fraser University
Burnaby, British Columbia V5A 1S6
Canada

Dear Dr. Hickin:

Thank you very much for sending me a copy of your proposal for a department of earth sciences at Simon Fraser University. I am sorry to have taken so long to respond to you. I returned last year from my sabbatical leave and my schedule has been very hectic indeed. I have not had sufficient time to make a complete review of your proposal but I thought I would at least pass on some general comments. The basic science core appears sufficient with the possible exception that I believe that students should take differential equations. It always seems disappointing to require students to take calculus yet never really apply it. I was pleased to note that you will also be requiring a statistics course for the students. I think that is very important indeed. The geology core courses look fairly comprehensive to me. However I am not sure that all students need take paleontology. For some of the emphasis it will be important and for others certainly it will be less so. I think one of the most important aspects of any geology or any earth science department is to offer a really good solid undergraduate education. As such I am not sure that the options that you offer are really necessary. The entering level for geology is a masters degree and I wonder if it's a wise idea to specialize very early in a student's career. For example, I would like to see more basic courses at the undergraduate level. Areas such as geophysics, geochemistry, and advanced structural geology are very important. It has been my experience that students that have a very solid background in the basics may go a number of directions at graduate school. I also think that your proposed program is a bit light on field work. I think it's a good idea to have several field courses prior to the field camp. You might want to have a freshman level course that would simply introduce students to field methods and perhaps some limited exercises. A second course then might involve actual mapping and other projects to better prepare the students for the more extensive field camp. Here at the University of California, Santa Barbara we have an extensive field program and I think the students really benefit from that. Concerning your igneous sedimentary and metamorphic petrology courses, I am not convinced that a whole semester need be given to metamorphic petrology. If I were designing the curriculum I might have three courses in petrology, but assign the workload a little bit differently so that more emphasis is given to igneous and sedimentary rocks.

I see in reading your proposal that you are concerned about the unnecessary duplication of geology offerings at other Canadian universities. I think you should not be too concerned about this if you are going to offer a basic geology or earth science curriculum. There are certain things you are just going to have to cover and by necessity then you're going to have duplication. I believe the weakest part of your proposal involves the students having to pick a specialization at the undergraduate level. I would rather see all students take basic courses in geophysics, geochemistry, advanced structural geology, global tectonics, and field courses.

Again thank you for letting me take a look at your proposal. I wish you all the best in establishing a department of earth sciences at Simon Fraser University.

Sincerely,

E. A. Keller
Associate Professor
Environmental Studies and
Geological Sciences

EAK:ed

Energy, Mines and Resources Canada
Geological Survey of Canada
100 West Pender, Vancouver
V6B 1R8

Énergie, Mines et Ressources Canada
Commission géologique du Canada
100, ouest, rue Pender, Vancouver
V6B 1R8

Your file *Votre référence*

Our file *Notre référence*

May 23, 1984

Dr. Mike Roberts
professor and Chairman
Earth Sciences Committee
Department of Geography
Simon Fraser University
Burnaby B.C. V5A 1S6

Dear Mike:

Thank you for letting me have a look at your proposal for establishing a Department of Earth Sciences at SFU. I have been on a field trip and to the GAC meeting at London, hence the delay in my reply.

My first reaction to the proposal is that its high time for a second earth science department in B.C. As the proposal points out with the quotation from Neale and Armstrong, it is inconceivable that the university does not offer some of the basic courses in geology. It is stranger still that the province only has one geology department. An Earth Science department at SFU will therefore fill two voids. Such a second department can be a complement to UBC's department, not competition. Each group can stimulate and support the other. A second department can open the way for mutually beneficial cooperative efforts.

I think the proposal is brief but thorough and compliment you on the thought that has gone into its preparation. I particularly like several of the ideas it incorporates. Specifically the desirability of unifying under one banner a number of individuals and courses taught currently by faculty of various departments. The concept of using adjunct professors to fill certain teaching needs is progressive and a good way to accomplish the job without having to hire a lot of new staff. I also like the idea of a co-op program.

I am concerned that the program you have outlined requires specialization at too early a stage and that it has too many options. The overwhelming need in the profession generally is for well trained generalists, not for people with specialized training at an early stage. In the end you are surely aiming to produce employable geologists. I suggest more emphasis on a solid undergraduate course, perhaps without any options. There is plenty of room for such a product: few Canadian Geology Departments are now turning out well prepared generalists. Such students can always specialize as the job requires, but the reverse, namely that they will get their general training after having specialized, is unlikely.

Why not consider an undergraduate program which includes most courses of the various options. Thus the following courses, listed as optional, might be required of all students: Advanced Sedimentology, X-ray Mineralogy, Economic Geology, Biostratigraphy, Basin Analysis, Fluvial Systems, Introductory Rock Mechanics, Geostatistics, and Geology of Mineral Deposits. A good case can be made that each of these is necessary to a general geological degree.

My other general comment concerns field training. Few Canadian students are getting anything approaching a good grounding in field geology. I suggest early field courses perhaps when the students first come to the department and repeated for several years. Field training used to come with summer work in Canada. Because there are progressively fewer such jobs now a gap has formed: you can fill it. Quality field training would make your proposed department attractive to students and your graduates attractive to prospective employers. I suggest two or three graduated field courses emphasizing different kinds of rocks and spread over several years.

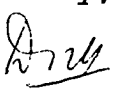
I am uncertain about the kind of person are you trying to attract in the Geostatistics Option? A mining engineer, a slope stability type? Surely someone with a general background can cover or learn the specialty, whatever sort of job he/she will end up doing. The same applies to the Coal Geology Option. What kind of person, what kind of job? A big problem in understanding the geology of coal deposits is in unravelling their structure. The other important concern around coal deposits is getting a handle on the coal quality from the petrology. Therefore it is critical to have someone with a thorough grounding in structural geology and coal petrology here.

I think I have answered some of your specific questions in the foregoing harangue. Namely, Is the basic science core sufficient, does it contain an unnecessary number of courses? and Are there important omissions in the core program? To the question of an Economic Geology Option I answer yes, but within the context of the foregoing you perhaps don't need it. This specialty will be well served if you go the route outlined. Your fourth question concerns additional advanced courses that should be offered. The only one I think you might consider adding is a third or fourth year level structural geology course.

To summarize: the proposal as it stands looks like it is motivated by the idea of getting all earth science related professors into one department but not by a plan for a focussed new entity. This needs to be corrected. I don't feel that the niche you plan to carve for yourselves, namely the "softrock" route, is a unique new offering and I feel you are selling yourselves short by offering it amongst several other options. Instead I suggest going for one strong undergraduate course with a broad general grounding and few options. I suggest inclusion of several graduated field courses as part of such a program. There is plenty of room for such a department in Canada.

Mike, I hope this is useful to you. I certainly think you should forge ahead and will discuss this further if you wish.

Sincerely,



Dirk Tempelman-Kluit

A3. Appendix 3

External referee reports on the graduate program

These letters of evaluation were solicited by the Assessment Committee chaired by the S.F.U. Dean of Graduate Studies. This Committee was charged with the task of evaluating the M.Sc. program of the proposed Department of Earth Sciences. The letters form two groups: those presenting the U.B.C. view, and another consisting of responses from the much wider Earth science community encompassing university, industry and government.

1. External referee reports

2. U.B.C. correspondence

Appendix 3

1. External Referee Reports

Energy, Mines and Resources Canada
Geological Survey of Canada
100 West Pender, Vancouver
V6B 1R8

Énergie, Mines et Ressources Canada
Commission géologique du Canada
100, ouest, rue Pender, Vancouver
V6B 1R8

Your file / Votre référence

Our file / Notre référence

December 19, 1986

Dr B.P. Clayman
Dean of Graduate Studies
Simon Fraser University
Burnaby, B.C. V5A 1S6

Dear Dr. Clayman:

Thank you for letting me preview the proposal for the new Master of Science program in Earth Sciences. I have read the document carefully and compliment you on what you have put together. I encourage you strongly with the concept - the opportunity for B.C. to have a second Earth Science program to augment that offered at UBC is a positive step. I only have a few specific comments, but will address your three specific questions first.

Is the academic quality of the M.Sc. program comparable to, or higher than, that of other programs with which you are familiar? As far as I am able to judge from the writeup the course requirements and the course list are fine and the proposed program looks adequate. I know that I'm preaching to the converted when I remind you that the quality of the eventual program will depend largely on what actually gets taught in the courses, which depends mainly on who does the teaching, and on how loaded down those individuals are with other duties, how well their efforts are integrated and how well the effort is supported through resources. The resources question is addressed nicely in the document and they seem adequate - they have been certainly been carefully considered. This leaves only the most important, and least quantifiable, question - who will teach. The academic quality of the proposed program depends heavily on the answer.

Here I would urge you that the proposed new Earth Science program be built around new faculty - specifically new geologists - as now conceived it is to be largely staffed with

.../2

Canada

existing faculty and aims to draw mainly on them for its energy. Without taking anything away from the individuals this will give you an Earth Science program in name only.

Given that understanding the makeup, disposition, properties and origin of surface materials is critical to predicting and managing man's intelligent use of the surface environment justifying the need and identifying the customer for the program is easy. It is difficult to estimate the future demand for graduates and the number of students likely to seek admission to the program- your second and third questions. The answer will vary with economic climate. Forecasting this is not my game and I am not going to try here. Your most informed answer may come from someone in a university department in western Canada that runs similar programs.

I reiterate some points from my original response to the proposal. We need more and better instruction in field geology not just in B.C., but in Canada generally - many geology graduates are uncomfortable with real rock exposures. We need more glacial geology and glacial geomorphology - these are becoming lost arts. We also need more engineering geology than is currently being taught. The proposed program can fill one or more of these voids.

I have a few minor specific questions - what is the difference between the proposed "Clastic Sedimentology" and "Physical Sedimentology" courses and between "Fluvial Geomorphology" and "Fluvial Sedimentary Systems" courses?

I trust that these comments are useful to you and urge you to press ahead with this initiative.

Yours truly,

Dirk Tempelman-Kluit
Research Scientist

MEMORIAL UNIVERSITY OF NEWFOUNDLAND
St. John's, Newfoundland, Canada A1C 5S7

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January 5, 1987

Dr. B. P. Clayman
Dean of Graduate Studies
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Dear Dr. Clayman:

This is in reply to your recent letter asking for my views of the proposed M.Sc. program in earth sciences at S.F.U. I have read the program outline, consulted with two colleagues, Dr. John Gale (an engineering geologist) and Dr. Robert Rogerson (a physical geographer) and declare myself generally in favour of the program but with some serious queries and reservations.

The idea of initiating a modest program in graduate studies is sound. Not only is a program required to complement UBC's offerings but that School and the province would benefit from some serious competition. The idea of focussing on areas where you already have a creditable reputation, faculty in place, and adequate facilities and equipment is a good one. I like the idea of recruiting part-time students from industry and providing them with opportunity for academic upgrading and I like the idea of recruiting part-time faculty members in special discipline areas. My guess is that this will fill a pressing provincial need and, if done very carefully, can be done well.

That said, my reservations are best expressed by answering your specific questions:

(1) Concerning academic quality -- it is hard to state whether or not it is comparable to that of other programs because much will depend on what is taught under the various subject headings (course outlines were not

included with the program outline) and even more on who will teach it. Also, much will depend on whether a thesis is required (not clear in your outline) and, if it is, what sort of standards will it have to meet. The outline suggests that it is an optional single course equivalent.

If the thesis is optional and the M.Sc. can be gained by course work alone, a six-course program in which several of the courses are methodological suggests a light weight degree. If a solid, publishable thesis is required, then five courses in addition to it present a time-consuming obstacle course.

Although you plan to offer an unusually wide range of courses for a new program, some of the core courses of an admittedly Quaternary specialization would seem to be missing. Many of your graduates who are not proceeding on to Ph.D.'s will likely become involved in such mundane things as waste disposal, groundwater contamination, and various engineering projects. For this reason, I would expect courses in hydrogeochemistry and contaminant hydrogeology to have a prominent part in the program. Also, many of the graduates are going to work closely with engineers and will have to understand the language of engineers. For this reason, I would expect the offering of rigorous courses in soil mechanics and fluid mechanics.

My hope is that you are requiring a sound foundation in basic sciences and mathematics as an entry to this program and that some of the topics I have mentioned above will be covered under existing course headings, e.g. hydrometeorology and groundwater hydrology.

Superficially, however, the program has a "soft science" aspect which may be more akin to Waterloo's environmental M.Sc. than to its very successful earth science M.Sc. I would suggest that a geological or geotechnical engineer be included among the sessional instructors hired. One or

two such people should eventually be considered for full-time positions in Earth Sciences with a Quaternary emphasis.

(2) Future demand -- at present, judging by course offerings, I would guess that you are catering to too narrow a group and that you will fill the demand in a few years. However, if you produce people suitable for the ever-growing fields of contaminant geology and engineering--related earth science, then your enrolment predictions are realistic.

(3) I am in no position to give an estimate of the numbers who would seek to be admitted -- except to state that if you advertise it well you should have all you can handle initially. After that it will depend on what you turn out and the reputations of those identified with the program.

I enclose, with his permission, the memorandum that Professor Rogerson sent to me on your program. You will note that I disagree with his opinions on the enrolment of part-time graduate students and the use of part-time faculty members. His experience is based on the local scene where we have only a small scientifically-educated population to draw upon. I have seen this work well elsewhere, as you must have, and it is one of the attractive aspects of the program. Professor John Gale, who had a very successful career in the Waterloo program before joining us at Memorial, is enthusiastic about a similar program in British Columbia but feels that as proposed it is rather a smorgasbord offering that may lack vigour. He would be pleased to correspond further with you or your colleagues on the subject.

I hope this is helpful. All best wishes.

Sincerely yours,

E. R. W. Neale
Vice-President (Academic)

ERWN/gw

c.c. Dr. John Gale
Dr. Robert Rogerson

MEMORIAL UNIVERSITY OF NEWFOUNDLAND
St. John's, Newfoundland, Canada A1B 3X9

Department of Geography

Telex: 016-4101
Tel.: (709) 737-7417/8

DEC 30 1986

December 30, 1986

TO: Dr. E.R.W. Neale, Vice President(Academic)

FROM: R.J. Rogerson, Head, Department of Geography

SUBJECT: M.Sc. in Earth Sciences at Simon Fraser University

I welcome the establishment of a Master of Science in the Earth Sciences at Simon Fraser University. I have not seen the proposal for the undergraduate program referred to, nor know the identity of faculty who will be hired, have been hired, or seconded to the department. Were SFU to follow the practice of MUN, the make-up of the department, the degree to which faculty are research and graduate-student oriented, would be important in defining what type of program and which specific courses are offered. Graduate instruction is a specialized and highly demanding area of academic responsibility, and quite frankly, not all faculty are up to it. The idea of using "sessional instructors from the local geoscience community for those courses where campus expertise is lacking" is likely to be a poor idea. Our experience at MUN is that such people are appropriate for a seminar, a lab, an excursion, a lecture or two, but never for a course at the graduate level.

My experience at MUN is that part-time graduate students are a big problem. They seldom develop a sense of identity with department or supervisors, and are usually reluctant to consult closely with supervisors. Their work in courses and in theses (which usually take forever!) is often of marginal academic value, though businesslike and usually well presented. They write reports which are usually heavy in description, but lightweight in perception and real thought. In geography we no longer accept part-timers, but insist that all MA or MSc students are full time for at least one semester. I forecast that a program which has part-timers as its core is a program which will face a mountain of logistical problems and will wrestle with maintaining true academic standards.

The existing courses and those proposed are, I assume, of one semester duration. There is no single focus; particularly odd are Coal Geology, and Subsurface techniques (mining, exploration, survey?) which may serve a local need, but which do not match well with the other topics. Perhaps they represent the interest of one of the projected faculty.

The program is not clear to me. EASC 600 is compulsory, but is EASC 800, the MSc Thesis? If not problems will ensue. A 6-course MSc is too weak if it is a course only program and would not provide an adequate introduction to doctoral work. If the thesis is compulsory, and subject to external examination (therefore having to meet a general Canadian Masters

thesis standard), five other courses may be too many. At MUN, 2 courses is the minimum, and few programs which produce graduates within 2 or 3 years have as many as 6 courses.

The model proposed is not to my mind close to those at U of A and U of W: both of which offer the PhD in earth science areas.

Specific answers to the questions asked are:

1) impossible to judge quality from this information. The structure is, as yet, ill-defined. The calibre of faculty will be a critical item.

2) the demand for an EASC MSc is undoubtedly there.

3) no, but the estimates they provide are impressively ambitious: if they get them it will be a big program, not as here described, a small one.

I recommend the proposal be carefully rewritten by an academic to clarify some of the uncertainties I identify. I hope they get it sorted out because I find it amazing that Universities in B.C. put so little emphasis on undergraduate and graduate studies in Earth Sciences.

Robert J. Rogerson
Professor and Head

RJR:bam

IMPERIAL METALS CORPORATION

January 26, 1987

Dr. Bruce Clayman
Dean of Graduate Studies
Simon Fraser University
Burnaby Mountain
Burnady, B.C.

Re : Geology Department and Masters Degree Program at SFU

Dear Dr. Clayman,

This letter is a response to your enquiry concerning the feasibility of a separate Department of Geology or Earth Sciences at SFU, and the potential effectiveness of a Masters Degree Program. As mentioned in our conversation a few days ago, certain aspects are difficult to forecast, and the conclusions must be regarded as tentative.

(1) I fully support the principle that a Department of Geology be established at Simon Fraser University. It is unrealistic that a school of this size does not have a separately organized Earth Sciences unit. This area of science is one of the fastest growing areas of knowledge, a fact which has been recognized by many other Canadian universities which are smaller than Simon Fraser. In my opinion, such a department should not attempt to be "all things to all people" but should accept a more specialized role in its early years.

(2) A Masters Degree Program is a desirable adjunct to a Geology Department. To be viable, which entails attracting candidates, it will need to offer something different and/or better than can be obtained elsewhere in Western Canada. The proposal aims at specialization in surficial and environmental geology. These are certainly growing segments of Earth Sciences, but have also attracted a lot of attention at other Canadian schools with the result that similar emphasis has been taking place at many departments in Eastern and Central Canada during the past decade.

(3) The potential enrollment of students in a new department and for a new post graduate course is very difficult to forecast. Interest has been dramatically affected in past economic cycles by the perceived health (or otherwise) of the resource industry. There is currently something of an over-supply of new geologists coming on the market. I suspect that many of the

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undergraduate students in new department of geology will initially be taking courses as adjuncts to other major degree courses. In the Masters Degree Program, I would not expect more than 3-5 applicants per year, unless a clearly defined specialty exists which cannot easily be duplicated elsewhere in the West.

(4) It is also difficult to comment on the funding aspects of the proposal. To do so would require more knowledge of SFU and its financial resources and potential sources of funds than I have. One note of caution is that NSERC funds have been frozen by the Government so competition for financial assistance from this source will be heavy.

I hope that these answers will be of some use to you and your committee. I regret that I cannot be more specific. I am presently a member of the NSERC Earth Sciences Committee, and will shortly be attending the Annual Review Meeting in Ottawa. This usually provides much insight into current developments in the Earth Sciences of Canadian universities. If there should be anything relevant, I will relay it to you after my return in late February.

Yours sincerely,

Hugh C. Morris

HCM/il

Appendix 3

2. U.B.C. Correpondence

THE UNIVERSITY OF BRITISH COLUMBIA
6339 STORES ROAD
VANCOUVER, B.C. CANADA
V6T 2B4

DEPARTMENT OF
GEOLOGICAL SCIENCES

December 22, 1986

Dr. B.P. Clayman
Dean of Graduate Studies
Simon Fraser University
Burnaby, B.C.
V5A 1S6

Dear Dr. Clayman:

In response to your letter of November 17, 1986 I enclose my comments on your proposed M.Sc. program in Earth Sciences item by item as numbered in the description you sent me. In addition, I offer the following response to the specific questions you raise in your letter.

1. It is not possible on the basis of material supplied to evaluate the academic quality of the proposed programs as no details are provided. It seems likely however that the quality established by your Geography Department will be maintained so tradition is in your favour.

2. Demand for Earth Science graduating students at all levels is remarkably low relative to the past dozen years or so. In the mineral industry optimists are anticipating slow revival of the industry but there is a lot of slack to be taken up among unemployed earth scientists before the employment situation can be considered rosy. The same arguement applies to the Petroleum industry and geotechnical - groundwater hydrology fields. Even environmental geosciences has not expanded to become a major employer as might have been anticipated 5 to 10 years ago.

   U.B.C. graduates (M.Sc. and Ph.D.) in earth sciences find either company or government jobs or, as increasing numbers are doing, enter the service contract market in which they end up with a series of temporary jobs and/or part-time work. Present job prospects are dim and there is substantial competition for jobs with clearly defined career progress components.

...../2

Others, less optimistic, look upon the mineral industry as a "Sunset Industry" with decreasing potential for employment in the high cost North American market. Employment in the industrial minerals segment may offset present decreased employment possibilities if a pronounced economic expansion takes place in B.C., an unlikely scenario over the short to middle term.

3. I can add little to the estimates in the proposal except to relate them to our experience at U.B.C. The Geography Department at U.B.C. has not experienced dramatic increases in enrolment in graduate programs in physical geography and geomorphology. Output of M.Sc.'s and Ph.D.'s total 1 to 4 per year since 1979-80. Geological Sciences get half a dozen requests per year for admission to graduate programs in structual geology and hydrogeology. Some are referred to Geography, others to Civil Engineering and some are accepted, particularly in groundwater hydrology and more recently geotechnical aspects of geological engineering such as slope stability and mass movement. Demand seems to be more-or-less static in both Departments; certainly there is no large horde waiting to enter these types of programs.

4. Most new courses that form part of the proposed program have their counterparts in graduate or (in a few cases) upper level undergraduate courses at UBC. The only course for which there are no clearly equivalent courses at UBC is EASC 680 (at UBC probably included, in part, in Geol 445, Geop. 400).

   Courses already in place at SFU reflect different emphasis than at UBC even though some duplication is apparent.

   In general, it appears that the newly proposed courses are almost coincident with courses at UBC and except in archaeological and Quaternary geology fields would represent duplication of effort with UBC and divert competition for potential students.

...../3

In general, my view is strongly against the SFU proposal for the very obvious reason that we already have substantial and wide ranging but underfunded earth science programs at UBC. Why produce another small department that will be strained to fulfill the proposed aims and will certainly detract from efforts to restore earth science at UBC to their position of 5 years ago, particularly in times of decreased student demand.

In recent years Geological Sciences has had a net loss of more than 5 FTE faculty slots not to mention losses in Oceanography, Geography, etc. Total losses of professional earth science personnel at UBC are substantially greater than the eight new faculty positions in the SFU proposal. Under these circumstances it is difficult for me to support a program that is in large part of duplication of courses and expertise here at UBC.

I would, on the other hand, applaud continued support and growth in fields at SFU that are already complementary to the expertise at UBC including Quaternary Geology, Archaeology and remote sensing, in particular. It seems to me that continued effort in these fields at the graduate level can be accomplished easily through the Institute of Quarternary Research and that a new Earth Science Department is premature at this time.

Yours very truly,

A.J. Sinclair
Head

/sg

H5/30

DETAILED COMMENTS

ON PROPOSED M.SC. PROGRAM

IN EARTH SCIENCES

AT

SIMON FRASER UNIVERSITY

BY

A.J. SINCLAIR

(Sections numbered as in summary of proposal).
(See also covering letter)

December 22, 1986

II: PROGRAM DESCRIPTION

1. Objectives:

All are laudable although there is clear potential for duplication (not necessarily bad) with offerings at U.B.C. Quaternary Science must seriously overlap the Physical Geography - Geomorphology programs in the Dept. of Geography, U.B.C., and will surely overlap geological engineering and physical environmental studies in the Dept. of Geological Sciences. This field has been recently supported at U.B.C. by the appointment of a new faculty member in surficial geology, Dr. K. Wayne Savigny, Associate Professor.

Similarly, the field of sedimentology will potentially overlap comparable work in our Departments of Geography and Geological Sciences.

Geostatistics at U.B.C. is taught at the undergraduate level in the Department of Mining and Mineral Process Engineering and Geological Sciences, and at the graduate level in the Department of Mining and Mineral Process Engineering. Several graduate degrees in this field have been awarded in the recent past and several are in progress.

but see 2 in covering letter

I am uncertain as to what is meant by the term environmental geoscience. If it includes physical aspects related to geotechnical matters or groundwater and surface waters then it will overlap and probably duplicate programs in Geological Sciences and Geography. Similarly, we have a long tradition in applied geochemistry, with its overtones of environmental geoscience.

The foregoing details are mentioned to allow some perspective of the extent to which the proposed S.F.U. program might overlap and/or duplicate existing U.B.C. programs. I don't regard this as bad in principal if there is adequate demand for graduates in these fields i.e. is there some numeric justification to the programs.

2. Relationship of degree to the role and mission of the University.

The M.Sc. program is a "direct extension" of a proposed undergraduate program. This need not be the case. Much of what is recommended for a graduate program could be handled through an "Earth Sciences" Institute without the necessity of a new undergraduate program. It is unfortunate in my view that a fairly dramatic expansion of earth science offerings is being envisaged at a time when programs elsewhere at both the graduate and undergraduate levels are undergoing retrenchment because of static or seriously declining student enrolments.

Few faculty

Insofar as the envisaged program further develops ongoing activities at SFU it can be handled as a multi-disciplinary Institute at the graduate level and need not depend on a new expanded undergraduate program.

a small dept!

3. The University of British Columbia offers graduate degrees in a variety of Department's that qualify as earth sciences.

Geological Sciences (including Geological Engineering)
Geography
Soil Science
Oceanography
Geophysics and Astronomy

In addition, some of our geological engineering students pursue M.A. Sc. programs in Mining and Mineral Process Engineering (rock mechanics) and Civil Engineering (Geotechnics) in fields with an important earth science component as well as an environmental geoscience component.

4. Relationship to the Program at U.B.C.

The suggestion that U.B.C. cannot accommodate part-time graduate students is incorrect. Of the four graduate students I am personally supervising at the moment two are part-time. Page 132 of the present U.B.C. calendar indicates that part-time study is accessible to graduate students in many programs including Geological Sciences, Geography, Geophysics, Civil Engineering, and Mining and Mineral Process Engineering, i.e. in most of the "earth science" departments on campus. The S.F.U. program is therefore clearly not required for that particular reason.

Any Earth Science program at S.F.U. must necessarily duplicate some aspects of programs at U.B.C., particularly as related to core courses. However, it is desirable that S.F.U. programs complement those at U.B.C. as much as possible rather than duplicate them extensively.

Quaternary research is clearly a field where both Universities have existing expertise, at U.B.C. in Geography and Geological Sciences and at S.F.U. through departments affiliated with the Institute of Quaternary Research. It seems to me that it is preferable to strengthen existing fields of expertise and perhaps each group develope new fields rather than knowingly duplicate strength in a particular field such as geomorphology, for example.

already separate programs.

Sedimentology is a traditional field of study at U.B.C. both in terms of Quaternary Geology (Geography Dept.) and older materials (Geological Sciences). The selection of sedimentology as a field of expertise at S.F.U. is an expansion into a field with room for duplication of U.B.C. endeavours if some interaction between appropriate representatives of the two schools is not forthcoming. The same could be said of the field of environmental science, a somewhat nebulous term that should be spelled out in detail and the program designed to complement U.B.C. offerings.

MIKE STEPHENS

Geostatistics means different things to different people. Considering the course offerings it is not clear to me that there is any plan to do research in geostatistics, rather it is a tool to be applied to earth science problems. I believe that geostatistics is essential in this respect in all earth science programs. If research were undertaken in this field it is unlikely that it would conflict with a geostatistical research at U.B.C. which is very much directed towards mining and mineral exploration - related topics.

The S.F.U. programs could have been complementary to those at U.B.C. if discussions had taken place with U.B.C. personnel as the S.F.U. program evolved over the past few years. This was not the case and the lack of detail on how the S.F.U. programs will be focussed leaves one in limbo regarding the extent to which existing and proposed earth science programs will duplicate each other. 5. Curriculum

In the existing courses there is substantial departure from what is offered at U.B.C. Although some overlap exists, understandably, the new courses for the most part have an exact counterpart in existing U.B.C. courses. Of course, the contents of courses with comparable names can differ.

There is no indication that a thesis is required. I personally believe that a clear distinction should be made between a classical masters (with thesis) and a "non-thesis" masters.

6. Missing

7. Missing

8. Consultation with Non-University Agencies.

I have only seen the responses of (g) six individuals across Canada and the United States. The enthusiasm of distance and lack of awareness of the local situation regarding University funding is clearly reflected in their tremendously positive and now outdated responses.

There is no indication of serious discussions with appropriate U.B.C. personnel. WHY

III: NEED FOR THE PROGRAM

1. Rationale for the Programs

Academic: The justification here seems to be on the basis of mineral wealth in the province but there is little indication that any of the proposed programs are related particularly to the mineral industry. The second area used to justify the programs, geological engineering related programs, is clearly one of the strengths at U.B.C. Our groundwater hydrology group is one of the best in North America. We have recently added a geotechnical engineer - surficial geologist to our faculty. The Geography Department also covers this type of training. Students from these engineering and Quaternary programs, as well as from other departments at U.B.C. are potentially involved in industrial minerals as are graduates of more general geological programs. Part-time graduate programs are commendable and have worked well at U.B.C. for some years.

In summary, the justification presented here clearly pertains to existing programs at U.B.C. even more so than to the proposed SFU program.

2. Enrolment

Evidence from people attending short courses of the Institute of Quarternary Research borders on heresay and certainly does not constitute hard data regarding demand for the proposed M.Sc. program.

Experience at U.B.C. shows:

(1) A small static demand exists for entry to both undergraduate and graduate programs with a Geomorphology emphasis. There have been a total of 1 to 4 graduating M.Sc. and/or Ph.D. students per year since 1979/80.

(2) There is a decreasing demand for entry to graduate geology programmes at U.B.C., particularly by qualified Canadian students. In Geological Sciences we have expertise in Coal Geology and Coal Petrology, Sedimentology, Geostatistics, Groundwater Hydrology, Surficial Geology (incl. aerial photography and Remote Sensing), for which we have maintained roughly constant graduate enrolment over the past decade.

Enrolment Predictions

Predictions listed do not appear unrealistic but are speculative. It is unclear what proportion of existing Geography graduate students would be perceived as enrolling in the proposed programs. Four graduate students per potential supervisor is probably optimistic but might be achieved. Geological Sciences at U.B.C. presently operates at an average of three students per supervisor, a moderately heavy load when added to teaching and other duties.

3. Types of Jobs for which Graduates Will Be Suitable

These comments are generally true but ignore the question of demand. At the present time there is a dramatic decrease in demand for earth scientists with the principal exception being in the field of geophysics. The Federal Geological Survey would not be a career track for many graduates of this program because they hire scientists with a Ph.D. Even provincial surveys prefer Ph.D.'s of their earth scientists.

Industrial jobs are not available to nearly the extent they were in the recent past. There are many local geologists with Master's and Ph.D. degrees who have lost their jobs in recent years leading to a tremendous local surplus of highly qualified people who unwillingly were reduced to part-time consultants and/or part-time service/contractual professionals.

To imply there is demand for graduates of the programs by listing "jobs for which the graduates will be suitable" is to totally ignore the effect that restraint has had on both local and national hiring practices.

IV: PRESENT AND PROJECTED RESOURCES

1. Administrative Personnel

I interpret this section to mean that in addition to the 2 1/2 administrative secretarial staff required for the proposed undergraduate program an additional graduate secretary will be required.

2. Faculty

The use of sessional lecturers from the local geoscience community is a commendable approach to supplementing faculty expertise in my view, and has worked well in the many ongoing cases where we have used this approach in the Department of Geological Sciences at U.B.C. We have one of the largest concentrations of earth science expertise in North America in the Vancouver area and it is most appropriate that those outstanding individuals outside the University be involved as much as possible in career-related programs at the universities.

3. Library Resources

It seems to me that if the thrust of this program were fully documented it would be relatively easy to list journals, monographs, maps etc. that will be required and then come up with a specific cost of additional library resources. As an example, the DNAG publications on North American geology will be essential to all Earth Science libraries at a minimum pre-publication cost of $2,000. Costs of important books can build up to a very high figure!

4. Capital Costs

It seems to me this section should include a detailed cost estimate.

5. External Funds

No comment

A.J. Sinclair

/sg

H5 5/29

THE UNIVERSITY OF BRITISH COLUMBIA

INTERDEPARTMENTAL MEMORANDUM

TO: Dr. D. R. Birch
Vice President Academic and
Provost

FROM: A.J. Sinclair, Head
Dept. of Geological Sciences

DATE: February 17, 1987

Re: SFU Earth Science Dept. Proposal

On February 11, 1987 a combined group from UBC and SFU met to discuss the SFU proposal for a new Department of Earth Sciences. The group consisted of H.O. Slaymaker, R.M. Ellis and A.J. Sinclair from UBC and M.C. Roberts and E.J. Hicken from SFU. The meeting began in my office at 5:00 p.m. and adjourned to the Faculty Club for dinner.

The following views were presented by the UBC contingent.

1. UBC in general favours some form of earth science department at SFU, one that does not overlap excessively with existing programs at other B.C. institutions, but rather, builds on expertise already in place at SFU and complements earth science offerings elsewhere in the province.

2. The proposed undergraduate program at SFU is perceived as essentially duplicating offerings at UBC.

3. Undergraduate enrolment in Geological Sciences and Geological Engineering at UBC has dropped overall by about 40% from a high of four years ago. A time of such seriously declining enrolment provides no encouragement for duplicating an existing program at another B.C. University.

4. SFU should seriously consider two alternatives, viz.

   (a) delaying implementation of the proposed program until some later date when it becomes evident that student demand is significantly greater,
   or

   (b) rewriting the earth science proposal with a more specific focus to emphasize Quaternary and Environmental sciences, fields in which SFU has specialized in the past and which provide a useful complement to programs offered at UBC. Some core courses would necessarily overlap with those at UBC but significant numbers of upper level courses would be oriented particularly towards Quaternary and Environmental sciences. Such a program would meet an important and growing demand for scientists concerned with environmental problems as well as providing the basis for general earth science training for non-specialists.

...../2

5. The proposed undergraduate focus would lead naturally to graduate research in comparable and allied fields and would effectively be building on existing strength at SFU while clearly complementing offerings at UBC.

6. A suggestion was put forward that the two universities should investigate the possibility of exchange-teaching from time to time of selected courses in the earth sciences. For example, a SFU faculty member might teach a course in Quaternary geology at UBC; whereas a UBC faculty member might teach a course in sedimentology at SFU.

The meeting was useful in airing views and supporting opinions. While there was extensive appreciation of each others views I conclude that we parted amicably with an appreciation of each others outlook and agreeing to disagree somewhat and to maintain closer contact in the future.

A.J. Sinclair
Head

AJS/sg

cc: H.O. Slaymaker
R.M. Ellis
E.J. Hicken
M.C. Roberts

H 5/84

To: Dr George Ivany
Vice President Academic
and Chairman,
Academic Planning Committee

From: Dr Michael C. Roberts
Chairman, Earth Sciences
Committee

Subject: Proposed Earth Science Department

Date: 1987:02:16

Since the letter from Al Sinclair arrived on your desk I have met again with the Heads of Earth science Departments at U.B.C.. An outline of the discussion at that meeting and a brief summary of our impressions are given below for your information; I was accompanied by my co-proposer, Ted Hickin (Geography) and the meeting took place at U.B.C. on Wednesday, 11 February, 1987 (3.30 pm - 8.00 pm). The U.B.C. participants were

Dr A. Sinclair; Head, Dept of Geological Sciences, UBC
Dr R. Ellis: Head, Dept of Geophysics and Astronomy, UBC
Dr O. Slaymaker: Head, Dept of Geography,UBC and Chairman of the Earth Sciences Committee, Faculty of Science, UBC

These three administrators were asked to arrange a meeting with us by the Vice-President, Academic, at U.B.C., Dr Dan Birch. The intent of the meeting was for us to explore their concerns about the structure of the proposed department at S.F.U. vis-a-vis Geological Sciences at U.B.C.. The discussion was about **both** the undergraduate and the graduate program.

We will summarize briefly the main topics that were discussed in the 4 hour meeting.

OVERALL THRUST OF THE PROGRAM

All three U.B.C. people took the position that the details of our M.Sc. proposal were not of concern to them. They believed that the quality of the M.Sc. program was a direct function of the people we hired. If we brought excellent people to our campus then our graduate program would reflect that quality and details of the actual structure of the degree was really an internal S.F.U. matter.

With respect to the undergraduate Earth science proposal they wanted us to emphasize the Quaternary and environmental geoscience aspects of the program. After some probing they acknowledged that they were comfortable with our position that sedimentology was an area of study that would not unduly duplicate their offerings. Coal geology, on the other hand, was regarded by Dr Sinclair in particular as an entirely

inappropriate choice of course in an S.F.U. program because of existing and under-utilised resources in this area at U.B.C.

Dr Sinclair was concerned that the distinctive nature of the S.F.U. program be emphasized so that its focus be clearly distinguished from that of U.B.C.. It was the S.F.U. position that, indeed, our proposal made such a distinction; in either case we remain willing to modify the current document prior to presenting it to Senate in order to make clear the case for the distinctive nature of the S.F.U. program.

Dr Ellis was receptive to the notion that we wished to have a geophysics component in the program. In fact, he encouraged the inclusion of geophysics courses as an important part of the education of geologists.

In these discussions our U.B.C. colleagues made it quite clear to us that they thought our program was academically sound but that they wished we were proposing our iniatiatives at some time other than the present. They repeated at length that this was a bad time for a new program. We suggested that there was never a good time to bring forward new programs and that this was as appropriate a time as any other! Indeed, we would argue that, in addition to its strong academic rationale, our program has the virtue of being sufficiently applied in nature that it would add another badly needed dimension of skills for direct use by students entering the geoscience industry.

DUPLICATION

Our position in this part of the discussion was that our basic undergraduate requirements simply accorded with requirements of other geology-based departments across Canada. The duplication that exists was of a kind that occurs between all academic departments of the Provincial Universities: eg. all History Departments require a course in Canadian History! This is a duplication of necessity; it is accepted because there are certain essential common elements in the curriculum of any discipline.

It was agreed in our discussions that the above position is quite reasonable in principle. Where the U.B.C. position became critical was over the inclusion of upper level courses common to those at U.B.C.; here the main offenders clearly are the coal and economic geology courses in our curriculum. They argued that these courses were clear duplication of their specialised offerings and that they should be removed from our program. We agreed that this may be an area of compromise.

ENROLMENT DECLINES IN GEOLOGY AT U.B.C.

It emerged that one of the major concerns of Dr Sinclair, in the final analysis perhaps his only real concern, was the impact of the S.F.U. program on enrolments in his department at U.B.C.. Since the contraction

began in the mining industry in B.C. in 1982 there has been a sharp decline in enrolments in geology at UBC. Until there is a resurgence in UBC enrolments he believes that there should be no new initiatives of a geological variety by us. We argued that we will be attracting students into a program that will be different enough from U.B.C. Geological Sciences to have a minimum impact on their enrolments. Students wishing to receive an academic training with an emphasis in surficial geology were not going to be the same as those in U.B.C.'s traditional market: candidates for a hard-rock/ore geology ticket into the mining industry. To the extent that the S.F.U. initiative is a professional program, our students will be trained to enter the industrial minerals sector of the mining industry (sand and gravel; clay), and to compete in the area of environmental geoscience.

An additional factor we believe must be recognized is that we will continue to attract students from the growing population of the Fraser Valley (Surrey, Coquitlam etc) who will attend S.F.U. and not U.B.C. as a matter of choice at the Institutional level.

CONCLUSIONS

In short, the U.B.C. position is that if the economy were growing and if U.B.C. did not have enrolment problems, then they would warmly receive and support our proposed program in Earth Sciences. But as things stand they are opposed to another program competing for what they see as a declining pool of students. However, if we insist on moving ahead with the proposal at the present time, they want us to remove the economic geology/coal courses and to emphasize, more emphatically the Quaternary and environmental geoscience thrust of the program.

We found the meeting with Dr Sinclair particularly useful and encouraging. In spite of his quite understandable preoccupation with the possible potential negative impact of our initiative on the U.B.C. scene, his view of the S.F.U. proposal clearly is more positive than his earlier letter had led us to believe.

We believe, for the reasons outlined above, that U.B.C's fears are not well founded. We also believe that the proposal can and should be modified to some extent in the spirit of defining the distinctiveness that they would like to see presented.

We would be pleased to elaborate on the issues addressed here if that seems to be useful.

Respectfully,
Drs M.C. Roberts & E.J. Hickin

A4. Appendix 4

Selected Graduate Theses in Earth Sciences Completed at SimonFraser University

Allan, L., 1973. M.A. Extended Essays. (1) Vegetation management on powerline rights-of-way, with emphasis on the lower mainland of British Columbia; (2) Adventive weeds, with particular reference to their significance in Canada. Department of Geography, S.F.U.

Archibold, O.W., 1974. Ph.D. Vegetation Recovery Following Pollution Control at Trail, British Columbia. Department of Geography, S.F.U.

Bhuiya, A.H., 1980. M.Sc. Delta Form and Process: A Flume Study. Department of Geography, S.F.U.

Brierley, G.J., 1983. M.Sc. Channel stability and downstream changes in particle size on the Squamish River, British Columbia. Department of Geography, S.F.U.

Cawker, K.B., 1979. Ph.D. Historical Dynamics of Big Sagebrush, Artemisia tridentata Nutt. in Southern British Columbia. Department of Geography, S.F.U.

Cochrane, D., 1974. M.A. Cartographic Display Operations on Surface Data Collected in an Irregular Structure. Department of Geography, S.F.U.

Fick, S., 1981. M.A. Louis Agassiz's Contributions to Glaciology. Department of Geography, S.F.U.

Gale, R.J., 1979. M.Sc. The Channel Geometry of Two Discontinuous Gullies. Department of Geography, S.F.U.

Hutchinson, I., 1981. Ph.D. Ecological Modelling and the Stand Dynamics of Pinus caribaea in Mountain Pine Ridge, Belize. Department of Geography, S.F.U.

Hyatt, R.A., 1978. M.A. An Evaluation of Large-Scale Landscape Land Classification for Land Evaluation in the Merritt Area, British Columbia. Department of Geography, S.F.U.

King, M., 1980. M.Sc. Palynological and macrofossil analyses of lake sediments from the Lillooet area, British Columbia. Department of Biological Sciences, S.F.U.

Lai, Food See, 1981. M.Sc. The Impact of Urbanization on Peak Flows in the Lower Mainland of British Columbia. Department of Geography, S.F.U.

Leonard, E., 1974. M.A. Extended Essays. (1) Price Lake moraines: neo-glacial chronology and lichenometry study; (2) Parks and resource policy: the role of British Columbia's Parks, 1911-1945. Department of Geography, S.F.U.

McLennan, D.S., 1981. M.Sc. Pollen transport and representation in the Coast Mountains of British Columbia. Department of Biological Sciences, S.F.U.

Melcon, P., 1975. M.A. Landforms and Weathering on McKeen Ridge, Cathedral Park, B.C. Department of Geography, S.F.U.

Nanson, G.C., 1977. Ph.D. Channel Migration, Floodplain Formation and Vegetation Succession on a Meandering-River Floodplain in N.E. British Columbia, Canada. Department of Geography, S.F.U.

Rood, K.M., 1980. M.Sc. Large Scale Flow Features in Some Gravel Bed Rivers. Department of Geography, S.F.U.

Smith, L., 1981. M.Sc. An Island Biogeographic Study of Subalpine Forest Islands. Department of Geography, S.F.U.

Warner, B., 1984. Ph.D. Late Quaternary Paleoecology of eastern Graham Island, Queen Charlotte Islands, B.C., Canada. Department of Biological Sciences, S.F.U.

Wetzel, W.A., 1982. Ph.D. Weathering and Development of Weathering Residuals on the Boulder Batholith, Southwestern Montana. Department of Geography,

S.F.U.

White, J., 1983. Ph.D. Late Quaternary Geochronology and Palaeoecology of the Upper Peace River District, Canada. Department of Archaeology, S.F.U.

Wilson, A., 1971. M.A. Plant Colonization on part of the Hope landslide. Department of Geography, S.F.U.

Yarnal, B.M., 1982. Ph.D. The Relationship Between Synoptic-Scale Atmospheric Circulation and Glacier Mass Balance in Southwestern Canada. Department of Geography, S.F.U.

A5. Appendix 5

Membership of the Earth Science Program Committee

The Senate Committee on Academic Planning approved the formation of an Earth Science Program Committee on July 6, 1983. The composition of the Committee is:

Dean of Science
Dr. J.M. D'Auria, Department of Chemistry
Dr. K.R. Fladmark, Department of Archaeology
Dr. E.J. Hickin, Department of Geography
Dr. R.W. Mathewes, Department of Biological Science
Dr. M.C. Roberts, Department of Geography (Chairman)
Dr. M.A. Stephens, Department of Mathematics & Statistics