Pitching Your Project
A Workshop on Proposal Writing

July 27, 2023

Computational HEP Traineeship

Summer School

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Writing in Science and Engineering (WSE)

Insider’s Guide to Peer Review

For Applicants

NIH Center for Scientific Review

To help new and established applicants submit better applications, CSR asked six current and retired study section chairs to share their personal insights on what makes a good NIH grant application. They responded with great enthusiasm. We present some of their responses in their own words to preserve their sprit and impact. Applicants are encouraged to consider the additional tips and official application guidelines on the NIH Web site: **http://grants.nih.gov/grants/grant_tips.htm.**

Propose something significant: It is a real turn-off to read an application that is basically a re-hash of a previous project with a new tissue. The same goes for “me too” research. Identify an area of current controversy and importance within your field. Make it something that would interest more people than you and your coworkers. Will it be important to clinicians or other investigators? Are you dealing with key questions or controversies in the field?

Good ideas don’t always sell themselves: Tell me why it’s important up front in the background section, and I’ll be ready to roll. Tell me what’s known and what isn’t known and how, after you complete your studies, you’ll move the field forward or answer important questions. A lot of people really are unaware of how absolutely important it is to tell the reviewer from the beginning why it’s worth doing. If you’re seeking an incremental advance over what’s known, it’s essential to justify it.

Make it exciting: I love to see fresh, well-supported ideas that have a good hypothesis behind them that could really open up an area. And I find it both exciting and intellectually stimulating to encounter new approaches to major problems and research that could advance both clinical and basic science. Even if it’s somewhat high risk, if it comes with a good hypothesis and you can test it, I’d find it very exciting.

Probe for mechanisms and seek new models. We need to know how something happens—not just what happens. With this knowledge we can affect outcomes and design something to prevent something from happening. If you don’t know what’s happening on the bench, you’re not going to move to the bedside with any reproducible or knowledgeable treatment.

If you really want to know how to write a good application, serve on a study section.

Rozanne M. Sandri-Goldin
University of California, Irvine

Avoid proposing to "collect more data." It might help you to set up the system, but if it is not critical to fundamental understanding do not dwell on it. Although some experiments might take a lot of time to perform, they will not necessarily qualify as specific aims.

Be very clear and very concise about what you want to do, why it’s important, and what you expect to get out of it. Keeping it clear doesn’t mean doing away with complexity. Just make sure your general sense and key questions come across very clearly ***throughout*** your proposal.

Don’t assume too much: Not all reviewers will have the same in-depth, highly expert, knowledge you do. Avoid any unnecessary technical jargon, and write your application assuming it will be reviewed by intelligent scientists who have a breadth of knowledge around your area. So consider getting a researcher at your institution who isn’t an expert in your field to read your application and tell you how well it flows.

Be brief with stuff everyone knows: Lots of people go too far describing routine laboratory methods, which just take up space and really distract reviewers. It gives the message that the applicant is not really as organized as they should be. New investigators, however, should make a little more effort to show that the techniques they proposed to use are within their capabilities.

Aim each aim: Spend time on the Expected Outcomes, Data Interpretation, Pitfalls, and Contingencies section for each aim. The “expected outcomes” section shows you’ve got a logical strategy. The section on Data Interpretation gives insight into your depth of understanding the problem. The Pitfalls section shows how familiar you are with the proposed techniques and methodologies. Finally, in discussing alternative strategies, you can give us confidence you are able to deal with the problems that arise when experiments don’t work as expected.

Pull it together: At the end of your methods section, have a succinct, one paragraph summary of what you intend to do, how you intend to do it and what it is going to tell you. Write it like a manuscript abstract. It is really helpful at the very end if I can get the take home message.

Don’t jump too fast into writing your application, particularly if you’re a new applicant. The most critical parts are the summary and specific aims sections. So write a one-page summary page with specific aims first and share it with someone who is experienced, has their own funding or—ideally—someone who has served on a study section. If you can’t wow them, start again and use the time you saved to come up with some fresh ideas.

Don’t test the waters to see how reviewers like your initial ideas or let them find the limitations for you. Find the limitations yourself and discuss them in the application.

Don’t cram your application like a suitcase: At every single meeting, I hear reviewers complain about small font, tiny margins, numbered references (because they require readers to constantly flip back to the reference section) and statements such as “See the reprint in the appendix for details.” I love to see spaces between paragraphs, spaces between sections, and figure legends I don’t need to bring up the PDF magnification to 200x to read.

Proofread your application. Better yet, have someone else proofread it!

The key word for applicants is persistence. Half the applications reviewed are not discussed. So don’t despair. You’re in good company. Go through your critiques with your investigators. If there’s a fatal flaw, stand back and then decide the best route to take next time. But usually the weaknesses are fixable. Fix them and re-submit.

NIH Tips for Applicants Video
http://www.csr.nih.gov/video/video.asp

Get More Grant Writing Tips from NIH
http://grants.nih.gov/grants/grant_tips.htm

Learn More About the Peer Review Process
https://public.csr.nih.gov/






In appreciation for their many contributions . . .

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And Dr. Sandra Melnick Seitz, SRO, CSR Infectious Disease, Reproductive Health, Asthma, and Pulmonary Epidemiology Study Section.

Review Criteria at a Glance (for Parent Announcements)

	Research and Research Center (R, DP, RC, P, etc)	SBIR/STTR (R41, R42, R43, R44)	Fellowship (F30, F31, F32, F33)	Career Development (K01, K02, K07, K08, K23, K24, K25, K99)	Institutional Training (T32)	Shared Instrumentation (S10)
Overall Impact	Overall Impact	Overall Impact	Overall Impact/Merit	Overall Impact	Overall Impact	Overall Impact/Benefit
Scored Review Criteria (Scored individually and considered in overall impact/priority score)	✓ *Significance* ✓ *Investigator(s)* ✓ *Innovation* ✓ *Approach* ✓ *Environment* PAR & RFA: May add questions to each scored or additional criterion — FOA-specific — Not given individual criterion scores	✓ *Significance* ✓ *Investigator(s)* ✓ *Innovation* ✓ *Approach* ✓ *Environment*	✓ *Fellowship Applicant* ✓ *Sponsors, Collaborators, and Consultants* ✓ *Research Training Plan* ✓ *Training Potential* ✓ *Institutional Environment & Commitment to Training*	✓ *Candidate* ✓ *Career Development Plan/Career Goals & Objectives/Plan to Provide Mentoring* ✓ *Research Plan* ✓ *Mentor(s), Co-Mentor(s), Consultant(s), Collaborator(s)* ✓ *Environment & Institutional Commitment to the Candidate*	✓ *Training Program and Environment* ✓ *Training PD/PI* ✓ *Preceptors /Mentors* ✓ *Trainees* ✓ *Training Record* Other T programs use other criteria	✓ *Justification of Need* ✓ *Technical Expertise* ✓ *Research Projects* ✓ *Administration* ✓ *Institutional Commitment* • Overall Benefit (not scored)
Additional Review Criteria (Not scored individually, but considered in overall impact/priority score)	R01-BRP only: • Partnership and Leadership All: ✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* • Resubmission • Renewal • Revision	• Phase II • Fast Track ✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* • Resubmission • Renewal • Revision	✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* • Resubmission • Renewal	✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* • Resubmission • Renewal • Revision	✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* • Resubmission • Renewal • Revision	✓ *Biohazards* • Resubmission
Additional Review Considerations (Not scored individually and not considered in overall score)	R01-BRP only: ✓ *Technology Transfer* All: • Applications from Foreign Organizations • Select Agents • Resource Sharing Plans ✓ *Budget & Period of Support*	• Select Agents • Resource Sharing Plans ✓ *Budget & Period of Support*	✓ *Training in the Responsible Conduct of Research* • Applications from Foreign Organizations • Select Agents • Resource Sharing Plans ✓ *Budget & Period of Support*	✓ *Training in the Responsible Conduct of Research* • Select Agents • Resource Sharing Plans ✓ *Budget & Period of Support*	✓ *Recruitment & Retention Plan to Enhance Diversity* ✓ *Training in the Responsible Conduct of Research* • *Select Agents* ✓ *Budget & Period of Support*	✓ *Budget & Period of Support*
Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant

Overall Impact versus Significance

Since the release and implementation of NOT-OD-09-025, "Enhancing Peer Review: The NIH Announces Enhanced Review Criteria for Evaluation of Research Applications Received for Potential FY 2010 Funding," there has been some confusion regarding the distinction between Significance and Overall Impact. In response, the NIH Office of Extramural Research convened a working group consisting of NIH review and program staff to develop additional guidance on this issue.

Contents

DEFINITIONS FROM NOT-OD-09-025

Significance: Does the project address an important problem or critical barrier to progress in the field? If the aims of the project are achieved, how will scientific knowledge, technical capability, and/or clinical practice be improved? How will successful completion of the aims change the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field?

Overall Impact: Reviewers will provide an overall impact score to reflect their assessment of the likelihood for the project to exert a sustained, powerful influence on the research field(s) involved, in consideration of the following five core review criteria, and additional review criteria (as applicable for the project proposed).

KEY POINTS

Overall Impact

- Overall Impact is not a sixth review criterion.
- Reviewers will write a paragraph summarizing the factors that informed their Overall Impact score.
- Overall Impact is not necessarily the arithmetic mean of the scores for the scored review criteria.
- Overall Impact takes into consideration, but is distinct from, the scored review criteria.
- Overall Impact is the synthesis/integration of the five core review criteria that are scored individual and the additional review criteria which are not scored individually.
- To evaluate, the reviewer(s) make an assessment of the *likelihood* for the project to exert a *sustained, powerful influence* on the *research field(s)* involved, in consideration of the scored review criteria, and additional review criteria (as applicable for the project proposed).
    - *Likelihood* (i.e., probability) is primarily derived from the investigator(s), approach and environment criteria.

- *Sustained powerful influence* is primarily derived from the significance and innovation criteria.
- *Research field(s)* may vary widely, so it would be helpful if reviewers identify in their reviews the research field(s) they believe will be influenced by each project.

Significance

- Significance is evaluated and scored independently of the evaluation and scoring of Investigator(s), Innovation, Approach and Environment.
- The evaluation of significance assumes that the "aims of the project are achieved" and/or will be "successfully completed."
    - Moreover, reviewers should evaluate the significance of the project within the context of a (research) field(s). For example, autism is a significant field of study but not all studies (projects) of autism are significant.
    - Research field(s) may vary widely, so it would be helpful if reviewers identify in their reviews the research field(s) within which the project addresses an important problem or critical barrier to progress.
    - The research field may be focused on a specific basic research area (enzymology) or a specific disease (*e.g*., autism), or may be more broadly defined to cut across many health issues (*e.g*., language training, psychology).

FREQUENTLY ASKED QUESTIONS

Frequently Asked Questions are available at the Enhancing Peer Review website.

CASE STUDIES

- Case studies are intended to provide further clarity on the distinction between Significance and Overall Impact.
- They are not meant to be comprehensive or to be interpreted literally.
- Rather, they are intended to provide a conceptual framework for how to think about Significance and Overall Impact.
- Case studies are available at the Enhancing Peer Review website.

GUIDE FOR ASSIGNED REVIEWERS' PRELIMINARY COMMENTS ON RESEARCH GRANT APPLICATIONS (R01)

Please use the following guidelines when preparing written comments on research grant applications assigned to you for review. The goals of NIH-supported research are to advance our understanding of biological systems, improve the control of disease, and enhance health. In your written review, you should comment on the following aspects of the application in order to judge the likelihood that the proposed research will have a substantial impact on the pursuit of these goals. **NOTE: Your written reviews should not bear personal identifiers because unaltered comments will be sent to the investigator.**

DESCRIPTION: The NIH now scans the abstract on page 2 of an application for use in the Description section of the summary statement. However, as a reviewer you must be prepared to present a summary of the goals of the application to the Study Section so that all members can follow the critiques and discussion. Thus, any description you write (in prose or in bullet form) is for your use in making this presentation.

CRITIQUE: Include as little descriptive information in this section as possible. Please address, in five individual sections, each criterion listed below. In addition: for competing continuation (renewal) applications, include an evaluation of progress over the past project period; for amended applications, address progress, changes, and responses to the critiques in the summary statement from the previous review, indicating whether the application is improved, the same as, or worse than the previous submission. Comments on progress and response to the previous review should be provided in a separate paragraph and/or under the appropriate criteria.

1. **Significance** Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge be advanced? What will be the effect of these studies on the concepts or methods that drive this field?

2. **Approach** Are the conceptual framework, design (including composition of study population), methods, and analyses adequately developed, well-integrated, and appropriate to the aims of the project? Does the applicant acknowledge potential problem areas and consider alternative tactics?

3. **Innovation** Does the project employ novel concepts, approaches or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?

4. **Investigator** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and other researchers (if any)? PLEASE DO NOT INCLUDE descriptive biographical information unless important to the evaluation of merit.

5. **Environment** Does the scientific environment in which the work will be done contribute to the probability of success? Do the proposed experiments take

advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support? PLEASE DO NOT INCLUDE description of available facilities or equipment unless important to the evaluation of merit.

OVERALL EVALUATION: In one paragraph, briefly summarize the most important points of the Critique, addressing the strengths and weaknesses of the application in terms of the five review criteria. Recommend a score reflecting the overall impact of the project on the field, weighing the review criteria, as you feel appropriate for each application. An application does not need to be strong in all categories to be judged likely to have a major scientific impact and, thus, deserve a high merit rating. For example, an investigator may propose to carry out important work that by its nature is not innovative, but is essential to move a field forward.

PROTECTION OF HUMAN SUBJECTS FROM RESEARCH RISKS: Evaluate the application with reference to the following criteria: risk to subjects, adequacy of protection against risks, potential benefit to the subjects and to others, importance of the knowledge to be gained. (If the applicant fails to address **all** of these elements, notify the SRA immediately to determine if the application should be withdrawn.) If all of the criteria are adequately addressed, and there are no concerns. Write "Acceptable Risks and/or Adequate Protections." A brief explanation is advisable. If one or more criteria are inadequately addressed, write, "Unacceptable Risks and/or Inadequate Protections" and document the actual or potential issues that create the human subjects concern. If the application indicates that the proposed human subjects research is exempt from coverage by the regulations, determine if adequate justification is provided. If the claimed exemption is not justified, indicate "Unacceptable" and explain why you reached this conclusion. Also, if a clinical trial is proposed, evaluate the Data and Safety Monitoring Plan. (If the plan is absent, notify the SRA immediately to determine if the application should withdrawn.) Indicate if the plan is "Acceptable" or "Unacceptable", and, if unacceptable, explain why it is unacceptable.

GENDER, MINORITY AND CHILDREN SUBJECTS: Public Law 103-43 requires that women and minorities must be included in all NIH-supported clinical research projects involving human subjects unless a clear and compelling rationale establishes that inclusion is inappropriate with respect to the health of the subjects or the purpose of the research. NIH requires that children (individuals under the age of 21) of all ages be involved in all human subjects research supported by the NIH unless there are scientific or ethical reasons for excluding them. Each project involving human subjects must be assigned a code using the categories "1" to "5" below. Category 5 for minority representation in the project means that only foreign subjects are in the study population (no U.S. subjects). If the study uses both then use codes 1 thru 4. Examine whether the minority and gender characteristics of the sample are scientifically acceptable, consistent with the aims of the project, and comply with NIH policy. For each category, determine if the proposed subject recruitment targets are "A" (acceptable) or "U" (unacceptable). If you rate the sample as "U", consider this feature a weakness in the research design and reflect it in the overall score. Explain the reasons for the recommended codes; this is particularly critical for any item coded "U".

Category	Gender (G)	Minority (M)	Children (C)
1	Both Genders	Minority & non-minority	Children & adults
2	Only Women	Only minority	Only children
3	Only Men	Only non-minority	No children included
4	Gender Unknown	Minority representation unknown	Representation of children unknown
5		Only Foreign Subjects	

NOTE: To the degree that acceptability or unacceptability affects the investigator's approach to the proposed research, such comments should appear under "Approach" in the five major review criteria above, and should be factored into the score as appropriate.

ANIMAL WELFARE: Express any comments or concerns about the appropriateness of the responses to the five required points, especially whether the procedures will be limited to those that are unavoidable in the conduct of scientifically sound research.

BIOHAZARDS: Note any materials or procedures that are potentially hazardous to research personnel and indicate whether the protection proposed will be adequate.

BUDGET: Evaluate the direct costs only. Do not focus on detail. Determine whether the total budget is appropriate for the project proposed. Provide a rationale for suggested modification in amount or duration of support.

OTHER CONSIDERATIONS (for Administrative Notes in the Summary Statement): These comments are useful to NIH but should not influence your overall score.

FOREIGN: If the applicant organization is foreign, comment on any special talents, resources, populations, or environmental conditions that are not readily available in the United States or that provide augmentation of existing U.S. resources. In addition, indicate whether similar research is being performed in the U.S. and whether there is a need for such additional research. These aspects do not apply to applications from U.S. organizations for projects containing a significant foreign component.

NSF Review Criteria, as described in **http://www.nsf.gov/pubs/policydocs/pappguide/nsf08_1/gpg_3.jsp#IIIA**

A. Review Criteria

The National Science Foundation strives to conduct a fair, competitive, transparent merit-review process for the selection of projects. All NSF proposals are evaluated through use of two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities. For example, proposals for large facility projects also might be subject to special review criteria outlined in the program solicitation.

The two merit review criteria are listed below. The criteria include considerations that help define them. These considerations are suggestions, and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which the reviewer is qualified to make judgments.

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?[33]

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Proposals as Arguments

Significance

Applications

Context for the research

Highlighting of novelty

Question or Problem

Orienting to the unknown
by describing the known

What needs to be done is MY PROJECT

Feasibility

Resources – Environment and Researcher

Methodology

Expected Results

Expected unexpected results, and how to resolve them

Alternative approaches – I have a PLAN!

MY PROJECT will succeed and will solve the problem

MY PROJECT = SPECIFIC AIMS

Orienting and Motivating: Structuring the introductory material

I: Naïve list of elements	II: Functions/Purposes	III: Functional Elements
Background	Consensus	Orienting information Field, significance, known
Narrowing	Disruption	Motivating Problem Question, controversy, unknown
Specific Project	Promised Resolution	Contract/Thesis The project statement Specific Aims of this proposal

Title of Proposal: Carbon isotopic measurements of dissolved inorganic carbon: A new tool to assess groundwater-river exchange in the Brazos River Basin
Focus Categories:
Keywords: groundwater, groundwater-river exchange, radiocarbon, carbon isotopic composition, dissolved inorganic carbon
Duration: March 2007 through February 2008
Federal Funds Requested: $5,000
Non-Federal Funds Pledged: $10,000
Names and contact information of participants:

Name	[redacted]	[redacted]
Classification	Graduate Student	Assistant Professor
Department	Earth Science	Earth Science
University	[redacted]	[redacted]
Phone		
[redacted]		
Address	Department of Earth Science Rice University MS 126 6100 Main St. Houston, TX 77005	Department of Earth Science Rice University MS 126 6100 Main St. Houston, TX 77005

Congressional District: 31, 17, 10, 22, 14
Statement of Critical Regional Water Problems:

Population growth and the associated increasing urban water demands are expected to create water stresses in Texas (NAS Committee, 2005). To better manage water resources, groundwater-river exchange needs examination and quantification because this process is a key component influencing water quality (NAS Committee, in press). There are many approaches to track groundwater and surface water exchange. However, different techniques apply to different spatial and temporal scales (NAS Committee, in press). Carbon isotopic techniques may be particularly valuable because they can integrate data over larger spatial and temporal scales compared to less soluble tracers like methane and radon, and salinity-sensitive tracers like radium (Gramling et al., 2003).

Nature, Scope, and Objectives of the Research:

<u>Introduction</u>

In systems where groundwater is exposed to carbonates, river water sources (groundwater and surface runoff) have significantly different DIC carbon isotopic compositions. DIC in groundwater, originating principally from soil respiration and dissolution of carbonate, has a carbon isotopic composition of $\Delta^{14}C \approx -500‰$ and $\delta^{13}C \approx -10‰$. DIC in surface runoff is primarily derived from respiration of organic matter in ecosystems and atmospheric CO_2 exchange, and thus has a carbon isotopic composition of $\Delta^{14}C \approx +60‰$ and $\delta^{13}C \approx -15‰$. $\Delta^{14}C$ can typically be measured to ±2‰ and $\delta^{13}C$ to ±0.05‰. These make it possible to use coupled analyses of DIC concentration, $\Delta^{14}C$, and $\delta^{13}C$ to quantify groundwater discharge to estuaries and the coastal ocean in the northeastern U.S. (Gramling et al., 2003). It is necessary to measure both $\Delta^{14}C$ and $\delta^{13}C$ because variation can be introduced to them due to ecosystem carbon aging (making $\Delta^{14}C$ lower) and grassland carbon input (making $\delta^{13}C$ higher). There are no conditions under which groundwater and surface runoff overlap on a $\delta^{13}C$ vs. $\Delta^{14}C$ plot in carbonate systems (Gramling et al., 2003).

The hydrologic and geologic settings of the Brazos River Basin have been described in detail

(Cronin et al., 1963; Cronin and Wilson, 1967). There are abundant major and minor aquifers in the Brazos River Basin. Limestone is found in some aquifers which outcrop in the Brazos River Basin upstream of Bryan, TX. There is no contact between carbonate-containing aquifers and the river system downstream of Bryan. Therefore, the DIC of groundwater discharged from upstream aquifers should have a strong carbonate signal ($\Delta^{14}C \approx -500‰$ and $\delta^{13}C \approx -10‰$). As for many rivers in the tropics (e.g. the Amazon) and temperate areas (e.g. the Hudson and the Columbia) (Mayorga et al., 2005; Raymond et al., 1997; Park et al., 1969), the Brazos River is expected to be supersaturated with respect to CO_2 most times of year because of the high temperature (average annual temperature 60-69°F) and moderate to high precipitation (annual mean precipitation 19-45 inches) in its basin (Brazos River Authority, 2007). Supersaturation drives evasion of CO_2 from river water to the atmosphere, preventing the dissolution of atmospheric CO_2 into the river. The rate of CO_2 evasion controls the temporal and spatial scales of the groundwater DIC isotopic signature added upstream. If the river is strongly supersaturated and groundwater CO_2 evades rapidly, the groundwater DIC isotopic signature will be localized and thus can be used to locate specific regions of groundwater discharge. If the river is weakly supersaturated and CO_2 in river water turns over slowly in comparison with the river flow rate, it is possible to use the groundwater DIC isotopic signature as a large-scale tracer of the total river groundwater fraction.

Objectives

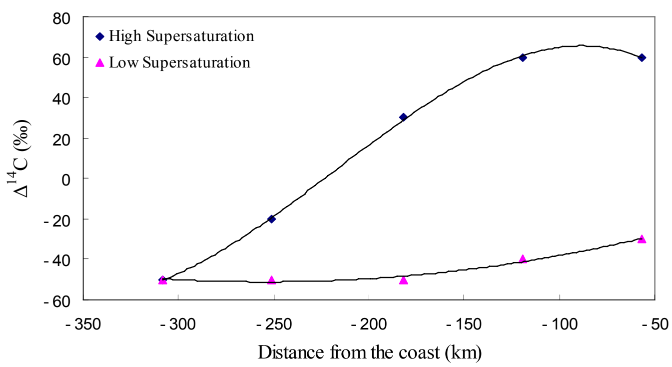

Fig. 1 Predicted downstream $\Delta^{14}C$ trend of riverine DIC in the lower Brazos. X axis is the distance between each sample site and the Gulf Coast. Negative values mean northwest of the coast. Bryan is about 224km northwest of the coast. Error on $\Delta^{14}C$ is typically ±2‰.

Figure 1 shows the predicted downstream $\Delta^{14}C$ trends of riverine DIC in the Lower Brazos for both high and low CO_2 supersaturation conditions based on the hydrologic and geologic settings of the Brazos River Basin. I will use the time and length scales of the trends to determine how DIC isotopic measurements can be used to assess groundwater discharge to the Lower Brazos River System.

Experimental design

(1) Study area and sample sites

The study area is the Lower Brazos River Basin south of Waco. I propose to sample at 7 sites. Five are in the Brazos River: 2 upstream of Bryan (where aquifer carbonates are in contact with the river), 3 downstream of Bryan (where aquifer carbonates are not in contact with the river). Two are groundwater sites (springs and deep wells).

(2) Timeline

(a) March to June of 2007: I will investigate suitable sampling sites and optimize my sampling procedure.

(b) July to October of 2007: Each site will be sampled 3 times (total 21 samples). River samples will be collected when the river is under low flow conditions to maximize the potential groundwater DIC signature.

(c) November 2007 to February 2008: All riverine DIC and groundwater DIC samples will be prepared at Rice and then sent to the NOSAMS (National Ocean Sciences Accelerator Mass Spectrometry) lab of WHOI (Woods Hole Oceanographic Institution) for $\Delta^{14}C$ and $\delta^{13}C$ measurements. I will also measure pCO_2 on all samples with the LICOR7000 at Rice University to estimate CO_2 evasion rates.

Results Expected from this Project:

This project will determine if DIC isotopic measurements in the Brazos River are a durable, large-scale signal of groundwater input which can be used to estimate the groundwater contribution to the river system, or if they are a localized signal which can be used to locate regions of groundwater discharge into the river system. The result obtained from this study can help water researchers and planners better understand groundwater discharge to subtropical rivers.

Citations

Cronin JG, Follett CR, Shafer GH, and Rettman PL. 1963. Reconnaissance investigation of the ground-water resources of the Brazos River Basin, Texas: Texas Water Commission Bulletin 6310, 152 p

Cronin, J.G. and Wilson. C.A., 1967, Ground water in the flood-plain alluvium of the Brazos River, Whitney Dam to vicinity of Richmond, Texas: Texas Water Development Board Report 41

Gramling CM, McCorkle DC, Mulligan AE, and Woods TL. 2003. A carbon isotope method to quantify groundwater discharge at the land-sea interface. Limnology Oceanography 48 (3): 957-970

Mayorga E et al. 2005. Young organic matter as a source of carbon dioxide outgassing from Amazonian rivers. Nature 436: 538-541

NAS Committee. In press. River Science at the U.S. Geological Survey. The National Academies Press.

NAS Committee. 2005. The Science of Instream Flows: A Review of the Texas Instream Flow Program. The National Academies Press.

Park PK, Gordan LI, Hager SW, and Cissell MC. 1969. Carbon dioxide partial pressure in the Columbia River. Science 166 (3907): 867-868

Raymond PA, Caraco NF, Cole JJ. 1997. Carbon dioxide concentration and atmospheric flux in the Hudson River. Esturies 20 (2): 381-390

Brazos River Authority, http://www.brazos.org/crpFacts.asp 01-04-2007

Abstract

The isotopic composition ($\Delta^{14}C$ and $\delta^{13}C$) of dissolved inorganic carbon (DIC) is a potential tool to assess groundwater discharge to rivers where groundwater is exposed to carbonates. In these systems DIC $\Delta^{14}C$ and $\delta^{13}C$ of river water sources are significantly different (groundwater: $\Delta^{14}C$≈-500‰, $\delta^{13}C$≈-10‰; surface runoff: $\Delta^{14}C$≈+60‰, $\delta^{13}C$≈-15‰), making water from carbonate reservoirs easily identified.

Limestone is common in aquifers upstream of Bryan but absent in aquifers downstream, making the Lower Brazos River Basin an ideal study area. DIC isotopes may give two different types of information on groundwater-river exchange, depending on the river's rate of CO_2 evasion. If the river is highly supersaturated with respect to CO_2 (like warm tropical rivers), the groundwater CO_2 signal will be lost rapidly, creating a tracer which can detect regions of groundwater entry. If the river is weakly supersaturated (like cooler temperate rivers), the groundwater CO_2 signal will persist longer distances, acting as a large-scale tracer of aquifer-river exchange processes.

I propose to measure the $\Delta^{14}C$ and $\delta^{13}C$ of riverine DIC and groundwater DIC to understand the systematics of the dual $\Delta^{14}C/\delta^{13}C$ isotopic groundwater tracer in the Lower Brazos River System.