REPORT OF THE COMMITTEE OF VISITORS, 2002-2004
Surfaces Earth Processes Section
Earth Sciences Geology and Paleontology (EAR/GE) and
Hydrologic Sciences (EAR/HS) Programs

INTRODUCTION

The Committee of Visitors (COV) for the Earth Sciences Geology and Paleontology (EAR/GE) and Hydrologic Sciences (EAR/HS) programs reviewed proposal jackets, analyzed GE/HS data, and spoke with Program Officers (POs) and administrators on July 13-15 2005 at NSF headquarters.

The 2005 COV members are: Susan L. Brantley, Chair (Penn State), Estella Atekwana (University of Missouri-Rolla), Philip J. Bart (Louisiana State University), Paul Brenckle (Consultant), Carey Gazis (Central Washington University), Fred J. Molz (Clemson University), and John C. Steinmetz (Indiana University).

The charge to the COV was to provide assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions and to comment on how the results generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals. Specifically, the COV was directed to assess the integrity and efficiency of the ***processes*** related to proposal review and the quality of the ***results*** of NSF's investments that appear over time. Information provided to the COV included spreadsheets of proposals for the fiscal years 2002-2004, electronic jackets for the proposals, and the 2002 COV report and response.

GENERAL OBSERVATIONS OF THE COV

We were very impressed that the POs represent a hard-working, hands-on, and efficient team dedicated to funding and managing a large and diverse set of projects for quality research and education in the Earth Sciences. The COV was pleased that the POs consider both Intellectual Merit and Broader Impacts of their awards. GE and HS are funding high quality science that results in publications in the top-rated journals and that corresponds to national priorities. They are also implementing educational programs that are congruent with national needs and agency mission. The Program Officers are lauded for their time-consuming efforts to help their communities grow and to keep up with that growth.

Of particular note is the national importance of research funded by GE and HS. Water and soil are the two most fragile resources underpinning human society: some of the nation's top scientists are enabled by GE/HS funding to study geochemical, hydrological, and microbiological interactions within soil and surface and ground waters. GE funding also facilitates scientists trying to read the record of climate change on earth and its effect on biota, even as we contemplate the future effects of global climate change. GE and HS are healthy programs that fund a vibrant and growingly diverse community of scientists. Given the vibrancy and significance of GE and HS, improvement in the programs will allow NSF to meet national priorities and needs more effectively.

The COV noted the following problems and suggestions with respect to procedural, funding, and communications issues:

Procedural

- High proposal loads make it difficult for Program Officers to complete their work: staffing should be augmented (A.1.7).
- The meaning of the Broader Impacts criterion is not clear: Program officers should help the reviewers, panelists, and proposal writers reach consensus on the meaning of the Broader Impacts criterion (e.g. A.1.3).
- Few faculty from under-represented groups and minority-serving institutions receive funding from GE and HS: Program Officers should seek out new ideas and/or strategies to accomplish more participation of faculty and students from under-represented groups and minority-serving institutions (A.4.12).
- Two of the funded large initiatives in GE/HS were not reviewed using a substantive review process that included careful mail review *and* panel review: such initiatives should be reviewed in a defensible and consistent fashion using Best Practices either by the EAR Instrumentation and Facilities panel itself or by using the Best Practices of that program (A.1.8; A.3.4).
- Large sums of money, such as the several million dollars of funding awarded in the area of Geoinformatics, should not be awarded without a publicized solicitation: such activity, along with the lack of panel review, could yield the appearance of impropriety (A.5.3).
- The COV faced significant hurdles in gathering information about program actions with respect to the larger initiatives: both electronic and printed spreadsheets of *all* actions per program over the timeframe of interest should be provided so that the COV can be confident that all program activities are transparent and so that all program activities are included in statistical calculations of diversity (A.4.12; C.2; C.4).

Funding

- The COV found it particularly puzzling that the one large initiative that was reviewed following Best Practices was not awarded discretionary funds: wherever possible, funding for large initiatives should not erode core budget funding significantly but should be enabled partially or completely by discretionary funds (A.1.8; A.5.4).
- EAR should work with the GE/HS communities to articulate a clear vision for both growing and traditional areas and funding levels should be matched to this vision: for example, funding for high-growth areas should not disappear when a program disappears but should be put back into core programs when the core programs have changed to include the new areas (A.5.3; A.5.4).
- HS and GE are both consistently receiving very highly rated proposals that are not getting funded: new money should be found to increase the core funding of these programs so that low success rates do not seriously impede the excellent science within GE/HS (A.4.1).

Communication and Vision

- A significant lack of communication apparently existed during 2002-2004 and may still exist to date among the GE/HS Program Officers, Section Head, and Division Director: communication must be fostered so that Program Officers understand funding priorities and allocations, so that all communities have equal knowledge of and access to funding

opportunities, and so that administrators understand needs for both emerging and traditional areas of science and education (A.5.3).

Note to reader: Between 2002 and 2004, the GE program began to split into one panel to consider Geobiology and Low-temperature Geochemistry (GG) and Geomorphology and Land Use Dynamics (GLD) and another panel to consider Sedimentary Geology and Paleobiology (SGP). By spring 2004, two different panels were used. Throughout the review by the COV, we often refer to results of analysis by the first panel as the GG panel and the second panel as the SGP panel. This split was fostered by the recognition that the GE panel was very diverse and the panel reviews would be improved with more disciplinary specific panels. As of 2005, the GE program has now fully split into GG, GLD, and SGP programs with three separate panels.

FY 2005 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

Date of COV: 7/13/05-7/15/05
Program/Cluster: EAR Hydrologic Sciences (HS) and Geology and Paleontology (GE)
Division: EAR
Directorate: Geosciences
Number of actions reviewed by COV: Awards: 48 **Declinations:** 50 **Other:**
Total number of actions with Program/Cluster/Division during period being reviewed by COV: Awards: Declinations: Other:
Manner in which reviewed actions were selected: COV reviewed proposals that were awarded and declined and that were ranked close to the dividing line between award and decline

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review procedures. Provide comments in the space below the question. Discuss areas of concern in the space provided.

A.1.1. Is the review mechanism appropriate? (panel, ad hoc reviews, site visits)
Comments:

For both GE and HS, the COV examined mail and panel reviews. The COV concluded from this scrutiny that both the GE and HS review mechanism is appropriate. For example, for all the 48 jackets perused in GE, at least 3 mail-in reviewers were used. Both declined and awarded proposals received thorough and fair appraisals by the panel and mail reviewers. In general, the panel had the advantage of the mail-in reviews to formulate a more detailed assessment of the proposal. With a few exceptions, there is a strong correlation between the mail-in and panel reviews. When the panel and mail reviews had divergent views on the merit of the proposal, the comments from the panel seemed to carry more weight and may reflect the fact that in the PO's judgment the panel did a more thorough analysis. Accordingly, there were instances when awards were granted to lower-ranked proposals at the discretion of the PO. For the most part, the circumstances dictating the award were clearly articulated in the review analysis and correspondence to the PIs and appear appropriate.

A.1.2. Is the review process efficient and effective?
Comments:

GE requested about 2300 mail reviews per year, of which about 1400 were returned. Similarly, HS requested about 1900 per year, of which about 1200 were returned. The COV recognizes that this level of return is characteristic of such a review process, and given the care with which proposals are handled, it was concluded that the process is as efficient as it could be. Despite some lost time associated with corresponding with potential reviewers who choose not to participate in the process, the majority of the proposals were scrutinized within 6 months.

A.1. 3. Are reviews consistent with priorities and criteria stated in the program's solicitations, announcements, and guidelines?
Comments:

For both GE and HS, reviews are generally consistent with priorities and criteria stated in the program's solicitations, announcements and guidelines. However, there is a problem with review of the Broader Impacts component of the proposals because there is no clear consensus concerning what constitutes the appropriate quality of Broader Impacts. For example, sometimes graduate education is deemed appropriate/sufficient whereas in others cases, projects were criticized for including only this level of activity. The COV points out that the community is unclear as to what Broader Impacts means, and to help in this regard, the Program Officers might provide helpful examples and continue to educate the community. This criterion is now being addressed by almost all proposals but without consensus concerning the meaning of this criterion, the inconsistencies in evaluation will hurt some proposals while helping others.

A.1.4. Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's recommendation?
Comments:

The GE and HS reviews from the panel and mail-in reviewers generally provide adequate justification/explanation for the PI to understand the decisions. These comments often include encouragement and recommendations for improving the proposal for re-submittal.

In some cases it was noted that the numerical values provided by mail reviewers did not seem consistent with the verbal evaluations, i.e., an excellent numerical rating was accompanied by verbal negatives. Sometimes these cases were noted by the panel reviews and ultimately influenced the funding decision. This is another important role played by the panels. It is not clear why this apparent discrepancy turned up on a few proposals. Program officers might find it helpful to provide examples of the definitions of the rating terms so that reviewers can become more standardized.

A.1. 5. Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation?
Comments:

The COV found that in many instances, the panel summary is listed under the pulldown heading "Review analysis" in the e-jacket but did not exist in either correspondence or panel summary. Thus, in some cases it was difficult to find the Panel Summary.

However, where it was possible to review the summary, the GE panel summaries provided sufficiently detailed information for the PI to understand the basis of a panel recommendation. The COV was surprised to find that in one case, the panel's summary endorsed comments by the mail-in reviewers that were not necessarily fair. Such an instance appeared to be an anomaly.

In the HS program, it was also found that the panels provided good feedback information to PIs. The panels generally considered the individual reviews carefully and, when necessary, provided an integrated interpretation. Through this process, sometimes a highly rated proposal was not funded, or a lower rated proposal was funded. Evidence indicates that in these cases thoughtful, well-balanced and fair decisions were made.

A.1. 6. Is the documentation for recommendations complete, and does the Program Officer provide sufficient information and justification for her/his recommendation?
Comments:

In some cases within the GE portfolio, the documentation for recommendations from the Program Officer was complete and provided sufficient information; . In other cases, information provided to the COV was vague. This was particularly true for a few borderline proposals within Geobiology and Geochemistry (in GE) where the panel recommended funding but then the proposal was not chosen for support due to insufficient funds. In such cases, PIs should be given specific recommendations for improving the proposal to make it more competitive.

The COV found evidence in the e-jackets that the HS Program Officer provides especially good and consistent feedback to PIs.

With respect to panel review, the COV noted a misleading piece of information that was communicated to PIs regarding the CHRONOS reviews. Awardees within CHRONOS received a form from NSF (General Information for PIs) that stated, "Your proposal was among 146 reviewed at spring 2003 Panel for G and P program." However, as indicated on NSF Form 7 in the proposal jacket, these proposals never went to panel. In follow-up communications with the Section Head to clarify this situation, the COV learned that CHRONOS PI's received two letters: one was a form letter selected from a list by the Program Officer when the proposal was processed and the other was an individual e-mail from the Program Officer. The form letter contained the erroneous information regarding panel review. Goldstein noted that a correction was sent to all CHRONOS proponents to indicate the error.

A.1.7. Is the time to decision appropriate?
Comments:

The two reviewed programs handled a large number of proposals per year: the proposal load increased from 261 to 289 (GE) and from 163 to 204 (HS) from 2002 to 2004. Sixty-seven and 60% of the proposals handled by GE and HS respectively were handled within a dwell time of < 6 mos. These values are slightly below the GPRA standards and probably relate to the large number of proposals handled per program officer in these programs. Given the high proposal

load, these statistics are exemplary. In addition, the Program Officers indicated that in the cases for some interdisciplinary proposals, a longer dwell time was necessary in order to allow other Program Officers at the Foundation to look at the proposal for possible joint funding. Since program panels meet at different times, some of these interdisciplinary proposals probably experienced longer dwell times.

Overall, it appears that both the GE and HS funding decisions are derived in reasonable time periods. The COV applauds efforts by the Program Officers to find funding for strong proposals even when this means a longer dwell time.

A.1.8. Discuss any issues identified by the COV concerning the quality and effectiveness of the program's use of merit review procedures:

Large initiatives allow communities to grow, allow interdisciplinary science and education to thrive, allow synergistic effects, and lead to the potential for increased funding. Such added value must spur NSF to foster such initiatives. However, large initiatives can have failings. For example, initiative funding can erode core budgets for small-PI science, initiatives can be exclusionary, and initiatives can drive science in directions that might hinder more ideas or approaches driven by single PI proposals. Thus NSF must foster such initiatives by articulating and implementing the vision for an appropriate review/selection process by which large initiatives can develop.

Given such considerations, the COV was disconcerted to learn that over the period 02-04 within GE/HS, large initiatives were reviewed and handled inconsistently. The three large initiatives discussed as part of the period 02-04 were CRONUS (funded in 2005 with core budget money from several programs within EAR), CHRONOS (funded with $1.95M discretionary funds from Geoinformatics during 2002-2004), and CUAHSI (funded with $4.61M discretionary funds from Geoinformatics and EAR during 2002-2004). Before reviewing the large initiatives, one member of the COV spoke with the Program Officer for Instrumentation and Facilities (IF) in order to understand how large initiatives are generally handled in EAR. The COV was told that IRIS, an established consortium in seismology that receives significantly larger sums of money than any of the large initiatives in GE or HS, underwent a review process in their last renewal that involved 34 mail reviews from geoscientists both within and outside of seismology; a site visit; and review by two panels, one specifically for the IRIS proposal and the regular IF panel.

The review process for each of the large initiatives in GE and HS is discussed sequentially in the following paragraphs.

CRONUS. During the 2002-2004 period, proposals for CRONUS received seven mail reviews (with an average score of 4.5) and were reviewed by both the Geology and Paleontology panel and the IF panel. CRONUS was rejected by panel and was resubmitted and eventually funded (in 2005) after its second round of panel and mail reviews. Because CRONUS was not funded within the time period of review for the COV (02-04), we did not peruse the proposal jacket. CRONUS was funded in 2005 at $5.8M over five years.

CHRONOS. In contrast to CRONUS, funding for CHRONOS ($1.95M discretionary funds during 2002-2004, awarded over two years) was awarded based upon mail reviews but no panel review. The proposals that received funding within CHRONOS consisted of 8 proposals submitted as a Collaborative Research effort; 7 PIs that submitted as part of this Collaborative Research project were declined. Mail reviews for the CHRONOS project averaged 4.33. For comparison, the average scores for funded proposals and for the top ten declined proposals in GE in Spring 2004 were 4.31 and 4.07, respectively. In NSF Form 7, the Program Officer stated, "A panel did not review it [the CHRONOS proposal] because it is a Geoinformatics proposal, for which there is no panel." In his own review of this proposal, the PO pointed out that one of the review criticisms was that reviewers saw a tendency to have the same group of people serve as managers and lead users of CHRONOS. The PO made a CHRONOS award but at a significantly reduced level of funding.

Conversations with the Section Head for Surface Earth Processes within EAR (after the NSF meeting) indicated that the duration and scope of CHRONOS created serious budget issues within EAR and the decision was made to fund the proposal at a reduced level only for two years instead of the three years originally proposed. Most reviewers commented on the overall goals of the project and did not comment specifically on the different parts. The final funding decision was largely made by the Program Officer and is documented in the jackets (as detailed to the COV by the Section Head). As indicated by the Section Head, these decisions appear to be sound and based on a careful analysis of the proposed work. PIs that were funded were those that proposed activities central to the goals of the project within the first two years. The COV regrets that it did not have time to analyze these jackets more thoroughly (see section C.2) but does not have any questions about the analysis provided by the Section Head with respect to funding for CHRONOS.

CUAHSI. CUAHSI was funded within HS during the 02-04 period ($0.39M in 2002, $1.22M in 2003, and $3.0M in 2004). The CUAHSI proposals we reviewed were each evaluated by 6-8 mail reviewers, who gave mixed evaluations. The two sets of mail reviews for CUAHSI proposals which we reviewed had average review scores of 3.66 (in 2001) and 4.00 (in 2004). For comparison, the average scores for funded proposals and for the top ten declined proposals in HS in Spring 2004 were 4.16 and 3.98, respectively. The COV thus noted that the mail reviews for CUAHSI did not document consensus among mail reviewers in HS with respect to the proposal. The HS Program Officer indicated to us that, because the scope and nature of these proposals is so different from the typical Hydrological Sciences proposals, they were not brought to Panel Review.

The COV noted that the mail reviews for the CUAHSI proposal came in at about the same time. We were told that the proposal was initially submitted with one individual as the senior PI through the CUAHSI office; the proposal was reviewed and a decision to fund was made. However, after Program Officers expressed concerns over CUAHSI's ability to manage the award, a second, identical proposal was submitted through the University of Texas. The original reviewers were then sent a letter explaining that the same proposal was being submitted for review again under a different organization. Most of the reviewers stated that their original reviews remained valid for the re-submitted proposal. These reviews were then uploaded for the new proposal at the same time and hence, the identical dates.

COV evaluation of review process for large initiatives. In summary, the COV saw review statistics for one initiative (CRONUS) and jackets for two larger initiatives (CHRONOS, CUAHSI), all of which passed through GE and HS during the review period. One of the three (CRONUS) was not funded until 2005. Curiously, CRONUS was the only one of the three that went through mail reviews and review by panel(s), and the only proposal that will be funded from core program money.

The COV was disturbed that in some cases, large sums of money are dispensed without review by a panel and without a consistently implemented review process. We suggest that the programs in the Surface Earth Processes Section use a common, substantive review process for larger initiatives that include both mail and panel review. The Instrumentation and Facilities program has considerable experience in ramping up and administering large initiatives and we suggest that the Program Officers in the Surface Earth Processes Section take advantage of the Best Practices used by IF or that the IF Program Officers handle the large initiatives.

A.2 Questions concerning the implementation of the NSF Merit Review Criteria (intellectual merit and Broader Impacts) by reviewers and Program Officers. Provide comments in the space below the question. Discuss issues or concerns in the space provided.

A.2.1. Have the individual reviews (either mail or panel) addressed both merit review criteria?
Comments:

Approximately 70% of the GE proposals in 2002 addressed both review criteria: by 2004 the percent addressing both criteria had increased to 90%. While most of the proposals in HS also addressed both criteria, the improvement in the three year period was lower (>60% in 2002 increasing to 80% in 2004). The HS Program Officer needs to be vigilant in educating the HS community to consider both criteria in reviewing the hydrological proposals. As noted elsewhere in this review, there appeared to be confusion in the review process on what should be included under "Broader Impacts."

A.2.2. Have the panel summaries addressed both merit review criteria?
Comments:

Both the GE and HS panel reviews always address both criteria, but again there was inconsistency in many of the reviews regarding "Broader Impacts."

A.2.3. Have the *review analyses* (Form 7s) addressed both merit review criteria?
Comments:

The GE and HS review analyses address both criteria consistently.

A.2.4. Discuss any issues the COV has identified with respect to implementation of NSF's merit review criteria.

There seems to be confusion by the PIs on the understanding of the Broader Impacts criteria. We also found that the GE and HS panels did not uniformly apply the standard to all proposals. This was particularly true within the HS submission and review process, where there appeared to be some minor to moderate, but fairly consistent, confusion concerning what should be included under "Broader Impacts." Sometimes "educational efforts" were considered Broader Impacts; sometimes they were not. In several cases, the panel reviews themselves broke the evaluation into 1) Intellectual Merit, 2) Broader (scientific) Impacts, and 3) Educational Impacts. This latter system may have merit. Perhaps appropriate units within NSF could consider such questions.

A.3 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

A.3.1. Did the program make use of an adequate number of reviewers?
Comments:

The average number of reviews per proposal for GE was 5 from 2002 to 2004. Over this time period, only 4 proposals out of more than 900 received 2 or less reviews. In HS, the average number of reviews per proposal over the same time period was 6; no proposals received 2 or less reviews. These data document exemplary reviewer numbers for both GE and HS proposals and document the care with which the Program Officers complete their work.

A.3.2. Did the program make use of reviewers having appropriate expertise and/or qualifications?
Comments:

Overall, both GE and HS reviewers had excellent qualifications based upon the jackets that the COV perused.

A.3.3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups?
Comments:

Reviewers for both GE and HS were drawn from all 50 states during the period 2002-2004. Some states are heavily represented (e.g. NY, CA), while others are poorly represented (e.g. NV, WV, SD). Program officers are encouraged to seek reviews from the under-represented states.

Data collected concerning the type of institution from which reviewers derived was provided the COV. However, most of the reviewers did not release information about the type of institution. The COV could not, therefore, assess this statistic. However, based upon the little data that was provided, it is assumed that most reviewers derive from research-intensive institutions. This seems appropriate considering the nature of most of the research proposed to the GE and HS programs.

The data provided for the minority/majority status and the gender of the reviewer was inadequate to fully assess these characteristics. For example, it appears that the percentage of GE reviewers declaring themselves as minorities is exceedingly low (i.e., <2%), while the number of reviewers who do not report their ethnicity is over 80%. The remainder of reviewers report that they are not minorities. This large percentage of reviewers who choose not to identify their ethnicity makes it impossible to judge the level of minority participation in the review process. If it can be assumed that minorities reported themselves as minorities, then the statistics provided by NSF indicate that minority participation in the review process is extremely low. The Program Officers might find that using minority reviewers is a very efficient way to educate the minority community about NSF proposals: thus, using minority reviewers could help increase the submission of proposals from the minority community. The COV feels that such attempts to increase minority reviewers should be explored and implemented if this has not happened already.

Another way to encourage broader participation in GE and HS is to redouble efforts of the Program Officers to place minority scientists or women scientists or scientists from states that are under-represented on panels.

A.3.4. Did the program recognize and resolve conflicts of interest when appropriate? Comments:

All reviewers are asked for conflicts of interest and are asked to excuse themselves if there is a Conflict of Interest. For both GE and HS programs, 1-2% of reviewers indicate a COI; however, 20-30% of reviewers choose to not complete a review without indicating a reason. At panel reviews, COI are handled by the Program Officers by asking panelists with COI to sit outside the room during discussion of those proposals. Overall, although this is difficult to assess based on data provided, the GE and HS programs appear to recognize and resolves conflicts of interest when appropriate.

The COV also explored a potential conflict of interest involving the CHRONOS initiative. We noted that the Geoinformatics money which was used to fund CHRONOS was under the supervision of a Section Head with a relationship with Boise State University, and that one of the funded PIs in the CHRONOS group was from Boise State. The COV thought this was an especially important question to address because of the lack of a panel review for CHRONOS and because of the lack of an announced NSF program for Geoinformatics. We were informed that once the COI was discovered, the involvement of the Section Head was discontinued with respect to all aspects of the review or award. While this is a satisfactory handling of this particular conflict, the COV believes that this case emphasizes the benefit of a more rigorous and standardized review process for large proposals.

The COV also identified one COI with respect to the COV itself. One of the committee members had a COI with one of the Program Officers. This COI was handled satisfactorily by disallowing this committee member from evaluating the program run by the PO with the COI. However, it would have been preferable to have all committee members without a COI with NSF personnel who fall under the review.

A.3.5. Discuss any issues the COV has identified relevant to selection of reviewers.

Demonstrable participation of minorities in the review process is a major issue that should be addressed given NSF's goal of increasing minority participation. To encourage self-reporting of ethnicity, the literature provided to reviewers should emphasize NSF's goals and purposes for requesting this information. NSF should seek out minorities and non-minorities within the community to draft this rewording. Given the low participation of minorities within the geosciences, it might be advisable to seek minority participation in the review process from related sciences (sub-disciplines of physics, biology, chemistry, etc.) where minority participation is relatively higher.

It was noticed that some interdisciplinary proposals (those combining distinct disciplines as opposed to slightly different disciplines) sometimes faced more extensive reviews than single discipline proposals. The reviewers from the various disciplines covered in the proposal could be quite critical of the proposed work within their discipline, while not considering the other discipline(s). With this approach, the synergistic effects, if present in the proposal, could be lost if no reviewer capable of commenting upon synergy was utilized in the review process. This problem might be viewed as a systematic problem for funding of interdisciplinary research. The COV encourages the Program Officers to consider this issue. One solution might be to incorporate younger researchers, trained in interdisciplinary programs such as IGERTS, into the review process.

A.4 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided**.**

A.4.1. Overall quality of the research and/or education projects supported by the program. Comments:

For the competition we reviewed, only highly ranked proposals are being funded. The proposals being supported in both the GE and HS programs are of the highest quality. For example, the average scores for funded proposals and for the top ten declined proposals in HS in Spring 2004 were 4.16 and 3.98, respectively. Similarly, the average scores for funded proposals and for the top ten declined proposals in GE in Spring 2004 were 4.31 and 4.07, respectively. The high ratings for proposals that are funded is evidence of the high quality of research and education funded by these programs. The high ratings for proposals that are declined indicates that funding is limited to the point that some very good to excellent research and educational activities can not be funded.

To examine whether there are any trends in the quality of funded and unfunded proposals during the review period, the COV obtained data on proposal ratings each spring from 2002-2004 (Table below). Based on these data, there are no obvious trends in the quality of funded and unfunded proposals through time. The ratings for unfunded proposals in HS appear to drop off more rapidly than those in GE. This could reflect either a greater depth of high quality proposals in GE or a different culture of proposal rating within the two programs. Clearly, proposal pressure is very high for both programs, and the pressure is from highly rated proposals.

Average Proposal Ratings

	Spring 2002		Spring 2003		Spring 2004	
	HS	**GE**	**HS**	**GE**	**HS**	**GE**
Awards	3.98	4.57	4.14	4.42	4.16	4.31
Declines						
1st 10	3.96	4.09	3.70	4.22	3.98	4.07
2nd 10	3.69	3.96	3.33	4.02	3.65	3.83
3rd 10	3.41	3.84	2.95	3.89	3.49	3.60
4th 10	2.99	3.78	2.63	3.79	3.35	3.00
5th 10	2.23	3.75	2.31	3.73	3.02	3.28

Numbers indicated are the average rating for all awarded proposals in each program for the period indicated (awards), and the top ten proposals declined (1st 10), followed by the next ten (2nd 10), next ten (3rd ten), etc.

A.4.2. Are awards appropriate in size and duration for the scope of the projects? Comments:

The award size in GE grew from $150k in both 2002 and 2003 to $179k in 2004. The duration of award roughly stayed the same at approximately 2.7 yrs. In HS, the award size is a bit larger than in GE: size averaged $253k from 2002-2004. The average duration was 2.8 yrs. Thus, over the three years under review, both the average amount awarded and the average duration is relatively consistent within each of the two programs.

For the most part, PIs were funded at the requested levels. For example, of 22 awards investigated in the GE program, 20 were funded at the requested amounts and only 2 were funded at reduced levels. Although it is possible that the high cost of projects may negatively impact their reviews, the COV found that, for the most part, high-cost excellent science was equally being funded as low-cost excellent science.

The COV noted that, as a general pattern, in cases where the awarded amounts are less than requested for GE proposals, the duration of the project was adjusted downward appropriately. In contrast, in HS many of the multiyear projects were only funded for the first year with future funding contingent on monies available in subsequent years. Program officers are encouraged to compare these strategies to maximum use of best practices.

The COV feels that awards are generally appropriate in size and duration; however, given the extreme levels of competition and low success rates inherent in these programs, the COV assumes that proposers are submitting bare-bones proposals, perhaps not congruent with the real cost of the science. The COV also saw no innate reason why GE proposals should have lower award amounts than HS proposals, at least for proposals in similar water-related areas of science.

A.4.3. Does the program portfolio have an appropriate balance of:

- **High risk projects? Comments:**

We note that GE funded at least four SGER proposals in the 2004 Spring. Given the data presented for us to evaluate, it was difficult to assess which proposals should be categorized as high risk. Other than SGER proposals, it does not seem that the merit-review system and the extreme limits to budgets easily permit Program Officers to fund "high risk" proposals unless they receive across the board support.

The risk level associated with HS funded proposals is also difficult to judge. The ideal high-risk proposal is a new idea that turns out to be a breakthrough. Such ideas are relatively rare, and when they come along they are difficult to recognize. There seemed to be a reasonable mix of more applied and more theoretical proposals that were funded. According to information supplied by HS (COV CD), the program has awarded a number of grants that fall within high risk (EAR 0210003, 0229019), multidisciplinary (EAR 0105322, 0313984, 0073912) and innovative projects (EAR 0001514, 0229896, 0337460). However, we would rate most funded proposals as medium risk.

If NSF truly wants to fund high risk proposals, some mechanism for identifying these proposals and quantifying them would be in order. Only then could a COV evaluate NSF's performance in this regard.

A.4.4. Does the program portfolio have an appropriate balance of:

- **Multidisciplinary projects? Comments:**

The COV feels that there is an appropriate balance of multidisciplinary projects: for example, in spring 2004 jackets, 4 of 15 funded proposals in the area of GE that was split out for the SGP panel were multidisciplinary. However, as mentioned previously, true interdisciplinary proposals may be innately harder to fund and the Program Officers are encouraged to include reviewers that have been trained in interdisciplinary science.

A.4.5. Does the program portfolio have an appropriate balance of:

- **Innovative projects? Comments:**

In both programs there was a good balance of innovative projects. Many important aspects of GE and HS were funded.

A.4. 6. Does the program portfolio have an appropriate balance of:

- **Funding for centers, groups and awards to individuals?**

Comments:

Within the 2004 Spring competition, 4 of the 15 GE proposals split out for the SGP panel that received funding were collaborative. In GG, 5 of the 12 proposals were collaborative. The COV felt that this balance between "individual" and "collaborative" projects is appropriate. Funded HS proposals also showed a reasonable mix of individual and collaborative projects. The ratio of these type proposals has remained relatively stable over the past three years. The COV viewed this as appropriate.

A.4.7. Does the program portfolio have an appropriate balance of:

- **Awards to new investigators?**

Comments:

Between 2002 and 2004, 20-32% of awardees in GE were New Investigators while 24-31% of awardees in HS were New Investigators. Such a proportion is deemed an appropriate balance. The COV was told that the acceptance rates for proposals submitted by New Investigators are about equal to all proposals for GE and slightly below all proposals for HS. The term "New Investigator" refers to a first time awardee regardless of age or rank.

A.4.8. Does the program portfolio have an appropriate balance of:
Geographical distribution of Principal Investigators?

Comments:

While proposals to GE derived from all states, not all states host PIs that received funding during 2002-2004. Specifically, states that submitted fewer proposals were often observed to not receive any funding. The broad distribution of geographic location from which proposers derive suggests that the programs do a good job of soliciting proposals with respect to geography. We saw no evidence of geographic bias in proposal review or award basis.

A.4.9. Does the program portfolio have an appropriate balance of:

- **Institutional types?**

Comments:

Between 59 and 70% of awards in GE were made to research-intensive universities (top 100). A very small percentage of awards (<2%) were made to minority-serving institutions.

Between 70 and 80% of awards in HS were made to research-intensive universities (top 100). A very small percentage of awards (<2%) were made to minority-serving institutions and this occurred only in 2003.

While the proportion of funding that went to top 100 research universities was deemed appropriate, the Program Officers should be encouraged to find ways to increase support to faculty at minority-serving institutions.

A.4.10. Does the program portfolio have an appropriate balance of:

- **Projects that integrate research and education?**

Comments:

In GE over the years 2002-2004, 23-30% of the funded personnel consisted of graduate students and 24-28% of funded personnel consisted of undergraduate students. Postdoctoral associates comprised only 2-6% of the funded personnel. Senior (28-38%) and other (9-13%) comprised the rest of the funded personnel. Most of the personnel receiving funding from GE over this time period were thus from the student ranks. The COV felt that these data document that research and education were generally integrated within the projects funded over this time period.

In HS over the years 2002-2004, 28-34 % of the funded personnel consisted of graduate students and 14-19% of funded personnel consisted of undergraduate students. Postdoctoral associates comprised only 4-6% of the funded personnel. Senior (34-42%) and other (9-10%) comprised the rest of the funded personnel. Most of the personnel receiving funding from HS over this time period were thus from the student ranks. The COV felt that these data document that research and education were generally integrated within the projects funded over this time period.

A.4.11. Does the program portfolio have an appropriate balance:
- **Across disciplines and subdisciplines of the activity and of emerging opportunities?**

Comments:

Over the timeframe of this review, the GE program began to split into a Geobiology and Low-temperature Geochemistry (GG)/ Geomorphology and Land Use Dynamics (GLD) type panel and a Sedimentary Geology and Paleobiology (SGP) panel. This split was fostered by the recognition that the GE panel was very diverse and the panel reviews would be improved with a more disciplinary specific panel. In addition, the GE program has now fully split into GG, GLD, and SGP programs. The panel split appears to highlight three important sub areas within GE. Thus the split is perceived by the COV as an important step in improving the program.

Evidence of funding for cross-disciplinary research can be found in the nature of the funding sources used by the Program Officers. Given the interdisciplinary nature of the fields represented, it is appropriate that co-funding of grants will occur. The COV saw ample evidence of co-funding in the documentation of these two programs. Between 2002 and 2004, more than 50 proposals managed by GE derived funding from programs other than GE within NSF. This represents more than $2 million dollars of funding that derived from other programs but was used to advance science promoted by GE PIs. Between 2002 and 2004, more than 70 proposals managed by HS derived funding from programs other than HS within NSF. This represents more than $4 million dollars of funding that derived from other programs but was used to advance science promoted by HS PIs.

Many sub-disciplines within GE and HS were funded. For example, in HS, funding included work to investigate microorganisms in the vadose zone, slope stability/hydrology, ground water quality, colloid transport in the vadose zone, rainfall variability, LNAPL and heterogeneity, hyporheic zone processes, stochastic subsurface hydrology, isotope hydrology, biogeochemical processes and percolation theory. The COV identified a healthy mix of sub-disciplinary funding within HS. With regards to the balance of the portfolio in GE, the COV identified a possibly heavy emphasis on paleontology-based projects within the SGD portfolio. The COV is unclear whether this is true over long periods of time, or is just an artifact of a small sample number. Evidence for a healthy mix of sub-disciplinary funding in GG was noted.

A.4.12. Does the program portfolio have appropriate participation of underrepresented groups?
Comments:

Between 2002 and 2004, between 16 and 18% of the awarded Principal Investigators in GE were women; similarly, between 11 and 24% of the HS awardees were women. For comparison, between 2002 and 2004, the average proportion of women proposers was also roughly 20% for GE and HS.

Between 2002 and 2004, between 0 and 3% of the awarded Principal Investigators in GE were self-reported as minority; similarly, between 3 and 10% of the HS awardees were minority. For comparison, between 2002 and 2004, the average proportion of proposers drawn from under-represented minority groups was <5 and 5-10% for GE and HS respectively.

To increase minority representation among awardees, it will be necessary to increase the number of proposers derived from minority groups.

For both programs, the success rates of women (percent of proposals that were awarded) were roughly equal to that of men. However, the success rates of proposals awarded to self-reported minority PIs in GE were consistently lower than the majority group (men self-reported as majority group). In contrast, the success rate of proposals awarded to minority PIs in HS were sometimes higher and sometimes lower than similar rates to PIs from the majority group. These observations are best explained by the low number of submissions of proposals from minority groups between 2002 and 2004. Continued work on the part of Program Officers to encourage submission of proposals from PIs from minority groups is encouraged.

We also considered gender diversity for the larger collaborative proposals. We asked the question, does the gender diversity of the CUAHSI and CHRONOS projects differ from the gender diversity of the rest of the portfolio? We observed that of the 8 PIs (or coIs) funded for CHRONOS, only 1 is female; similarly, of the 7 CHRONOS proposals that were declined, only 1 investigator was female. Of the several submitted proposals for CUAHSI which we reviewed, the total number of investigators was 10**,** of which none were female (note that the year CUAHSI received funding, 2004, the representation of women as PIs in HS dipped to about 10%). However, at present, the CUAHSI leadership consists of 2 males and 3 females on the Executive Committee and 10 males and 5 females on the Board of Directors. The Program Officers should encourage large teams to consider diversity not only in the *running* of the large initiatives but also in the *planning* of such initiatives.

The COV team further asked if the summary statistics gave a slanted picture regarding gender and ethnic equity, since the spreadsheets did not include all proposals, as well as SGERs and workshops. We were told that the number of proposals not included (SGERs, Workshops, Supplement requests and CHRONOS) is small, so lack of full accounting is unlikely to alter the statistics appreciably, given the large numbers of proposals submitted to GE and HS.

A.4.13. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports.
Comments:

Science supported by both GE and HS provide innovative new ideas and techniques, as well as significant data to address important areas as identified for the Solid Earth Sciences in the NRC

report, Basic Research Opportunities in Earth Sciences. In addition, these two programs provide funding to educate personnel in these areas.

A.4.14. Discuss any concerns relevant to the quality of the projects or the balance of the portfolio.

A.5 Management of the program under review. Please comment on:

A.5.1. Management of the program.
Comments:

Management of the two programs depends on integration of multi-faceted duties, but the core task appears to be running the review process that leads ultimately to funding decisions. As covered in questions A1-A3 of this survey, the different aspects of the review process for smaller projects within HS and GE seem to be administered fairly and efficiently with a concern for good science, suggesting a maximum return for the amounts awarded. The POs should be encouraged to continue to be as inclusive as possible in making their portfolios reflective of the diversity in the general scientific population.

The COV did identify concerns with respect to management of the larger initiatives, as noted in Section A.5.3.

A.5.2. Responsiveness of the program to emerging research and education opportunities.
Comments:

Responsiveness of the HS and GE programs to emerging research and education is suggested in various ways. Both mail reviewers and panelists appear to be chosen from a broad cross section of the community, thus increasing the likelihood that emerging research will not be overlooked. The numerous workshops and town meetings conducted by the two programs in the 2002-2004 period provide vital leadership and feedback to identify new program directions.

The COV noted, however, that success rates have been declining (from above 20 % to approximately 10%) over the period under review for all programs evaluated. The number of proposals submitted has also been increasing over the same time period, while funding to the core programs have not increased significantly. For both programs, there is a desperate need for more funding within the core programs. The COV cautions that reduced success rates will negatively impact the scientific community as some PIs may become discouraged from submitting proposals. Of particular concern is the fact that proposals that are declined are receiving ratings that are Very Good or better (see section A.4.1). As such, important advancements in science will be stifled just at the point when new techniques and new innovative ideas are coming online.

A.5.3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.
Comments:

The COV identified a management problem that impacted GE and HS. In particular, communication among POs, the Section Head, and the Division Director appears problematic. We outline specific instances below to substantiate this observation. Communication is essential to prioritization and should improve within the unit.

The first example derives from the Geoinformatics funding: funding for Geoinformatics was available through the Section Head's office to promote the use and development of cyberinfrastructure within EAR. This discretionary funding was dedicated for cyberinfrastructure because of the need for this infrastructure and because of the possibility of big funding initiatives in the future with respect to such infrastructure. Of the three Program Officers within GE and HS, two of the three knew of the availability of Geoinformatics money while the third apparently did not. The PO of HS indicated that his PIs had been involved in workshops about Geoinformatics and that they knew that Geoinformatics money was available. Thus, despite the lack of an RFP for Geoinformatics, several hydrological cyberinfrastructure proposals were submitted with Geoinformatics in the box at the top of the Cover Sheet. Specifically, a group of collaborative investigators involved in CUAHSI working on an "Informatics Infrastructure for the Hydrologic Sciences" received Geoinformatics funding that comprised $2.5m during 2004 – 2005 for jackets 0413265, 0412904, 0412859, 0412975, 0413182. Similarly, the PO for SGP also indicated that his PIs knew of the availability of Geoinformatics money. CHRONOS funding as a collaborative project for $1.95m over 2003- 2004 (0311889, 0314113, 0312392, 0315216, 0314415, 0312171, 0313738, 03135424) was derived from this pool of discretionary funding.

In contrast to the POs for HS and SGD, the PO of GG indicated no knowledge of the availability of Geoinformatics money during 2002-2004 for GG PIs. The COV asked to see written information about Geoinformatics money that was available; however, the most explicit document we saw, dated Oct 5, 2004 and entitled "Geoinformatics in the Earth Sciences", stated that "It is important to stress that EAR does not have, at this time, a formal Geoinformatics program, and that the description and discussion provided here is not a solicitation for proposals…Investigators seeking to develop new Geoinformatics platforms should contact the Program Officer(s) in the subdiscipline(s) affected or the Program Officers in the Instrumentation and Facilities Program to discuss the potential project." Apparently, communication regarding funding for Geoinformatics was verbal within EAR and some of the POs were better informed than others.

Given these observations, it appears that certain communities may not have been able to access Geoinformatics money due to the communication problems within the Section. Coincidentally, the COV also knew of two anecdotal instances of scientists that had been seeking Geoinformatics funding but who had difficulty determining availability of these funds. In recognition of some of these problems, EAR has now formalized the handling of such proposals by giving the funding to the IF program to handle and to include as a topic in its solicitation.

While the issues with respect to Geoinformatics appear to be handled appropriately for the future, the COV views the communication breakdown as an important management issue that is

not isolated and that has impacted the ability of POs to advance science within their disciplines as outlined below.

Our second example of a communication breakdown is related to the area of biogeosciences. This area was identified in the NRC report, Basic Research Opportunities in the Earth Sciences as a growing area: for example, AGU abstracts submitted within the Biogeosciences have increased from 2001 (619) to 2004 (822) (see also A.5.3). Concomitant with this growth, funding for Solid Earth Scientists studying biogeosciences questions has been available from a variety of programs over the past decade, including Environmental Geochemistry and Biogeochemistry (EGB), Biocomplexity, Biogeosciences, and Low-temperature Geochemistry and Geobiology (GG). Of these programs, one has been cancelled (EGB), one continues with changing emphasis (Biocomplexity), one is on the verge of cancellation (Biogeosciences), and one has just been initiated (GG). Many researchers within the growing biogeosciences community are confused by the continuously changing nature of the funding in this area. Based upon conversations between COV members and Program Officers, the POs are also unaware of how funding will be allocated among the programs for the near future (for example, where will the Biogeosciences funding be allocated for the future?). Without communication about allocation of funding for the present and future, the Program Officers have difficulty planning for their respective communities.

Both of these examples of communications breakdowns have led to – and perhaps reflect -- a vision problem within the Surface Earth Processes group. The COV strongly encourages more communication between the administrators and POs about new science needs and directions and about budgetary issues, especially for new initiatives.

A.5.4. Additional concerns relevant to the management of the program.

Allocation of new money to core programs is an important management decision, especially as new programs form or as larger initiatives nucleate. For example, the area of biogeosciences is exhibiting fast growth: according to AGU statistics, as of July 2005, approximately 2000 AGU members are affiliated with the newly formed Biogeosciences section (see below). However, with the ongoing uncertainty about and sometimes terminations of programs such as Biogeosciences, NSF-funded scientists will go elsewhere for funding and the community will lose the ability to pursue avenues of fundamental research. Without a significant increase in the budget of the GG program to accommodate growth trends, success rates will decrease even further and will have a negative impact on the ability of geoscientists to advance this state-of-the-art area of research. The COV therefore recommends that at the termination of initiatives such as the Biogeosciences program, the money should be put into the core programs most related to the initiative to help with the support of the science in these cutting edge areas (GG).

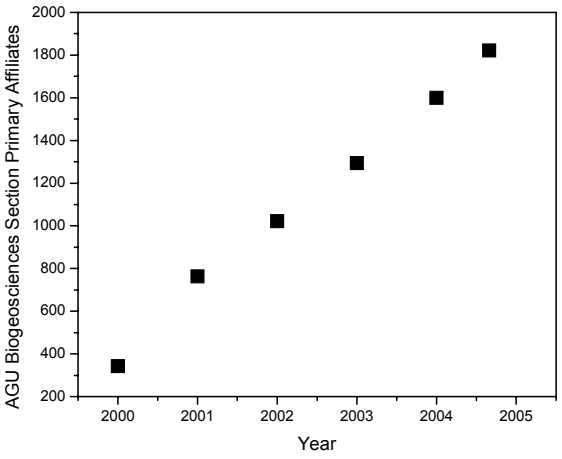

Chart showing the increase in AGU members claiming Biogeosciences as their primary affiliation over the period 2000 to July 05.

With respect to use of new (non-core) funding for large initiatives, the COV is very concerned that no discretionary money is currently utilized to support the CRONUS project within GG/GLD (see Section A.1.8). Funding for GLD PIs in the future will be limited partly due to use of core budget money instead of discretionary funds for this large project. This is particularly puzzling given that CRONUS went through a substantive review as compared to the review process used for the two other initiatives (CHRONOS, CUAHSI). Wherever possible, discretionary funds should be used to augment core programs when large initiatives nucleate and survive substantive review.

PART B. RESULTS OF NSF INVESTMENTS

NSF investments produce results that appear over time. The answers to the first three (People, Ideas and Tools) questions in this section are to be based on the COV's study of award results, which are direct and indirect accomplishments of projects supported by the program. These projects may be currently active or closed out during the previous three fiscal years. The COV review may also include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made. Incremental progress made on results reported in prior fiscal years may also be considered.

The following questions are developed using the NSF outcome goals in the NSF Strategic Plan. The COV should look carefully at and comment on (1) noteworthy achievements of the year based on NSF awards; (2) the ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcomes; and (3) expectations for future performance based on the current set of awards. NSF asks the COV to provide comments on the degree to which past investments in research and education have contributed to NSF's progress towards its annual strategic outcome goals and to its mission:

- To promote the progress of science.
- To advance national health, prosperity, and welfare.
- To secure the national defense.

• And for other purposes.
Excellence in managing NSF underpins all of the agency's activities. For the response to the Outcome Goal for Organizational Excellence, the COV should comment, where appropriate, on NSF providing an agile, innovative organization. Critical indicators in this area include (1) operation of a credible, efficient merit review system; (2) utilizing and sustaining broad access to new and emerging technologies for business application; (3) developing a diverse, capable, motivated staff that operates with efficiency and integrity; and (4) developing and using performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes (nuggets) as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for PEOPLE: Developing "a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens."

Comments:

GPRA Goals, Outcomes

Based on its review of the proposals, the proposal evaluation process (leading to award or denial), project data, and follow-up outcome data for both the GE and GG programs, the COV was satisfied that these programs are proactive and successful in developing scientists who are competitive and globally engaged. Diversity of scientists in the programs by underrepresented groups remains low, and efforts to increase diversity of the applicant pool should be encouraged. The COV found a few instances where such activities may be bearing fruit: for example, Native American students are being attracted to conduct geological research in EAR-0207750 (PIs: Williamson, NM Museum of Natural History, and Semken, Diné College, Shiprock, NM). These PIs are involving undergraduate students from Navajo Nation Diné College in field and laboratory research of post-Cretaceous/Tertiary boundary event vertebrate species. Such an investigation provides the students with a unique opportunity to learn both geologic history and vertebrate paleontologic investigative techniques, and allows them to contribute new scientific knowledge.

Information provided to the COV reveals data that permit assessment of program outcome goals. CAREER Proposal 0133666 (PI: Weissmann, Michigan State University) involves student researchers in integrated studies on aquifer and petroleum reservoir assessment. The research outlined in Proposal EAR-0309257 (PI: Cole, Institute of Ecosystem Studies) links hydrology and limnology studies to a larger educational outreach program that extends to the middle school level, thus pursuing a strategic goal to improve science and technology education at all levels. Similarly, the objectives of Proposal EAR-0409203 (PI: O'Day, UC-Merced) include the advancement of graduate and undergraduate education at a minority-serving campus.

The COV found many examples within GE and HS of projects that enhance our nation's goals to grow diverse talent within the fields of science and engineering.

B.2 OUTCOME GOAL for IDEAS: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."
Comments:
GPRA Goals, Outcomes

The GE/HS programs fund excellent science. One line of evidence exemplifying this is the observation that more than 23 articles were published in *Science* during 2002-2004 by GE-funded scientists alone. Two examples from the GE program, published in different issues of the journal *Science,* illustrate this point. One reports on the changes through geologic time in the chemistry of seawater based on fluid inclusions in sedimentary rocks. The investigation (EAR-9725740) brought together geologists and geochemists from SUNY Binghamton and Johns Hopkins University. The implications of their work will impact other related fields in our understanding of seafloor spreading rates, volcanism, global sea level, and mineralogy of marine rocks. A second example (EAR-0105543) was a collaborative effort by scientists from the U.S. National Museum, the Smithsonian Tropical Research Institute in Panama, Scripps Institution in California, UC Santa Barbara, the University of Florida, and colleagues in Australia. They investigated geologic, paleontologic, and biologic evidence demonstrating the long-term, worldwide decline of coral reef ecosystems. Results of their findings will have scientific and even policy implications to our understanding of climate change, human impacts on marine ecosystems, and the resilience of natural systems.

Two studies supported by NSF provide examples that idea goals are being successfully promoted within the HS program. A study of arsenic in groundwater in Bangladesh (EAR-0001098; PI: Harvey, MIT) published in *Science* fostered the goals of collaborative research, participation by underrepresented groups and institutions, and using discoveries in the service of society. A paper by Kirchner *et al.* in *Hydrological Processes* supported the outcome goals of collaborative research in the development of integrative and cross-disciplinary knowledge and tools. That study was supported by NSF award EAR-0125550 (PI: Kirchner, UC-Berkeley).

B.3 OUTCOME GOAL for TOOLS: Providing "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation."
Comments:
GPRA Goals, Outcomes

The COV observed that collaborative efforts among scientific investigators from across the United States, and often including international colleagues with appropriate expertise, were most effective in developing the tools that will be utilized by a broad cross-section of the scientific community. For example, tools being developed by the CHRONOS Project collaborators (EAR-0315216) will provide a framework for high-resolution geologic time control, a tool that will greatly benefit any of the geologic disciplines attempting to answer questions -- for instance, questions about the evolution of life, geologic processes, and the history of global climate change through geologic time.

Successful outcomes for HS tool goals are illustrated by two proposals. One from the SAHRA technology center (PI: Woodward, Univ. Arizona) shows how the collection and analysis of

water resource data in desert river systems aid in policy formulation for use of these scarce resources. Collaborative Research Proposal EAR-0412975 (PI: Hooper) within the CUAHSI initiative address the tool goals of development of an advanced cyberinfrastructure for interdisciplinary study of environmental systems and assembling a prototype hydrologic information system that will be part of next-generation research tools within the hydrology community.

B.4 OUTCOME GOAL for ORGANIZATIONAL EXCELLENCE: Providing "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."
Comments:

The COV observed that Program Officers were generally responsive to the scientific community's needs by directing research support toward areas where interest was high and outcomes looked promising. The POs were also proactive in using discretionary funding to promote areas of science that needed to grow. Additionally, the COV was greatly impressed with the NSF's adoption of the e-Jacket system to efficiently and effectively manage and track the vast numbers of proposals it receives each year and to ensure that the review and reward process is fair and well documented. The switchover to a completely electronic format for initiating and reviewing (e-jacket) research proposals ranks as a major step forward in streamlining the business aspects of the proposal process within the HS and GE (and other NSF) programs.

PART C. OTHER TOPICS

C.1 Please comment on any program areas in need of improvement or gaps (if any) within program areas.
Proposal Percentages, Community Size, Budget

GE and HS funding remains a major issue because the budget lacks resources to grow the core program as evidenced by shrinking success rates. Lack of funding for core programs may also reflect money going into larger initiatives. Work overload is another issue in that the POs are required to seek out new directions through organizing workshops, town meetings and educational initiatives while working through the proposal process in a timely manner. It is a tribute to the dedication of the Program Officers that the programs function as well as they do.

C.2 Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

The COV wanted to analyze the process by which large initiatives were funded in GE and HS. In response to our question about large projects in HS, we were told that CUAHSI received considerable funding from the Division of Earth Sciences over the period under review and we were given jackets for analysis. Upon asking for specific information about large initiatives for GE, the COV was initially told that no such large grants for initiatives had been made during the

reporting period. However, it was mentioned that one large initiative, CRONUS, was reviewed during the period 2002-2004 and not funded until 2005. Understandably, it was unclear whether CRONUS should be reviewed by this COV since it was not funded between 02 and 04. Appropriately, it was decided that the COV would be given information about the review process for this initiative but would not be given the e-jacket.

After the COV also asked to look at proposals that did not go to panel in GE, we were told late in the second day of our visit that a set of proposals was funded through GE as a collaborative project for $1.95m over 2003- 2004. This initiative was CHRONOS (e-jackets 0311889, 0314113, 0312392, 0315216, 0314415, 0312171, 0313738, 03135424). The COV was only given access to these proposals late during the evening of the second day and none of the COV had time to look exhaustively at the CHRONOS proposals. The COV was also told that the lead proposal jacket for this Collaborative Research project was not available for perusal because it was being read by someone in another NSF office. The lead jacket contains nothing different from the other jackets except the correspondence with the lead PI. The body of the proposal, the reviews, and the Program Director analysis are identical for all the jackets of a collaborative proposal, and the COV was able to peruse these for the other CHRONOS jackets. Because CHRONOS is a complex proposal with a proposed ~$11M budget over 5 years with 15 PI's (although the final awarded budget was $1,831,652 over 2 years for 8 PIs), the COV did not analyze it exhaustively.

The COV queried the Program Officers concerning how a large initiative such as CHRONOS could have been left out of the review process. The error occurred due to human error because the funding for CHRONOS came from a different budget than the GE budget and the GE panel did not review the proposals.

We recount this history because it exemplifies both the need for more communication among the Program Officers, Section Head, and Division Director (A.5.3) and the need for a spreadsheet that accounts for all proposals handled by the Program (C.4).

C.3 Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

The COV was shown data that documented that the workload for GE/HS Program Officers is high and the programs are for the most part understaffed. Our recommendation is to increase the staffing for these programs.

C.4 Please provide comments on any other issues the COV feels are relevant.

Before coming to NSF, the COV was given a spreadsheet of proposals handled in 2002-2004 by GE and HS. The spreadsheet included all proposals Division Director-concurred during FY '02-'04 excluding SGER's, Workshops and Supplements. The spreadsheet also did not include proposals that were withdrawn or returned without review (e.g., a few proposals did not discuss Criterion 2 in the Project Summary or Project Description and were returned without review as per NSF policy). As noted in C.3 above, the CHRONOS proposal was missing from this spreadsheet due to human error. This mistake was found when the COV asked to see an

accounting of how funds were spent among larger multi-PI and multi-institution grants for comparison to funding for smaller one- or two-PI grants, and when the COV asked to see proposals that did not go to panel.

Given the issues the COV experienced with respect to finding out which proposals should be reviewed by the COV, we would suggest that before arrival at NSF, the COV be given a spreadsheet of all proposals handled by the program. If such a spreadsheet had been given this COV, it would presumably have included proposals such as CHRONOS, which were inadvertently left off. Given that NSF rules for COVs indicate that all proposals for which the Program is the lead should be included in the COV review, we suggest that this spreadsheet should also include workshop, Supplemental and SGER grants, i.e. proposals that did not go to panel. Even with such a spreadsheet, it might be difficult to identify the large initiatives because they are sometimes broken up into many individual grants funded as large Collaborative Research projects. The Program Officers might seek ways to make this type of information more clear on such a spreadsheet.

It would have also helped if this spreadsheet had been given to the COV in both hard copy and electronic form. The hard copy will provide a complete, comprehensive map of the program under review.

C.5 NSF would appreciate your comments on how to improve the COV review process, format and report template.

The charts, diagrams and summaries included in the CD given to the COV provide critical information to evaluate the HS and GE programs, but they would be more useful if at least one hard copy was provided at the beginning of the meeting along with the list of all proposals and their rankings.

The electronic jackets did not contain all documents necessary to evaluate the proposals; nor was there consistency in the presence or absence of particular documents in the jackets. Frequently, the letter from the PO to the PI was not present in the electronic jacket and so a full picture of the communication to the PI about the review process was not available. In retrospect, after determining which proposals were going to be reviewed, it would have been best to assemble the paper jackets as backup for missing documents. This procedure could be followed in future COVs until the electronic jackets are complete.

The COV felt that the template of questions for the COV report was problematic in some regards. Some of the template questions are redundant: section A5, for example, appears to be a rehash of ground covered in sections A1-A4. In addition, it would have been helpful if the POs reviewed the template questions immediately prior to the COV meeting and provided oral summaries of most of the major topics in the template (review process, reviewer and panel selection, etc.) as well as a summary of their program in general and their vision for its future.

The in-depth analysis required of the COV to evaluate programs can not be accomplished in the allotted time of 2-3 days.