# Princeton University

## Department of Geosciences
## and Geological Engineering Program

# Senior Independent Research Guide

**Departmental Representative: Prof. Gerta Keller**

**Undergraduate Work Committee:**

| Name | | e-mail Address | Phone | Office |
|---|---|---|---|---|
| Gerta Keller | Chair | gkeller@princeton.edu | 8-4117 | 308 |
| Blair Schoene | Jr/Sr Advisor | bschoene@princeton.edu | 8-5747 | 219 |
| Adam Maloof | Jr/Sr Advisor | maloof@princeton.edu | 8-2844 | 215 |
| Daniel Sigman | Frsh/Soph Advisor | sigman@princeton.edu | 8-2194 | M52 |

**Undergraduate Coordinator:** Sheryl Robas, Room 110, Guyot Hall, phone 8-6144
email: srobas@princeton.edu

Senior Mentors: see undergraduate coordinator Sheryl Robas for information

# CONTENTS

## IMPORTANT DEADLINES

### FALL SEMESTER

**Senior Independent Research Proposal Form due:** ***1st Monday of October***
(download form: https://www.princeton.edu/geosciences/undergraduate/opportunities/

**Senior Independent Research Proposal for funding due:** ***1st Monday of October***
Guidelines below: (download form:
https://www.princeton.edu/geosciences/undergraduate/opportunities/

**Senior Independent Research Progress Report due:** ***15th of December***
Guidelines below: (download form:
https://www.princeton.edu/geosciences/undergraduate/opportunities/

### SPRING SEMESTER

**1st Senior Independent Research Thesis Draft due:** ***1st Monday of April***
Follow template in ST Guide:
https://www.princeton.edu/geosciences/undergraduate/opportunities/

**2nd Senior Independent Research Thesis Draft Due:** ***3rd Monday of April***
Follow template in ST Guide:

**Final Senior Independent Research Thesis due:** ***1st Monday of May***
Follow template in ST Guide:

**Senior Independent Research Oral Presentations:** ***2st Monday of May***
Follow template in ST Guide:
https://www.princeton.edu/geosciences/undergraduate/opportunities/

**Summer Support for Senior Independent Research: Office of the Dean of the College**
Juniors wishing to apply for summer research grants to conduct research on their upcoming Senior Independent Research projects must submit proposals in spring of their Junior year. Funds up to a maximum of $5000 may be available.
Deadline for submission of proposals***:*** ***2nd Monday of March***

**Support for Senior Independent Thesis Research: Office of the Dean of the College**
Limited funds up to $5000 are available from the Office of the Dean for expenses related to senior independent research projects. Due date: ***1st Monday of October***
https://www.princeton.edu/geosciences/undergraduate/opportunities/

**Departmental Supplemental Support for Senior Independent Research:**
Seniors may apply for the Geosciences Department supplemental research grants for up to a maximum of $1000 to supplement costs of independent research.
Proposal Guidelines below. Due date: ***1st Monday of October***

# SENIOR INDEPENDENT RESEARCH THESIS

The purpose of this guide is to inform students of what is expected in independent research and writing the senior thesis. The senior thesis is a full year effort and students should budget their time accordingly. Unlike the junior independent research, the senior independent research involves much more in-depth study on a chosen topic. In addition, the department requires that students submit a thesis proposal and several interim research progress reports, including the Fall semester progress report, a rough draft of the thesis for feedback, and the final thesis (see deadlines p. 3). The goal of these interim reports is to facilitate timely advisor-student feedback, help minimize the unavoidable thesis rush at the end of the year, and to ensure that the final product of the thesis is of the highest quality.

## I. Senior Advisors

Each Geosciences senior will choose an appropriate faculty member as senior thesis advisor in consultation with the Departmental Advisor and the faculty members that share the student's research interest. The student is expected to conduct research in the advisor's laboratory and work closely with the advisor and/or graduate students. See details below.

## II. General Considerations for Conducting Senior Independent Research.

One of the most important components of a successful senior thesis is choosing an appropriate research topic/question. This means, among other things, that the topic is intellectually challenging, the student is able to perform original research, and that the topic is sufficiently well defined that the work can be accomplished on a one-year time scale.

***Choosing a Research Topic:***

The Department publishes a "*Shopping Guide*", which lists research topics that the Geosciences faculty members are currently pursuing. This *Shopping Guide* is a good starting point to identify a list of topics and Research Advisors, from which a student can select a topic and advisor for their senior independent research in consultation with the Departmental Advisor and the faculty members. If a student is interested in pursuing research on a topic that is not part of this *Shopping Guide,* he/she is encouraged to approach their Departmental Advisor to discuss the feasibility of conducting such research either under the supervision of a faculty member in the department or in another department in the University.

***Research Progress and Grading:***

Once a research topic and a committed Research Advisor are chosen, the student and advisor should meet on a regular basis (once a week) throughout the year to apprise him/her of the progress, discuss research strategies, and get feedback. The thesis will be graded by the Research Advisor, and a second reader, who will be chosen by the Undergraduate Work Committee in consultation with the student. This second reader can be considered as a second Research Advisor, and should not be overlooked as a source of helpful advice. If the primary Research Advisor is outside the department, then the second reader must be a faculty member in the department.

***Time Table for Research Progress:***

One of the most common pitfalls encountered by seniors is underestimating the time required to complete certain tasks, in particular the actual writing of the thesis. Conceptually, it may be useful to think of the thesis as consisting of three separate tasks:

- Stating a hypothesis to test
- Defining the problem and reviewing the literature
- Collecting and analyzing the data
- Writing (including data synthesis and interpretation) and making figures

If the student's research is initially well defined (usually with the help of the student's Research Advisor) the first task might be reduced considerably, but otherwise one can expect each of these tasks to comprise a significant fraction of the total effort. The three tasks will naturally overlap in time. For example, the results of initial experiments might redefine the problem somewhat and require additional literature review. Hence it is very useful to begin writing long before the research is completed and the process of writing often exposes weaknesses in reasoning and may lead to new ideas to explore further.

## III. Funding & Proposal Writing: Due date 1st Monday of October

Limited funds are provided by the Office of the Dean of the College to cover the expenses related to the acquisition of data, travel, or other special requirements of a student's thesis. An announcement, requesting proposals, is usually made at the beginning of the Fall semester and proposals are due by the *1st Monday of October*. Students should discuss their research funding needs with their Advisors. They should submit a carefully crafted research proposal that is no more than 2 pages in length, single spaced, with figures, work plan, budget and bibliography included. Download form: https://www.princeton.edu/geosciences/undergraduate/opportunities/

The proposal must include:

- Tentative title
- Statement of hypothesis
- Significance of project, summary of objectives, original contribution, expected results (150 words)
- How will hypothesis be tested (objectives, methods)
- Original contribution (original analysis of field, laboratory or previously published datasets, and/or the development of quantitative and/or analog models).
- Work Plan: set up schedule from beginning to end of project.
- Budget: Funding is merit-based. If funds are required, submit an itemized budget with reasonable expenses for fieldwork, travel and/or laboratory analyses. Funding not to exceed $1000 from the Department.
- The proposal and budget must be approved by your Research Advisor.
- Letter of support from Research Advisor

Upload the proposal to Geosciences Undergraduate website for Seniors by midnight prior to 1st Monday in Ocotober: https://www.princeton.edu/geosciences/undergraduate/opportunities/

All proposals will be evaluated and ranked by the Departmental Representative with the help of Undergraduate Work Committee. The Dean's office may choose to fund all or none of the proposals. If the Dean's office decides to fund a proposal, the amount of funding can vary. If the award is less than the student's request, supplemental funds can be requested from the Department for up to a maximum of $1000.

Research Advisors may also have funds available for ST research related to ongoing funding projects.

## IV. Senior Thesis Writing Group

The Senior Thesis Writing Group is an informal group, coordinated by one or two Geosciences graduate students to help the seniors in the preparation of the thesis. The Princeton Writing Program and the McGraw Center for Teaching and Learning help in organizing these writing groups. The group leader schedules these meetings at regular intervals beginning Late October or Early November in consultation with the seniors. By attending these workshops, students can learn skills related to planning of their independent research in a timely manner, organization and presentation of research results, synthesis of data, and to the preparation of the thesis. As part of this group, the student will also be given the opportunity to practice their presentation for their peers and the coordinator. Students are encouraged to take advantage of these Senior Thesis Writing Groups from the very beginning.

## V. Guide to Written Assignments

Written assignments include:

| | |
|---|---|
| 1. Thesis proposal. | 1st Monday of October |
| 2. Proposal for funding ST research | 1st Monday of October |
| 3. Fall semester independent Research Progress | 15th December |
| 4. 1st Thesis Draft | 1st Monday of April |
| 5. 2nd Thesis Draft | 3rd Monday of April |
| 6. Final Thesis | 1st Monday of May |

All report should follow standard scientific format (e.g. organization of the content, reference to citations, writing style of the report (e.g., font size 12, Helvetica or Times New Roman, 1 in margins), as shown in templates of Appendix VII (ii). Illustrations must be of high quality with appropriate size text for viewing, black and white or color if necessary for clarity.

Students are encouraged to benefit from the help of the Senior Thesis Writing Group (discussed above) in the preparation of reports.

***Thesis Proposal: Due date 1st Monday of October:***

A completed thesis proposal form (Appendix VII (ii)) must be submitted by midnight of the due date. Students with questions on the selection of the project and research advisor must consult their Department Advisor.

***Fall Semester Senior Independent Research Progress Report: Due date December 15:***

The goal of the Fall semester progress report is to ensure that a substantial effort is put into the thesis before Winter break, and to allow for feedback from the Research Advisor before the end of classes. The Progress Report must include:

- Concise Title
- State hypothesis, summary of work to date (150 words)
- Introduction to problem and its importance
- A clear statement of the objectives
- Approach used and methods employed to solve the problem
- Background: Review of published literature on the problem with references
- Datasets to be used from published literature if any
- Investigations carried out to date
- Results of data generated so far in laboratory
- Preliminary interpretation of research results
- Further work to be carried out in the spring semester with time table
- Estimated schedule for completion of research in spring
- Preliminary Conclusions
- References

The report should be written in clear English with references and be no more than 10 pages of text double-spaced, not including references, figures, tables and captions. A successful Fall Semester progress report serves as an early rough draft of the final thesis, especially the Introduction, Background and Methods sections should be as complete as possible. A pdf file must be uploaded on the designated Department webspace dropbox by the due data.

***1st Rough Draft of Thesis: Due date 1st Monday of April:***

Students must write a rough draft of their thesis research following the same outline as given for the Progress Report. In this draft, the Results, Interpretation and Conclusion sections should be significantly expanded with the new data generated in the lab. This rough thesis draft serves several purposes: 1) organizes thoughts on research results and interpretations, 2) reveals shortcomings still to be addressed, 3) gives the Research Advisor(s) a chance to comment with enough time remaining for the students to address any significant issues or concerns that may arise. 4) Ensures that in a mad scramble to finish research, students will not leave the writing for the last week before the thesis is due. As the name implies, the rough draft need not be a polished document, but the more complete it is the more useful the student may find their advisor's comments. Students must upload a pdf file on the designated Department webspace dropbox by the due date.

***2nd and Final Draft of Thesis: Due date 3rd Monday of April:***

Students must submit a second, complete and polished draft of the Thesis that includes all revisions and rewriting that was deemed necessary in the first rough draft. A cover letter must describe the revisions made, and those not made and why they were not made.

The length of the Thesis depends on the research results and the scope of the thesis project. There is no set rule as to the number of pages, or figures, or tables. However, the Thesis must include all data tables, clear figures illustrating the data and any supporting material for the conclusions reached. The final draft of the thesis should have a table of contents, abstract, section headings, acknowledgements, references, page numbers, and the honor code with the student's signature.

This 2nd final draft should be the final version for one more review by the Research Advisor and 2nd Reader to point out shortcomings and suggest modifications. The student has one week to incorporate the revisions and produce the final Thesis. A cover letter must describe the revisions made, and those not made and why they were not made. As with the previous draft, a pdf file must be uploaded on the designated Department webspace dropbox by the due date.
https://www.princeton.edu/geosciences/undergraduate/opportunities/

***Final Thesis: Due date 1st Monday of May:***

Students must submit their final Thesis by the due date. The final version must incorporate all suggested revisions. The Thesis format for the Senior Thesis must follow the template of Appendix VIII in this document .

Students must submit four copies of their final Thesis Report: two originals for the library archive, and one copy for each advisor. The student's Research Advisor should receive a bound copy. One "original" should be bound in leather, and this copy will be archived in the Lewis Library. The second "original" should be unbound, and this copy will go to Mudd Library for black and white microfilming. For these two reports, the photos and drawings must be of very high quality (500 dpi).

All the reports must be submitted to the undergraduate coordinator by 5:00 PM of due date.

## VI. Guide to Oral Presentations

Students give a public oral presentation of their senior independent research one week after thesis submission. The format is 15 minutes for presentation and 5 minutes for questions. The presentation must include:

- Clear introduction (for non-specialists) explaining why the work is important
- State Hypothesis, Objectives
- Methods used
- Key results

- For the benefit of the audience not directly involved in the student's research, a clear distinction should be made between the background material and the work the student has conducted.
- Clear Graphics that succinctly convey the major points of the thesis.
- Interpretations and Conclusions

The oral grade will be based on the quality of the presentation, the quality of the thesis work, and the student's mastery of the basics of the topic as evidenced during the question-and-answer period. At the end of this document is a guide faculty uses to grade students oral performance and mastery of the research topic.

Students must upload the presentations as a pdf file to the designated Department website dropbox by midnight before the due date. The undergraduate coordinator will download the presentations onto a Department computer for the presentations on the following day.
https://www.princeton.edu/geosciences/undergraduate/opportunities/

***Tips for successful Oral Presentation*:**

- Avoid the temptation to include too much material. Concentrate on getting your 2 to 3 main points across (this is all your audience will remember after they listen to a half-day of presentations). A good rule of thumb is 10-12 slides for a 15-minute talk, but this will vary depending on the amount of data crammed into a slide. It is best not to cram slides with too much data; just concentrate on the important point you want to get across in each slide.

- Think about what you would like to say as you prepare your figures, and use your figures as a guide to help you through your talk. This will minimize the amount of rote memorization or "note cards" required. Don't say a lot that is not directly related to the figure on the screen; if it's not illustrated, it's probably not that important. If you can't show all you consider important on one slide, add another figure-slide.

- Make text legible from the back of the room! This includes axis labels! For an overhead transparency, this probably means at least a 14-point font. But check this out with the projector in room 155 and adjust your text size accordingly.

- Avoid an abundance of "text-only" slides. These put the audience in the position of having to decide whether to read them or to listen to you read them. If you have a few such slides, it is a good idea to state the points that appear on the screen in a different way.

- Present your advisor with an anticipated outline for your presentation. He/she has many years of experience in giving short talks, and has a good view of the "big picture" surrounding your work (hopefully by this point you do as well).

- Practice your talk beforehand. In a 15-minute talk there is little margin for "hemming" and "hawing". Attend the practice presentation session scheduled by the Senior Thesis Writing Group coordinator. This is a chance to get individualized feedback from both the coordinator and your peers.

- For students who have carried out original research, a clear distinction should be made between the background material and the work the student has conducted (for the benefit of those not directly involved in advising).

## VI. Grading Policies

The student's thesis is graded based on the quality of the written report and the oral presentation. The grading for senior thesis is as follows:

| | |
|---|---|
| Thesis Proposal Form: | 5% |
| Fall Term Progress Report: | 10% |
| Thesis: | 55% (graded by primary Research Advisor and second reader) |
| Oral Presentation: | 30% (graded by the entire faculty in Geosciences attending the students' presentations) |

These percentages quoted above are to be interpreted as general guidelines. The final grade is assigned at a meeting of the full faculty in May. At this time some renormalization is done to ensure uniform and equitable grading.

Occasionally it may be necessary for a student to change a thesis topic or even the Research Advisor after the proposal form is submitted (for example, as a result of an expected dataset not materializing, etc.). Under such circumstances, and with the agreement of all concerned, it is possible to change the research topic without penalty; grades for work already submitted will be simply carried over.

Thesis extensions are given only by the Departmental Undergraduate Representative under exceptional circumstances (typically serious illness or family emergencies). Lost computer files, printer problems, experiments not going exactly according to plan, etc. do not qualify; such pitfalls come with the territory and the students must budget their time accordingly. Late Theses will be penalized at the rate of 1/5 of a letter grade (2%) per day or one letter grade per week; and all interim assignments at the rate of one letter grade (10%) per weekday. For any submission beyond the date set by the Dean of the College for submission of senior theses, the student will receive an *Incomplete* if the student has permission from the Dean of the College. Otherwise the student will receive an *F*.

## SENIOR THESIS RESEARCH PROPOSAL FORM

***Must be filled out electronically (2 pages) and signed by your advisor; E-mail form to the undergraduate Coordinator, Room 110, Guyot Hall, Sheryl Robas:*** *srobas@princeton.edu*

Name _____

1. Tentative Title:

2. State your hypothesis:

3. Significance of project (150 words; summary of objectives, original contribution, expected results)

4. Objectives and Methods; how will you test your hypothesis?

5. Original contribution: (original analysis of field, laboratory or previously published data sets, and/or the development of quantitative and/or analog models).

6. Work Plan: Propose schedule for the full duration of the project, including expected completion dates for data collection, analysis, writing etc.

7) Budget: Funding is based on merit. If funds are required (e.g., fieldwork, lab analysis, travel) submit an itemized budget with reasonable expenses. Funding from the Geosciences Department may not exceed $1000. Students are encouraged to apply for outside funds (see undergraduate website on funding sources, applications and deadlines).

Signature of Advisor: _____ Date _____

Suggested second advisor/reader (signature not required):

_____

## SAMPLE OUTLINE OF WRITTEN SENIOR THESIS

**A. Title Page:**

# Early Proterozoic Climate

by

Earl A. Quincy '11

Senior Thesis Work
Advisor: John P. Stevens

Department of Geosciences
Princeton University, Princeton, NJ 08544
DUE DATE

**B: Table of Contents:** numbered sections and page numbers (see p. 2 of this document.

**Thesis text should follow outline below:**

**C.** **Abstract** (250 words max, no references; must summarize objectives, methods, results and conclusions)

**D.** **Introduction** (purpose and scope of study, background information, etc.; illustration with caption of study area, geographic map with location; reference any statements of fact, claims, information obtained etc., style of in-text references: (Fisher, 1998; Murray et al., 2010).

**E.** **Methods:** (fieldwork, material (type of samples) and analytical methods used)

**F.** **Description of Results: (**subtitled as necessary, illustrations of data and captions, data tables may be placed in appendix), give references wherever you take information or data from other studies.

**G.** **Interpretation of Results:** subtitled as necessary, (how do you interpret your data, how does it relate to published data of similar type, you may illustrate your interpretation), give references wherever you take information, interpretations or data from other studies.

**H.** **Conclusions:** (what is your overall conclusion of the project's outcome? You may write this as a short summary or as a number of bullet points specifying a series of specific conclusions.)

**I.** **Acknowledgments:** Funding sources, people who helped you with the study, read and corrected your drafts etc.

**J.** **References cited** using citation style of the GSA Bulletin.
***Do Not Use Footnotes!!***

**K.** **Acknowledgments:** Funding sources, people who helped you with the study, read and corrected your drafts etc.

**L.** **References cited:** use citation style as follows:

Dessert, C., Dupre, B., Gaillardet, J., Francois, L.M., and Allegre, C.J., 2003. Basalt weathering laws and the impact of basalt weathering on the global carbon cycle. Chemical Geology, 202, 257-273.

Wedepohl, K.H., 1971. Environmental influences on the chemical composition of shales and clays. In: Ahrens, L.H., Press, F., Runcorn, S.K., Urey, H.C. (Eds.), Physics and Chemistry of the Earth. Pergamon, Oxford, pp. 305–333.

***Do Not Use Footnotes!***

**M.** **Student Acknowledgment of Original Work** sentence:
*This paper represents my own work in accordance with University regulations," plus* **your signature.**

**SAMPLE**

**EVALUATION FORM FOR WRITTEN REPORT**

**Department of Geosciences**
and **Geological Engineering Program**

**Undergraduate Independent Work Evaluation Form - Written**

**Senior Thesis**

**Student Name:** **Faculty Advisor:**
**Paper Title:**

---

I. Performance in Areas (5=outstanding, 1=unacceptable, na=not applicable)
(Grade is not an equal-weight average of these marks)

| | | | | | | |
|---|---|---|---|---|---|---|
| A. **Intellectual Content** | | | | | | |
| Literature survey and summary | 5 | 4 | 3 | 2 | 1 | na |
| Critical evaluation and a synthesis | 5 | 4 | 3 | 2 | 1 | na |
| Original contribution, where appropriate | 5 | 4 | 3 | 2 | 1 | na |
| B. **Writing and Presentation** | | | | | | |
| Abstract | 5 | 4 | 3 | 2 | 1 | na |
| Proper headings | 5 | 4 | 3 | 2 | 1 | na |
| Style | 5 | 4 | 3 | 2 | 1 | na |
| Organization as scientific paper | 5 | 4 | 3 | 2 | 1 | na |
| References properly handled | 5 | 4 | 3 | 2 | 1 | na |
| Figures, clear, properly called in text, sources cited | 5 | 4 | 3 | 2 | 1 | na |

II. Faculty Comments: (to be added to those made directly in the text)

Faculty Signature _____

---

(Do not write comments for students below this line)

Overall Grade (not given to student)_____

**SAMPLE**

**EVALUATION FORM FOR ORAL PRESENTATION**

**Department of Geosciences**
And **Geological Engineering Program**

**Date:** **Senior Theses**

**Junior Paper**

**Oral Presentation**

**Comment and Grade Sheet**

**Student Name:** _____ **Topic:** _____

**Oral Grade:** _____

Circle following (5 = most favorable; 1 = unfavorable)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| delivery tone | 5 | 4 | 3 | 2 | 1 | organization of material | 5 | 4 | 3 | 2 | 1 |
| mannerisms | 5 | 4 | 3 | 2 | 1 | illustrations | 5 | 4 | 3 | 2 | 1 |
| "ums" and "ahs" | 5 | 4 | 3 | 2 | 1 | ability to evaluate data | 5 | 4 | 3 | 2 | 1 |
| reliance on notes | 5 | 4 | 3 | 2 | 1 | handling of questions | 5 | 4 | 3 | 2 | 1 |

**Comments:**