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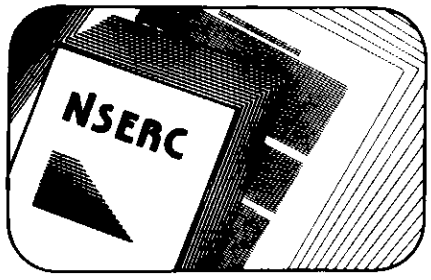

NSERC Earth Sciences Grants: Policies, Procedures and Problems

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Introduction

In 1980 the Earth Sciences Grants Selection Committee (ESGSC) of the Natural Sciences and Engineering Research Council of Canada (NSERC) recommended 502 new and continuing grants totalling over $7 million to the academic community. Additional awards (major equipment, strategic grants, etc.) were made through other committees. As the recent study of geoscience research and teaching in Canadian universities (Neale and Armstrong, in press) shows, NSERC funds are the principal source of research funding, hence the amount awarded and how and why the awards are made are of concern to academic earth scientists and to other Canadian taxpayers. For the last three years I have served as a member of the ESGSC and as its chairman during the last year (1979-80). Many on this committee regret that there is still some suspicion and misinformation about the policies and procedures of the ESGSC and this article aims to describe the latter in more detail than presently exists in the NSERC Awards Booklet, to offer some advice for applicants, and to discuss some current and future problems. This seem particularly timely with the publication of the Neale-Armstrong report of the Canadian Geoscience Council, the current reorganisation and improved funding levels of NSERC and some earlier debate on NSERC grants in this journal (Neale, 1978; Naldrett, 1979). This article was sent in manuscript form to members of the 1979-80 ESGSC but the views expressed are largely my own and have not been formally approved by NSERC (nor does it count as a referred publication!).

NSERC has developed a high level of efficiency and openness and now plans to allocate more funds towards the administration of the grant programmes. A list of all awards is published annually. The revised Awards Booklet and detailed application forms include much information on procedure. Despite explicit instructions, many applicants still submit incomplete or inadequate applications.

The Earth Sciences Grants Selection Committee

The ESGSC has been enlarged periodically and now has 12 members. The volunteer secretary is a geoscientist from NRCs Division of Building Research. The committee reports to the Council through a Group Chairman who is responsible for two or three committees and is a member of higher committees of NSERC. An Assistant Awards Officer from NSERC aids the committee and arranges many of the administrative details. Each Grant Selection Committee (GSC) has much freedom in its procedures and decision-making but NSERC provides a "Guidelines Book" recommending basic schedules, procedures, site visits and outlining the mandate of the committees. The main task is to make recommendations to NSERC for the award of research grants on the basis of supporting excellence for both the researcher and the proposed project. NSERC may change the amounts of the awards recommended by rarely does so. The main criterion for awards is the excellence of the individual as judged by his recent work, and the merit of his proposal. Whereas excellence may be difficult to define precisely, its recognition is made by the committee through peer evaluation using a wide spectrum of information, opinion, and judgement.

ESGSC members normally serve for three years so an attempt is made to rotate the members evenly, with four new ones each year. NSERC receives many nominations from individuals, departments, universities, etc. and these are sent to the ESGSC to consider along with its own suggestions. The ESGSC provides a list of three nominations for each vacant position to NSERC which makes the final decisions and invitations. Attempts are made to retain regional and discipline balance in the committee. Normally not more than one member from a given university is present on the committee and there is usually a gap of at least one year before another member is selected from that particular university. In recent years there have been at least two non-academics on the committee, usually specialists in the petroleum, mining, or geological engineering fields. A non-voting observer from the Geological Survey of Canada is present at the invitation of the committee. The chairman of the committee is usually someone serving his third year and is selected by a recommendation to NSERC from the previous committee.

The annual work of the committee members has become prodigious and demands the equivalent of at least four to six weeks. One week is devoted to annual site visits to universities, another to the February competition meetings in Ottawa, the remainder in reading the five volumes of applications (over 3000 pages), external reviews, a selection of reprints, site visit reports, and a variety of other NSERC material. This voluntary effort - and few members would advocate remuneration - is one of the strengths of the independent peer-review system, but along with their normal duties there is no doubt that the load is acutely felt by members in the larger GSCs like the ESGSC (third out of 21 committees in the number of applications received). One solution to relieve the work load is to split the ESGSC (e.g. Physics and Biology each have four committees), but the committee has been reluctant to take this step, seeing no easy way of dividing the discipline and appreciating the advantages of a single committee.

The new ESGSC is established by August, the past and present chairmen arrange many of the details (such as external reviewers primarily for renewal of three year operating grants) through the next few months. After the applications are received in October and checked for completeness by NSERC staff, the chairman is sent a complete set. He reviews these to see if some would not better be considered by another GSC and, at a meeting in November of all chairmen, some trading of applications takes place (for the benefit of the applicants). The set is also used by the chairman to make internal referee assignments so that each application is examined in depth and reported on by two committee members. NSERC reproduces and binds copies of the applications and Santa Claus delivers them to ESGSC members just in time for the Christmas break. All members are responsible for reading all application, with emphasis on those assigned in their own or related sub-disciplines.

Committee members pay site visits to universities before the February meeting. Groups of two or three visit departments and interview each applicant or potential applicant, tour the facilities and see how effectively earlier equipment awards are being used. They try to assess the needs of the individual, her effectiveness at

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research in her particular location, the environment for research in that department, the number and quality of graduate students, PDFs and support staff, the quality of analytical support, etc. The group usually meets with chairmen, deans or other administrators to determine future plans and priorities. At an initial general meeting, members also discuss the NSERC and ESGSC policies and transmit back any suggestions or criticisms. A site visit report is prepared and circulated only to ESGSC members; comments on each applicant would include: the impressions made, his productivity, other duties, number of graduate students and support staff, special needs or excuses, and an estimate of the level of the next award ("drastic cut", "maintain", "inflationary increase", "marked increase", etc.). Each university is visited every three years and old reports destroyed. The visits could be regarded as too superficial, with only 20 to 30 minutes being available for individual discussions with applicants, but with the broad range of academics being interviewed and the usual time and financial constraints, the visits are regarded as just one of several methods of assessment.

By the February competition meeting in Ottawa, members have read all the voluminous material, made copious notes on the individual applications, and then proceed to spend the next week closeted together with enough time to spend only a few minutes on each application. All members must vote on a level of award for each application after all discussion has been heard and the figures are averaged so that the award is a committee decision. If their own application is considered, ESGSC members leave the room. For colleagues at the own university, members are silent unless asked for factual information by the chairman. The ESGSC secretary maintains a graph to keep the committee awards within the available budget; the assistant awards officer and group chairman appear at intervals to check progress and to offer advice. Although individual applicants may feel their own submission to be a unique proposal, a committee member who reads 400 (or 1200 if one is in one's third year) finds that relatively few are really unique and most can be compared and assessed quite easily. Rarely, a member of the ESGSC may prove to be a weak assessor of the applications or not to have done all his homework; the committee has little patience in such cases and his comments may then count less.

During the week in Ottawa, there is discussion on a variety of policy and procedural points by the ESGSC. Many are included in the committee's annual report, together with the statistics of the awards made that year. Recommendations can be made to NSERC in this way, some initiated by individual applicants during the site visits.

From the ESGSC recommendations to NSERC in February follow the actual awards, distributed in late March. The chairman is left to receive in due course via NSERC a few critical letters from disillusioned applicants and to start some preliminary work for the next year's competition in collaboration with the new chairman.

Advice for NSERC Applicants

Compared to applications to the National Science Foundation in the USA, NSERC applications are brief to the extreme, being limited to about eight pages for either a one or a three year operating grant. There seems little excuse not to follow the precise guidelines prepared by NSERC, yet the ESGSC is frequently frustrated by academics who fail to properly complete these short forms. When dealing with several hundred applications, the committee has little choice but to review what is provided to them. Applicants should remember that the form will be read and reviewed in depth by two ESGSC members and read by the remaining 10 members with varying degrees of comprehension and sympathy. It is possible, with a little care and forethought, to write an excellent application that can be assessed by the full spectrum of individuals on the committee. A few tips are offered below for the different types of grants reviewed by the ESGSC.

Individual Operating Grants. These include one-year and three-year grants, and in 1980, including those currently being held, 456 were awarded totalling $6,670.00. The amount awarded is less than 60 per cent of that requested. However, the bulk of the ESGSC funds are directed to this grant category. The top grant now stands at about $55,000; the ESGSC establishes annually an upper level to the grants awarded.

It is useful, and now structured on the new form, to start with an overview paragraph outlining the long-term research objectives and how the present proposal fits into them. This summary statement is particularly useful to those committee members from different subdisciplines. The progress report and the proposal should be both detailed and separate. Funds have been received and expended - just what progress has been made and what is its significance? References to resulting publications can be made here with comments on the key conclusions. State who is involved in each project (the applicant, student X or Y, a PDF, etc.); explain failures as well as successes. The new proposal is requested to cover the next three year period, even if a one-year award is anticipated, and should be completed for that period, unless special circumstances justify a one-year appplication. Do not just give a brief "more of the same" paragraph, but detail precisely what, why, and how the research is to be conducted, and what results may be expected if successful; state who will do all the work necessary; it is helpful if applicants carefully reference their proposal to indicate they are fully aware of the latest studies related to their topic. The budget should be completed with as mush accuracy as possible and justified in the space below. Perhaps some funds are being received from another agency for part of the project. There is perhaps an art in blending realism with idealism, but I am an advocate of at least informing NSERC what the minimum funding required should be, even if that level cannot be awarded. There is no doubt that the assessment of an applicant's publication record is an important criterion in making an award. It is not simply a question of the number of papers published but also their quality, and that of the journals they appear in, their size and significance, and the number of co-authors (for colleagues will likewise list the same paper in their applications too), etc. Non-refereed papers are ranked lower and only minor attention is paid to abstracts. If space allows, list separate papers by PDFs and students on research funded by your operating grant. Some faculty publish with their students, others not at all; whatever policy you have should at least be clear to the ESGSC. Applicants are asked to mark (asterisk) their five most significant papers; many do not. Likewise, publications should be listed in the style, and only for the six year period, requested; it can be rather irritating at midnight on New Year's Eve to sort out someone's refereed and non-refereed papers from abstracts and theses with no page numbers indicated and which extend back for a decade or more.

It is useful to appreciate what information the ESGSC has available in reviewing applications. In addition to the forms, it has a 7-year print-out of past grants, the last site visit report, the detailed review by two members of the ESGSC and in addition, for renewal of completed three-year grants, a set of the three most significant publications from the applicant with her comments (read by the two internal reviewers), and up to four exter-

nal reviews from peers in Canada and abroad.

The average operating grant in Earth Sciences is now about $14,600 (Table I, Figure 1). This is hardly enough to fund a technician, let alone students, a PDF, field work, equipment, supplies, computer time etc. It is a grant-in-aid of research and will not necessarily cover all costs. The ESGSC regards the listing of other research funds as a positive feature and does not regard the holding of other grants as a reason for reducing an NSERC award. The committee could make the average grant higher by terminating a large number of lower awards but since several previous committees have been increasingly selective, extensive terminations now would threaten the current system of support and research in many geoscience departments. The answer is for more total funding with continued stress in selectivity.

Another problem is with upward mobility for exceptional researchers. In 1980, the funds for operating grants increased about 10 per cent. The only way to provide a 30 per cent increase for one person is to cut another substantially. It is easier to recognize and advocate upward mobility than downward spiral and some ESGSC members find it hard to practise this trade-off. The ESGSC does make increases and deceases of up to 100 per cent and has attempted to achieve greater mobility. The awards made often reflect messages from the committee: e.g., large or small changes, inflationary changes, exact amount as previous grants or exactly as requested. Also, terminal letters are issued which give the applicant one year (in reality six months) to correct the stated deficiencies.

As seen in Figure 1, 2 and Table I, most applications for individual operating grants are funded to some degree. Very few receive the amount requested due to limited funds. The ESGSC available budget is usually the previous year's amount plus, hopefully, an inflationary increase. A further amount is added for each new application, but there is no money provided for the reinstatment of applicants who were terminated earlier. Thus, when the committee reinstates an applicant, funds are drained from others in the system and this is a further incentive for the ESGSC to be selective.

One-year grants are normally given to new applicants, to those applicants who are perceived to merit rapid increases or decreases, when there is some degree of uncertainty about a proposal, and for terminal awards. New applicants nearly always receive a series of one-year grants until their research programme has stabilized or become clarified and then a three-year award is made. The latter type of award provides some long-term financial stability but only inflationary increases will be provided by NSERC within that period. Applicants will normally provide a three-year budget, but in making a one-year award, the committee can only award up to the figure

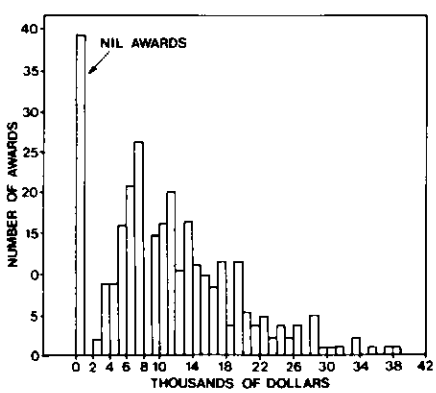

Figure 1 *Distribution of 1980 NSERC Operating Grants in the earth sciences.*

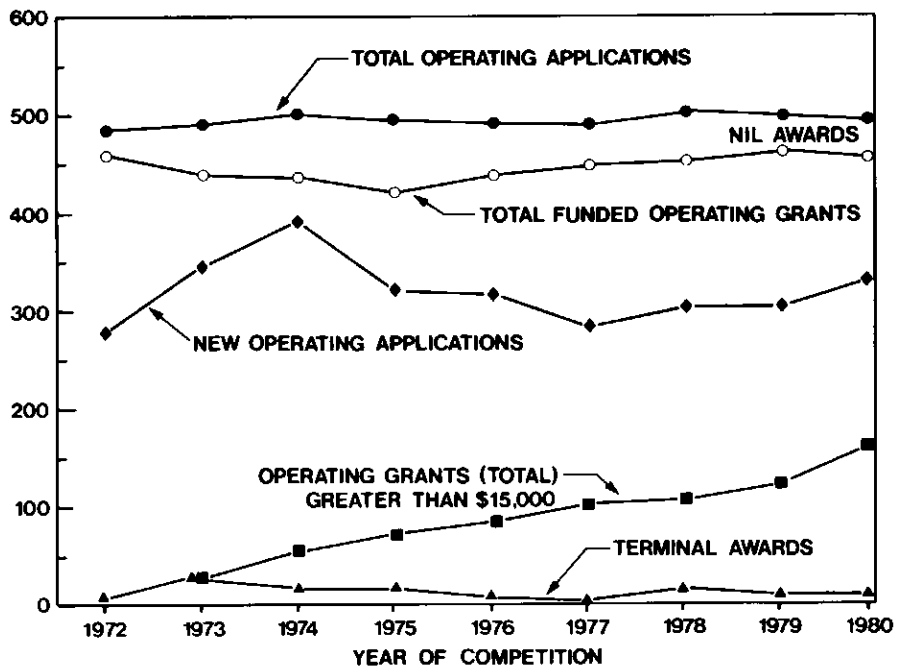

Figure 2 *Summary of grant statistics, 1972-80, for the NSERC Earth Sciences Grants Selection Committee.*

Table I *Data on earth sciences grants awarded by NSERC*

Total Funds Requested		Total of all grants awarded			
1980 ($000)	1979 ($000)	1980 ($000)	1979 ($000)	% change 80/79	% change 79/78
$12,835	$11,636	$7,299	$6,462	13.0	8.2

Average Individual Operating Grants			
1980	1979	% change 80/79	% change 79/78
$14,629	$12,963	12.9	8.5

Equipment Grants - Funds awarded as Percentage of Funds Requested			
1980	1979	1978	1977
41.1	29.2	38.3	31.7

Success Rate for New and Renewal Individual Operating Grants - Number of Grants Awarded as Percentage of Grants Requested			
1980	1979	1978	1977
88.1	88.1	84.7	87.4

Total Funds Awarded as Percentage of Total Funds Requested			
1980	1979	1978	1977
56.9	55.5	54.3	52.8

requested for the first year, not the average of the three years. The average figure is the maximum that can be awarded for three-year awards only. There are certain advantages to the ESGSC in awarding more three-year grants since it reduces the number of applications to be reviewed annually, allowing more time for those being considered; and the external referees' comments together with the analysis of principal publications allows for more in-depth assessments.

Equipment grants. Major equipment grants, for requests exceeding $75,000, are considered by another NSERC committee. However, the ESGSC reviews all the Earth Science submissions in detail, ranks the applications, and provides comments on each one. Two members of the ESGSC are assigned to provide an in-depth discussion and site visit information is particularly useful together with the excellence of the principal applicant. In earlier years, earth scientists generally received one, rarely two, awards each year out of a dozen or more requests; in 1980 with more funds available for equipment, four awards are made. Grant applications in this category must be of the highest calibre, well documented, requested by excellent researchers with a sound scientific need, adequate space, and technical support. The distribution of past awards to individuals and departments is also considered. It is important to indicate the number of potential users, and whether the equipment will be a regional co-operative facility. Most departments desire a battery of SEMs, XRFs, XRDs, probes, and the like, but there is simply not enough money. Selection thus favours excellent researchers doing imaginative first-rate science; applications are commonly improved through two or three submissions before approval. In future, perhaps special site visits should be made to interview all major equipment applicants; perhaps, also, the earth sciences community needs to identify regional centres for particular analytical facilities, as the chemists have.

Equipment requests in the $5,000-$75,000 range are considered by the ESGSC. In 1980, 27 awards totalling $510,000 were made; previously about one out of three requests was funded, usually at the amount requested, but with increased funds for equipment this ratio improved in the last year (Table I). Again, two members of the ESGSC review each application before general discussion. The quality of the applicant and his work are emphasized together with the need, potential results, previous awards, space and technical assistance, etc. Young applicants developing a laboratory are reviewed sympathetically. Generally, the higher the request the more critically it is reviewed since awarding one $70,000 item may mean rejecting seven $10,000 requests to keep within the budget. With a realisation by the federal government and by NSERC that Canadian laboratories have been running down over the last decade, the new funding levels for equipment will bring about much needed improvements. A large increase in applications is predictable, because many laboratory scientists have given up applying for the small sums available.

Travel grants. The amount provided in the ESGSC budget is 50 per cent of the total amount requested. Each application is reviewed by two committee members. Nearly all requests are for travel support for sabbatical leave and most are from researchers with a good record of achievement. A few applications from those with no grants, terminal awards, or with poor proposals are customarily rejected. Of the rest, those travelling to another institution within North America are generally given a lower priority by the committee. For those incurring much higher costs in travelling over-seas, an award covering all or part of the economy air fare is made - usually about $700 to Europe and $1500 to Australia or the Far East. In 1980, 14 awards were made totalling $15,900.

Conference Grants. As with travel grants, two ESGSC members review each proposal for the committee and only 50 per cent of the total amount requested is budgeted, hence the committee is forced to be strongly selective. Conference grants vary considerably in number (e.g. 4 to 14 in recent years), and quality and the ESGSC has few rigid guidelines. The funds are for the support of visiting speakers to a conference. Smaller, highly specialised conferences, international meetings held in Canada, or keynote speakers at major conferences are favoured. Those symposia held at national meetings are more able to secure support from registration fees and/or corporate donations. The scientific merit of the conference and the status of the organisers and the speakers is emphasised in the review process. In 1980, two grants were made totalling $12,450.

Team Operating Grants. Team grants are single grants made to two or more researchers working in close collaboration. The researchers cannot hold individual operating grants concurrently. In 1980, only four awards were made totalling $56,600. There are some wife-and-husband teams and some in which the particular project binds researchers together for a period of time. The grants work well but will probably always be few. Commonly, the applicants publish together and assessment of the team is easier than if they applied individually. My impression is that most team grants total rather less than the researchers might have been awarded if they had applied separately since certain cost-efficiencies can be effected.

Co-op Operating Grants. NSERC introduced this grant category some years ago to increase collaboration between scientists. The grants can be held in addition to individual operating grants and it is this feature which causes a dilemma for the GSCs. An award gives additional funds to a researcher at the expense of the individual operating grant of others since the funds come from the same budget. The GSCs may expect researchers to pool part of their individual operating grants to provide funding for co-operative projects since the research time expended cannot be applied to their other (individual) projects. Thus, those funded are special projects for which the simple pooling of resources would not be appropriate. In 1980, only one co-op grant was awarded of $45,000 and most GSCs gave few such awards. NSERC is still keen to develop this programme and a restructuring of the budgeting procedures may allow GSCs greater incentive to make more awards in future, certainly those considering applying should be more optimistic than in the past.

Core Grants. As with co-op grants, the core grant has never flourished. The intent was to grant funds for operating and maintenance cost of major installations or facilities. Most institutions have several such installations but NSERC was never able to provide sufficient funds to the GSCs to make a large number of awards. With the small budgets available, it seemed best to award no grants at all, and a few earlier ones have been gradually terminated. With the exception of astronomy and nuclear physics, other GSCs likewise award few or no core grants. However, with the increased NSERC budgets and reorganisation, this grant category is currently under review and, as with co-op grants, the GSCs could be more positive and see clear needs if new funding formulas are developed. Thus, potential applicants should keep in touch with new developments in this category.

Other awards. The main tasks of the ESGSC are to consider grants in the above categories, but there are some other awards it is involved with to some degree. It may decline periodically to make an award from its budget but suggest that the President fund it from his special discretionary allocation. Although Strategic Grants are awarded by separate committees, the ESGSC is asked to assess the excellence of the applicants. As more funding is allocated to Strategic Grants this has become a significant work load and one the ESGSC is not fully in agreement with. During the February competition meetings, committee members are frequently called to review applications in other committees, particularly the Interdisciplinary Committee. Finally, academics may seek grants at any time of the year for urgent new initiatives in research when it is essential to have immediate funding to pursue a promising avenue of research, develop an invention, or study a short-lived natural phenomenon.

Problems with the Granting System

The discussion above has outlined some of the policies, procedures and criteria used by the ESGSC in recommending research grants. There appear to be significant differences between the GSCs in many procedures. The committee, however, operates within the NSERC structure and also is bound by certain historical and disciplinary constraints. A few of the problems perceived are discussed below.

The main problem is inadequate funding. Over the last decade when universities and provincial agencies provided less and less for research operating funds, NSERC funding decreased sharply in terms of constant dollars. The present five-year plan with increased funding will only re-establish the level of funding as it was in 1969. In Earth Sciences, the average operating grant is about $14,600. Surely a mature and productive researcher will require, on average: 1 technician ($16K), 2 graduate students (2 x $2.5K, summer stipend only), 0.5 PDF ($7K), minor equipment ($7K), field work ($7K), supplies, computer time, miscellaneous ($3K), i.e. about $45,000, which is nearly the level of the maximum grant awarded by the ESGSC. Of course, academics should be encouraged to seek other funding but surely NSERC should remain the principal source and provide at least two-thirds of the required funding. The average grant should more realistically be about $30,000, double the present level. This can only be achieved by a continued realisation by the federal government of the need and economic benefits of such funding. The logic for this has been thoroughly discussed in the NSERC Five Year Plan publication.

Trying to assess the real budgetary needs of applicants from the amounts requested is hazardous. Some applicants ask for precisely what they need for their project; a few are excessive; most tend to be conservative, asking perhaps for a little more than they expect to receive rather than what is really required. If applicants ask for considerably more than they are likely to be awarded, they run the risk of the ESGSC viewing the project as impossible to achieve within the budget they can provide. In asking for less, they distort the view of what level of funds are required, i.e., total funds requested, as viewed by NSERC and government officials. Thus, in practice, neither figure of the total amounts awarded nor that of the amounts requested (Table I) bears any close relationship to the real budgetary needs to accomplish the proposed research. This acute shortage of funds has perhaps forced GSCs to award grants based, with more emphasis than desirable, on the excellence of the applicant at the expense of the nature of the project. As a result, in the earth sciences a large number of awards fall in the $5,000-$10,000 range; the applicants are worthy of support, yet the limits in funding result in modest awards that force conservative approaches and limited flexibility such that it is difficult to undertake imaginative science.

A further problem related to funding is the method and criteria for allocation to the various NSERC grant selection committees. Earth Sciences has historically received only about 8 per cent of the NSERC funds and its average grant has been significantly lower than that of several other fields (see also Neale and Armstrong, in press). NSERC now seems prepared to re-examine the present allocation formula.

Adequate assessment of applications is another problem and fundamental to the awards process. External reviewers are solicited for their opinions of applicants renewing three year operating grants. About 70 per cent actually reply and of their replies only 70 per cent are really useful. Thus, of 4 to 6 letters requested, perhaps only three or less are eventually considered. In some cases, these may not be sufficient to eliminate suspicions of professional jealousy or protectionism. The confidentiality aspect of the new Human Rights Code now means that applicants are free, upon request, to examine signed assessment documents. This has resulted in a few scientists refusing to provide assessments and those from some others being so bland as to be worthless. The ESGSC now seeks more letters than earlier: the applicant suggests two referees and the ESGSC members provide others to the chairman, who selects the reviewers from among those supplied. Some applicants are in such specialised fields that there may not be individuals in Canada capable of assessment and foreign specialists do not always understand and appreciate the NSERC granting system.

All applications are reviewed in depth by two members of the ESGSC and in most cases a fair assessment is achieved. Some fields are well represented in the ESGSC, others less so and the ability to provide two qualified reviews from 12 members covering 400 applications in all fields of earth science is not always possible. Hopefully, it averages out over several years, or in difficult cases the ESGSC will secure external assessments for the following year. One answer is to enlarge the committee, risking becoming unwieldy. Another is to subdivide the ESGSC into two to four committees with about seven to ten members each. The second may result in a more equitable treatment of the subdisciplines. One might envisage committees in geological sciences; geophysics; ocean and atmospheric sciences. However, this will increase the difficulties for those who straddle subdiscipline boundaries and will involve more administrative costs and site visits. More importantly, I think smaller committees run greater risks of becoming less objective, of there being only a small group of potential committee members with rather similar views of what is good science and of who is doing it. The freedom to engage in really innovative funded research is probably better protected by a large, broadly based committee than smaller more specialized ones. The answer may lie in increasing the present committee up to 15 members and reorganizing the internal duties in a more rigorous fashion. Certainly at present an examination of the average grant per subdiscipline in Earth Sciences (Neale and Armstrong, in press) shows some obvious anomalies. Some fields may have had persuasive representatives on the ESGSC, others like Physical Geography, seem to have many applicants who set their scientific sights too low and/or apply for only modest grants.

A future problem may be increased NSERC bureaucracy related to increased funding. NSERC has been remarkable free of unnecessary paperwork, has maintained a simple grant application procedure, and has required reasonable accountability in scientific productivity and audited statements.

Field work in remote areas is a problem which is not satisfactorily covered by the present granting system. Present awards are largely a measure of the degree of excellence of the researcher rather than the specific financial requirements of the project. An earth scientist specialising in theoretical studies may find most of his financial needs covered by his operating grant and the laboratory specialist or experimentalist can presently apply for equipment grants to supplement his research needs. However, those researchers requiring extensive field programmes frequently encounter major expenses concerned with drilling, transport, helicopter time, field equipment, field assistants, living expenses, and sample shipment. Such costs can amount to many thousands of dollars and shortcuts demanded by limited funds may seriously affect the safety of those involved. Field programmes in the Subarctic and Arctic, and in other remote areas, are becoming increasingly prohibitive to grantees because of escalating costs. NSERC can rectify this discriminatory anomaly in two ways. First, by establishing a new grant category, Field Operations Grants, for costs that exceed $5,000. The grants can be handled by the present committees and would be analogous to Equipment Grants. Secondly, in reviewing Core Grants, the new regulations should permit such grants to be awarded for the establishment and/or maintenance of regional field bases with group participation being encouraged. The problems of major field operations are not only faced by earth scientists but also by biologists, engineers and astronomers.

Over the past two decades, the nature of earth science research has altered drastically, especially in the analytical and computational techniques now available, in the amount of data acquired by the industrial sector, and in field work transport and techniques. Nearly everything has increased in cost by several orders of magnitude. It is said that earth scientists have barely scratched the surface of the earth. In the next decades, penetration of the surface through drilling and elaborate geophysical techniques will become increasingly necessary. At present, academics rarely request funds for drilling costs in their applications; it is just too expensive and makes their applications appear excessive. In a very real sense, the level of support provided by NSERC has seriously limited the scope of research that can be attempted by academics and hence the advancement of the discipline. There have been no serious attempts by earth scientists to advice NSERC and the federal government on just what advances could be made, in specific terms, given greater access to funds for field support, drilling (including deep sea drilling), more sophisticated geophysical arrays and techniques (cf. COCORP and COCRUST programmes), seismic stratigraphy, etc. Not all earth science research requires large-scale funding, but certainly the present structure of grant programmes and the present levels of funding curtail much frontier research in Canada and commonly exclude Canadian scientists from fully participating in key international programmes (DSDP, IPOD, NASA, etc.).

A final problem area has been the rapid growth of the Strategic Grant programme. Large additional sums are now expended in five major areas of natural (strategic) concern: Oceans, Energy, Environmental Toxicology, Food, and Communications. Recently, a sixth, general field has been established for strategic projects outside these five areas, but the number of applications that can be made from each university is restricted. These grants are being more effective than the term and co-op grants in encouraging interdisciplinary and interuniversity of interdepartmental research. Few geoscientists received awards in the initial years of the program, but last year they received about one million dollars which is proportionally equivalent to their share of the total operating grant budget. NSERC faces the problem of phasing out particular areas in the future and selecting new ones. The Canadian Geoscience Council has recently requested NSERC to consider two new fields: Mineral Resources and Environmental Change. These are also advocated by the ESGSC with the additional suggestion of Northern Development.

Summary

In 1980 NSERC awarded over $7 million in some 500 research grants in the earth sciences yet this was only a little more than half of the amount requested. Many budget requests by applicants have become very conservative in recent years and a doubling of individual operating grants would be a more realistic level to conduct satisfactorily earth science research in the university sector.

During interviews at site visits, it is evident that many applicants are not clear on the procedures and policies of NSERC and the ESGSC. This article attempts to outline some of these, to provide advice for applicants, and to discuss some current problems in the granting system. Present policies and procedures are not necessarily correct, but individuals should be aware of the current rules of the game. Suggestions for improvement are most welcome. Because it is an evolving system, and with a rotating membership on the ESGSC, some of the current procedures will change in future years. Applicants can secure additional and later information from NSERC, the ESGSC members and during site visits.

Academics and agencies such as the Canadian Geoscience Council have been making representations for increasing funding to NSERC and to federal and provincial governments. The federal government's acceptance of NSERCs Five Year Plan, at least in principle, was a major achievement. However, if approved in full, it only re-establishes the level of funding (as a percentage of the Domestic National Product) to that existing in 1969. In difficult economic times, intensive lobbying must be undertaken to secure additional funding. Applicants must recognise the extreme competition for existing funds and the criteria adopted in making awards. By attaining a high level of scientific excellence, individual applicants will secure increased levels of funding. In the long run, such excellence, particularly when combined with economic application, will justify to the taxpayers increased funding levels by governments.

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