Appendix 1 EarthScope AGeS Program
Interim Evaluation Report
June 2, 2016

Executive Summary

Major impacts of the AGeS program include success in promoting student scientists and their home advisor to collaborate with geochronologists in interdisciplinary geoscience projects addressing the evolution of the North American continent, the major goal of the EarthScope project. The funds completely funded some projects or parts of larger projects and also have initiated projects, relationships, and collaborations that have a life span beyond the grant's funding period.

New scientific and personal relationships have been formed among scientists and laboratories that will potentially lead to a more detailed understanding of processes addressing the EarthScope goal. A new group of scientists are more aware of the EarthScope goals, and perhaps more importantly, will continue interdisciplinary work involving geochronologists and new users of this type of data. There is widespread support among these participants of continuing this program for initiating these relationships and for the cost-effective use of NSF funds.

The external evaluation of the EarthScope AGeS program documents:
1. The program fills a need in the geoscience community as indicated by participation as well as comments from participant scientists,
2. The program was managed to maximize broad participation, to use funds efficiently and effectively, and to provide a fair and transparent process.
3. The AGeS should continue to refine the advertising, review and implementation processes a) to maximize the colleges and universities involved, b) to clarify for participants the expectations of scientific scope, budgets, and timing.
4. The program should seek funding for continuation.

Program Description

The EarthScope AGeS program is a multi-year educational initiative aimed at enhancing interdisciplinary, innovative, and high-impact science by promoting training and new interactions between students, scientists, and geochronology labs at different institutions. The program has two major components, a 2014 EarthScope Institute on Geochronology and the Earth Sciences and a program in 2015 and 2016 to support graduate students to collect and interpret geochronology data that contribute to EarthScope science.

The goals of the project are:
- Fostering of new relationships and interdisciplinary, innovative science between researchers and labs at different institutions.
- Generation of new opportunities for students to learn fundamental aspects of the techniques, theory, and interpretational methods associated with data acquisition in modern analytical facilities.
- Implementation of a low-cost mechanism for students to generate key, high-quality datasets for projects and publications of mutual benefit to students, advisors, and labs, while laying the foundation for future collaborative proposals.

- Promotion of science that provides an important contribution to EarthScope's core science goal to investigate the geologic history of the North American continent

Methodology

Purpose of the report

This report from an external evaluator provides evaluation to the project management regarding the program's value.

- Are the program activities designed and implemented to achieve the program's goals?
- Were program activities implemented effectively regarding procedures, timelines, communication, etc.?
- Were the expected outcomes achieved? Were there unexpected outcomes?
- Is this program of value?

The external evaluator worked closely with Principle Investigator Rebecca Flowers and Co-PI Ramon Arrowsmith to establish the evaluation plan and collect appropriate metrics associated with activities throughout the project. This report covers activities through May, 2016. This report will be updated to include evaluation data from the 2016 projects and further progress of the 2015 projects. IRB approval for exempted status was obtained by through Arizona State University.

Evaluation activities are both formative and summative. Project PI, Co-PIs, and the external evaluator agreed on the metrics, data, and responsibilities for the project evaluation, listed in their entirety in Appendix 2. The data collected by the Project Personnel is reported in their project progress report, but we have worked together to present an overall evaluative summary of the project.

Prior to the evaluator's involvement in the project, the Geochronology Workshop was held in the fall of 2014. A pre-institute and post-institute survey was administered by the project investigators. The results are presented in Appendix 3. 'Universal themes' that emerged from this survey, listed in the results section of this evaluation report and identified from the institute, were later incorporated into the interviews of students, lab mentors, and students' academic advisors to measure implementation and impact of the geochronology laboratory projects. These results are incorporated into the evaluation analysis.

Data Collection and Analysis

Data for the Geochronology Institute were obtained from surveys at the end of the workshop. These are listed in Appendix 3.

For the proposal and review process, the external evaluator sat in on the review panel's discussion and had access to all email communication during the 2015 process. Other qualitative data were obtained through on-line surveys as well as communication via email among the external evaluator and principal and co-principal investigators. The surveys were initially designed and intended for implementation in the fall of 2015; however, we sensed that little progress had been made in the 2015 projects by that date. Ramon Arrowsmith queried the students via email at this time, confirming this perception, and the surveys were revised and administered in May, 2016.

Surveys were designed to capture information regarding the EarthScope goals. The survey

design benefited from extensive input from all principal investigators. Some emphasis changed from the fall of 2015 to the spring, which the evaluator attributes to their watching the project unfold.

Similar surveys were tailored for the students, their home advisors, and the geochronology labs. All data with both questions and individual responses are listed in Appendices 3. Names of individuals and institutions have been removed.

Of 10 Students, 9 replied to the survey; one additional student was in the field overseas and will provide this data upon her return. Of 9 home institutions, 8 replied. Of 6 laboratories, 3 replied. A few people indicated they will provide this information in the coming weeks. The high return rate is aligned with the program size and the importance of this program to their academic success, as documented in the survey results.

Analysis

The surveys results are all in text form. The evaluation has used a standard text analysis to go through the survey results, noting recurring themes and individual responses that will inform the PIs for future changes in the program. These were reviewed in the context of the student, home advisor, and visiting laboratory to determine if all participants had a similar perception of the project's implementation and impact.

The survey returned extensive and thoughtful comments. People actually did elaborate in most cases. Responses from Home Advisors were more extensive than those from the analytical labs, perhaps as a result of the close relationship and long term investment between a student and his/her graduate research advisor.

Results

Results from EarthScope Geochronology Institute, 2014

From the presentation of project personnel at the 2015 Geological Association of America Meeting: "Some universal themes that emerged included the importance of:
1) close interaction between geochronologists and collaborating students at all stages of the process, even from the outset of study design so that optimal samples are targeted and collected properly,
2) using appropriate mineral separation and sample preparation procedures prior to arriving at the lab,
3) reporting the uncertainties associated with geochronology dates, and
4) developing skills to rigorously evaluate, present, and interpret geochronology data.
This hands-on training at the graduate level provides the foundation for students to become an expert user of these facilities throughout their careers."

Implementation of Project Selection

From observations by the external evaluator during the 2015 solicitation, she noted

- the advertisement was widely distributed;
- there was a significant number of applicants;
- individuals on the review panel were carefully selected to reflect a breadth of expertise and

lack of a conflict of interest;

- the goals of the project and review criteria were given to the reviewers and taken into consideration during selection of awarded projects;
- the panel worked assiduously and thoughtfully, with PI Flowers and Co-PI Arrowsmith who managed this process, for a fair distribution to student projects. This was not always easy as there were many high quality proposals, some from the same institutions and with varying alignment with EarthScope goals, and other considerations;
- there was concern among the panel that awards were made to support PIs' labs. This was only realized after the fact. We made all of the decisions and the awards and then realized that the PI labs had preferentially prevailed. Therefore, the PIs instituted limits on lab awards for the 2016 awards (only one in a year if there were one the prior year awarded, and only two at most in a year can go to a single lab);
- collectively the review panel, PIs, and external evaluator noted that the process was transparent and that no conflict was present. There is a limited number of labs performing specific types of geochronologic analyses;
- the entire group of PI and Co-Pis were actively engaged in monitoring the process and suggesting improvements, especially in making positive changes for the 2016 program.

Recommendations from the external evaluator to provide a more detailed Request for Proposals (RFP) in the second round to a) make the connection with EarthSope more explicit and b) provide more detailed guidance in writing the proposals. The PI's also made more explicit rules in the 2016 RFP about how many awards could be made to one institution: "2.2. Limits on proposals and awards per lab--If desired, labs can support up to 4 proposals in a given application cycle. However, participating labs will receive no more than 2 awards in a given year. If the lab is already supporting a project that received an EarthScope AGeS award the previous year, then the lab will be limited to 1 award in the current proposal cycle." http://www.earthscope.org/science/geochronology.

Impact of Geochronology Projects

Results of the surveys are summarized here in the context of each goal.
Goal 1. Fostering of new relationships and interdisciplinary, innovative science between researchers and labs at different institutions.

Unanimously, Students, Home Advisors (HA), and Laboratory representatives (LR) said that the collaborations are new. The student's noted research collaborations between themselves and their home advisory with the analytical laboratory. HA noted that although some of them had known people in the labs or had planned to work together sometime in the future, the AGeS program was a precipitating factor in providing new scientific collaborations. Interestingly, both students and LR appreciate personal as well as scientific relationships that extended their scientific network that included students, post-docs, and other scientists in the lab's institution. All respondent types repeatedly noted that collaborations would continue in the future with other students and with other scientific projects.

Some quotes supporting this result:
"Regarding both interdisciplinary and innovative science, through responses to several different questions, the scientists in the home institutions gave specific examples of how

AGeS has provided opportunity for geoscience subdisciplines to work together in new ways and naming future projects which might be carried out with these new working partnerships. The interdisciplinary and innovative nature of the projects incentivized by these funds was mentioned extensively through the implementation and their description of the program's success."

Some quotes about innovation include:
"…*pairing the ages with field relationships and modelled compositions as adding to a growing method of forward modelling of partial melts with the aid of geochronology."*

"…combining thermochronology and isotopic composition of accessory mineral as a provenance tool in Modern environments."

"…the longest, direct quantitative paleoseismic record that has ever been documented. By using syntectonic calcite veins to collect this record, we have also conducted a paleoseismic record which is sensitive to the role of fluids in the seismic cycle."

"…integrates thermochronometry with geodynamics and continental rheology."

"…trying to compare the intermediate geomorphic record to the short-term interseismic deformation record."

"…to link monazite and zircon growth to petrologic processes."

HA's speak to the innovative nature of their student's research:

"…The new collaboration has yielded dramatically high temporal resolution than previous techniques have permitted, and is likely to allow us to pinpoint timing of metamorphism with sub million year accuracy."

"…Not really innovative, but we do hope to address a long-standing question that lots of researchers have dabbled in…"

"…the combination of the technique (TIMS-TEA)plus the geologic setting in which it is being used is fairly innovative."

"…To my knowledge no one has ever attempted to determine a U-Th/(He) cooling age AND determine the 87Sr/86Sr ratio of the same apatite grain."

HA's speak to the interdisciplinary nature of the research:
"…merging high-temperature geochemistry, geochronology with structural geology and tectonics"

"… a geodesist/modeler (…at … College), a tectonic geomorphologist (home institution), and a geochronologist (… at …), and of course, a … MS student."

"…at the nexus between earthquake geology, geochemistry (particularly focused on diagenetic processes), and geochronology. it has changed the way my student and I think about these integrated systems."

Goal 2. Generation of new opportunities for students to learn fundamental aspects of the techniques, theory, and interpretational methods associated with data acquisition in modern analytical facilities.

The achievement of this goal can be described as the preponderance of responses were good to excellent, noting the communication (via email, phone, and Skype) and help in the student's preparing samples prior to visiting the lab. One student even did a 'previsit' prior to the actual work. Home Advisors described the labs as helpful, responsive, and timely in preparing for the analytical work.

When asked about what the student learned, students mentioned learning:

- How the technique and/or system works
- Collection and interpretation of data
- Sample preparation and chemistry
- Data reduction (fewer students mentioned this)
- Uncertainties (depending on progress in the project)
- Statistical considerations
- Working in a clean lab

Goal 3. Implementation of a low-cost mechanism for students to generate key, high-quality datasets for projects and publications of mutual benefit to students, advisors, and labs, while laying the foundation for future collaborative proposals.

As mentioned above, both students and Home Advisors routinely commented that they appreciate the opportunity to work with geochronological data and the scientists that use this data.

Student responses varied regarding their learning as the projects are in various stages of completion. They fall into three categories:

- those that are complete and the student is writing up the discussion for a thesis or paper (two students)
- two students are in sample collection phase (have done some preliminary analyses)
- 5 students are from 30% to 80% completed, and
- one not started due to having done field work and collecting samples during the past year.

There is also a variation in what the students actually did. Most students collected and prepared their own samples, did the analyses, and discussed results with the lab personnel as well as their own advisor. Others did not do the analyses but did the sample preparation and data reduction but did not participate in the analysis itself. One or two suggest that the lab did the analyses and provided final dates to the student. We will survey students and labs before the end of the project to further investigate this.

Both students and Home Advisors described the success of this program as contributing to 1) science/data, 2) research connections and collaborations, and 3) students' learning hands-on methodology.

All of the students expressed gratitude to the AGeS program as essential to the success of their research. Most projects said these funds covered costs or that any unanticipated costs were either minimal or easy to cover from other sources. Several of the students leveraged this grant to obtain funds from other sources including their own university and organizations such as the Geological Society of America.

A few responses in surveys, from both the user and lab sides, mentioned that the 'EarthScope pricing' was unclear, or that estimates for cost per sample and number of samples did not work out. Conversations between the labs and the PIs indicated that this program forced them to get organized and figure out the pricing.

Goal 4. Promotion of science that provides an important contribution to EarthScope's core science goal to investigate the geologic history of the North American continent

The responses to survey questions about innovation, interdisciplinary research, and success of the AGeS program all point to established and student scientists engaged in projects which address the goals of the EarthScope Program. Student projects are in varying stages of maturity so the final scientific impact of the AGeS project won't be known for months to years, even decades. Already project results are being disseminated, and a list of 2015 abstracts is presented below. All respondents discuss work in progress and their commitment to relating their results to the EarthScope program and to acknowledging the role EarthScope played in supporting this work.

Perhaps as important are the new collaborations between the producer and user of geochronological data. This extends the impact of EarthScope beyond the more dominant geophysical projects and also supports future interdisciplinary work in the future. On the decadal scale, these nascent scientists speak of expanding their scientific and personal networks. This is key to a rich future career in scientific research.

From a Home Advisor:
"The program is a terrific opportunity for students and I strongly encourage NSF continuing this. The benefit/cost ratio is extremely high, especially compared to other NSF programs (I have been on a number of panels). My main suggestion would be that the program should give the students more than 15 months or so to complete the project. The way it is framed, as a "new initiative", by the time the student receives these funds they will need more than that time to collect samples, process them, go to the lab to analyze them, and then ideally return to the lab to do a second round of analyses."

Both the evaluator and the PIs have captured the publications to May, 2016. The AGeS students' names are highlighted in bold type.

Bonich, M.B., **Samson, S.B**., Flowers, R.M., Metcalf, J.R., and Fedo, C.M., 2015, Isotopic-thermochronologic characterization of apatite as a new proxy for provenance analysis: National GSA meeting, Baltimore, MD, November 2015.

Delano, J., **C.B. Amos**, J. Loveless, and T. Rittenour (2015) Fluvial record of active deformation along the Canyon River fault in the Wynoochee River valley, WA, *Eos Trans. AGU,* Fall Meet. Suppl., Abstract T33C-2944.

Kinney, S.T., **Olsen, P.E.,** Schoene, B., Vantongeren, J., Setera, J., Hemming, S.R., 2015, Re-evaluating the White Moubtain Magma Series through high-preceision zircon U-Pb geochronology and trace element geochelistry: A preliminary report.Geological Society of America, Abstracts with Programs, v 47(7),

https://gsa.confex.com/gsa/2015AM/webprogram/Paper270062.html.

Kinney, S.T., **Olsen, P.E.,** Rasbury, T., Kent, D.V., Jaret, S., and Anders, M.H., 2015, New zircon U/PB age constraints for the Agamenticus complex of southeastern Maine. Geological Society of America Abstracts with Programs. v. 47, no. 3, Paper 54-10.

Williams, R. T., **Goodwin, L. B**., Mozely, P. S., and Sharp, W.D., 2015, Diagenetic controls on fault-zone architecture and permeability structure in normal faults: Temporal constraints on the distribution, recurrence, and duration of fault-zone fluid migration, Geological Society of America Abstracts with Programs, v. 47, p. 445.

Williams, R. T., **Goodwin, L. B**., Mozely, P. S., and Sharp, W.D., 2015, U-series dating of syntectonic calcite veins constrains the time scales of the elements of the seismic cycle in an intraplate normal fault, American Geophysical Union Annual Fall Meeting (San Francisco, CA).

In addition, 2 students are planning to submit 5 abstracts in 2016 and 3 students mentioned a publication in preparation.

Summary and Recommendations

Major impacts of the AGeS program include success in promoting student scientists and their home advisor to collaborate with geochronologists in interdisciplinary geoscience projects addressing the evolution of the North American continent, the major goal of the EarthScope project. The funds completely funded some projects or parts of larger projects and also have initiated projects which have a life span beyond the grant's funding period.

New scientific and personal relationships have been formed among scientists and laboratories that will potentially lead to a more detailed understanding of processes addressing the EarthScope goal. A new group of scientists are more aware of the EarthScope goals, and perhaps more importantly, will continue interdisciplinary work involving geochronologists and new users of this type of data. There is widespread support among these participants of continuing this program for its initiating these relationships and for the cost-effective use of NSF funds.

The external evaluation of the EarthScope AGeS program documents:

1. The program fills a need in the geoscience community as indicated by participation as well as comments from participant scientists,
2. The program was managed to maximize broad participation, to use funds efficiently and effectively, and to provide a fair and transparent process.
3. The AGeS should continue to refine the advertising, review and implementation processes a) to maximize the colleges and universities involved, b) to clarify for participants the expectations of scientific scope, budgets, and timing (Should students be at a point in their research to do analyses in a timely way, especially since these are funds with an expiration date?).
4. The program should seek funding for continuation.

Appendix 2 Goals and Metrics

Goal 1: Fostering of new relationships and interdisciplinary, innovative science between researchers and labs at different institutions.

Metrics for Goal 1

1. Compare past published works of laboratory and institution of student researcher. How many new institutional relationships? How many new faculty relationships? For example, is student's advisor previously in a research relationship with the lab in which she/he is proposing research (such as PhD student, Post Doctoral Fellow, past appointment, previous grants and publications)? (Eriksson and PROJECT PIS)
2. What is the innovative, interdisciplinary nature of proposals? What do the reviews say about the nature of innovation and of interdisciplinary research? (Eriksson documents reviewers' comments.)
3. Did review process take these goals into account when selecting projects?

- Observation by external examiner (Eriksson)
- Did rubric for selection account for this goal? (Eriksson)
- Final results of selection process (Eriksson and Arrowsmith)

Goal 2: Generation of new opportunities for students to learn fundamental aspects of the techniques, theory, and interpretational methods associated with data acquisition in modern analytical facilities.

Metrics for Goal 2:

1. Documentation of EarthScope Geochronology Institute (documented already in pre- and post-text and in Institute Agenda)

a. How many faculty presenting
b. Topics
c. Number and demographics of students attending
d. How do we measure whether they learned from Institute? Self perception from Institute survey.

2. Did proposals illustrate understanding of techniques, theory, and interpretational methods proposed?(Eriksson)
3. In interviews, can students explain the techniques, theory and methods of their proposals. (Eriksson)
4. In interviews, can supervising lab person assess the student's understanding – make a simple rubric. (Eriksson)

Goal 3: Implementation of a low-cost mechanism for students to generate key, high-quality datasets for projects and publications of mutual benefit to students, advisors, and labs, while laying the foundation for future collaborative proposals.

Metrics for Goal 3:

1. What was cost of each project? (PROJECT PIS)
2. Did project result in high-quality data? (Eriksson from interviews of lab mentor)
3. Document abstracts, theses, publications (during project and who to document 2-3 years

after conclusion of project). (PROJECT PIS)
4. Surveys of students, advisors and labs regarding short term benefits (Eriksson)
5. Survey of students, advisors, and labs regarding evidence of and intent for future collaborations. (Eriksson)

Goal 4: Promotion of science that provides an important contribution to EarthScope's core science goal to investigate the geologic history of the North American continent.

Metrics for Goal 4:
1. Do selected projects provide an important contribution – evidence from review process? (Eriksson analyses reviewers comments.)
2. Are projects presented in EarthScope annual meeting and/or EarthScope related sessions at professional meetings? (PROJECT PIS)
3. Do papers acknowledge EarthScope and this funding in their abstracts, posters, and publications? (PROJECT PIS)

Geological Society of America 2014 Geochronology institute survey results

http://www.earthscope.org/events/earthscope-institute-geochronology-and-the-earth-scienc

EarthScope Institute Summary: Geochronology and the Earth Sciences

Organizers: Rebecca Flowers (CU), Ramon Arrowsmith (ASU) Jim Metcalf (CU), Blair Schoene (Princeton), Tammy Rittenour (USU)

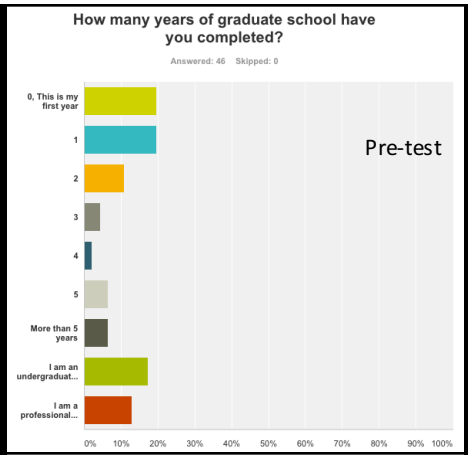
The EarthScope Institute on Geochronology and the Earth Sciences brought together 43 participants and 16 geochronology experts in Vancouver, British Columbia on October 17-18, 2014, immediately before the 2014 Geological Society of America National Meeting. The audience consisted of graduate students and faculty who are interested in using geochronology in their research, but have little actual experience with the methods.

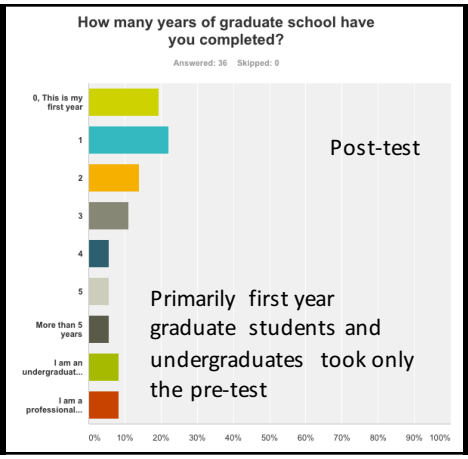
This course had two primary functions. First, it introduced the participants to the basic theory of well-established geochronology methods, highlighted examples of how geochronology datasets can be used to answer significant Earth science questions, and emphasized practical considerations and tactical strategies for designing projects that include geochronology. The methods covered ranged from U-Pb and 40Ar/39Ar to luminescence and 14C dating. The speakers included a mix of longstanding leaders in their fields and early to mid career scientists. In addition, the course introduced the new EarthScope Geochronology Graduate Student Research and Training program, a multi- year project that will offer support of up to $10,000 to graduate students to collect and interpret geochronology data with relevance to EarthScope science targets through visits and hands-on data acquisition in participating geochronology labs (see more information at http://www.earthscope.org/science/geochronology/). The program aims to promote interdisciplinary and innovative science by fostering new relationships between PhD students, scientists, and geochronology labs at different institutions. The awards will be made via a competitive

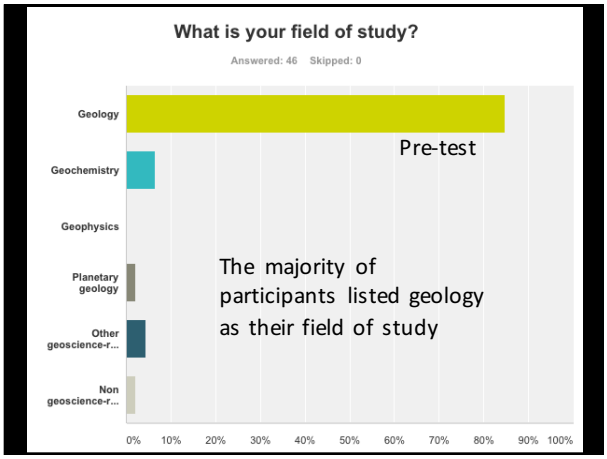
Survey statistics

- Pre Survey n = 46
- Post Survey n = 36

Demographics

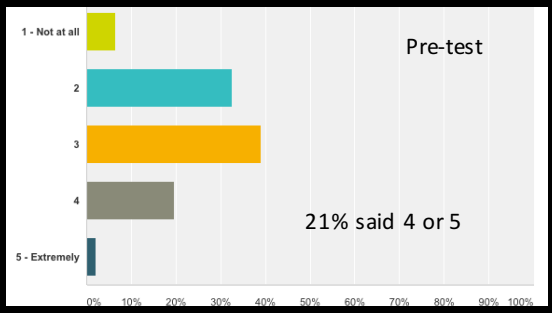






Concept questions

To what extent do you consider yourself knowledgeable in geochronology concepts?



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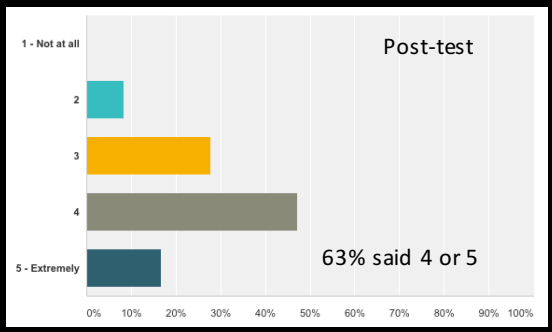
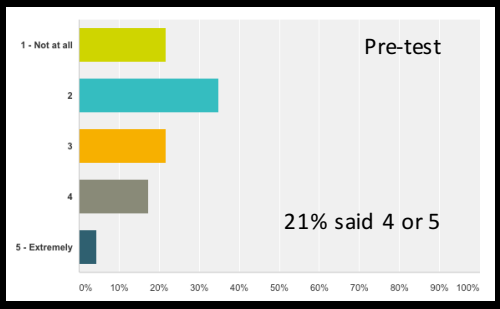


To what extent do you consider yourself knowledgeable in geochronology methods (i.e., sample preparationm lab techniques)?



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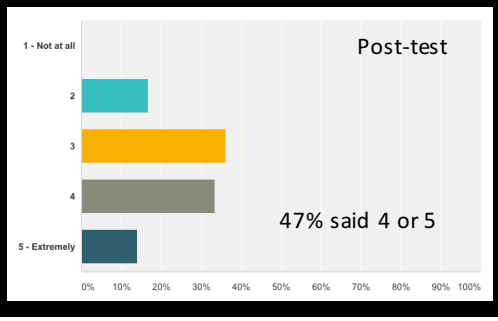
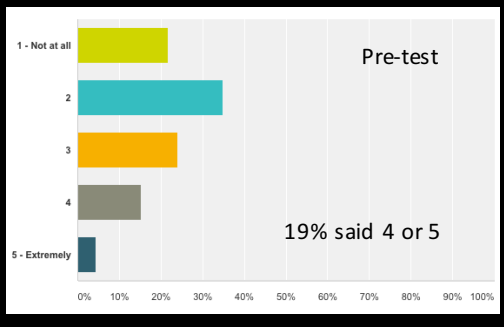


How confident are you in performing geochronologic lab work, including sample preparation and analysis?



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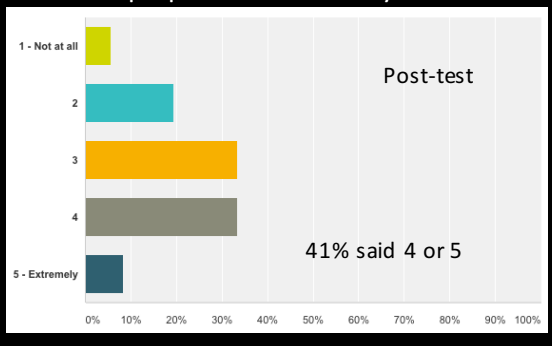
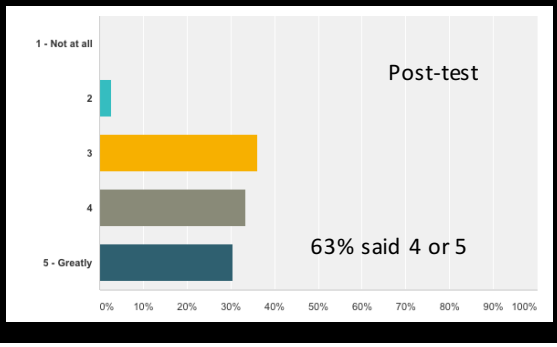
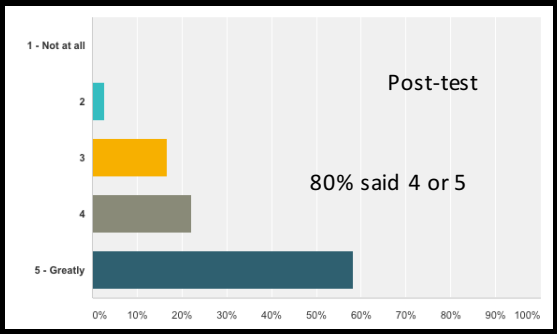


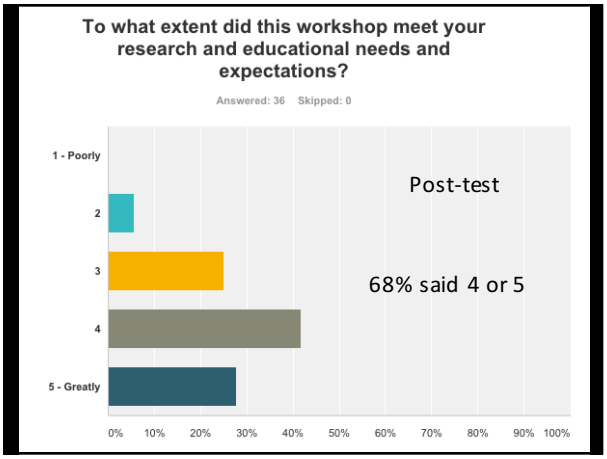
Workshop Overview questions

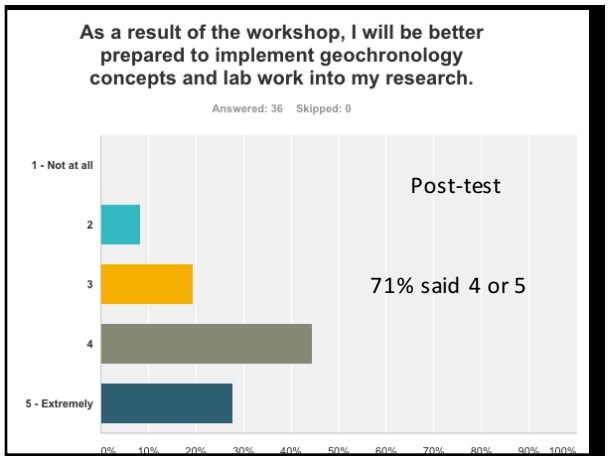
To what extent has your professional knowledge been enhanced by the workshop activities?

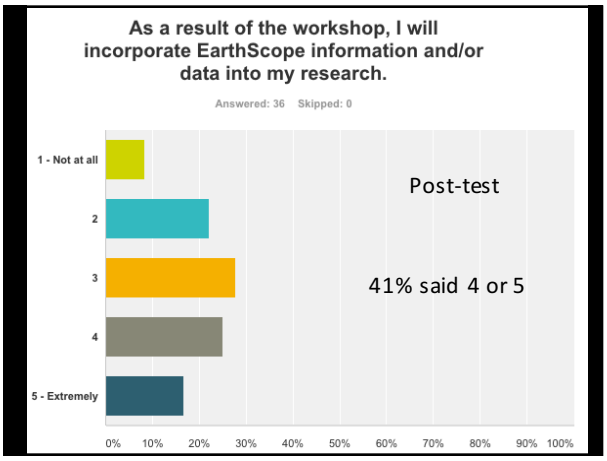


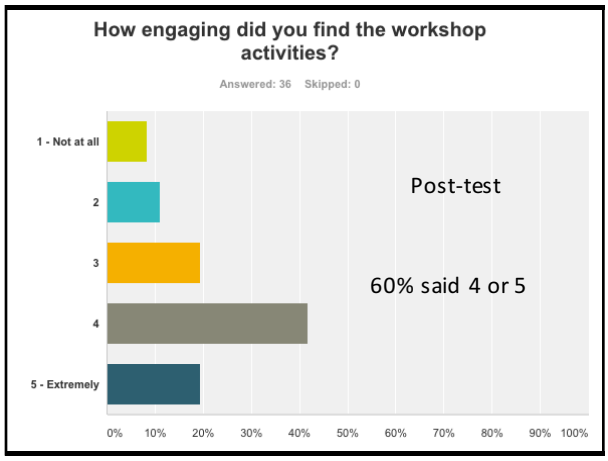
Has this workshop been a learning experience for you?

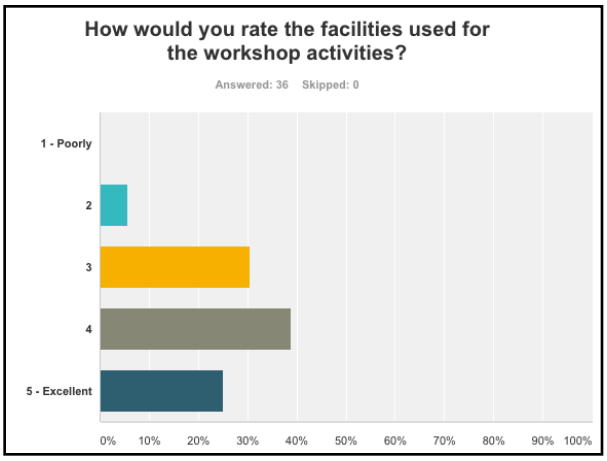


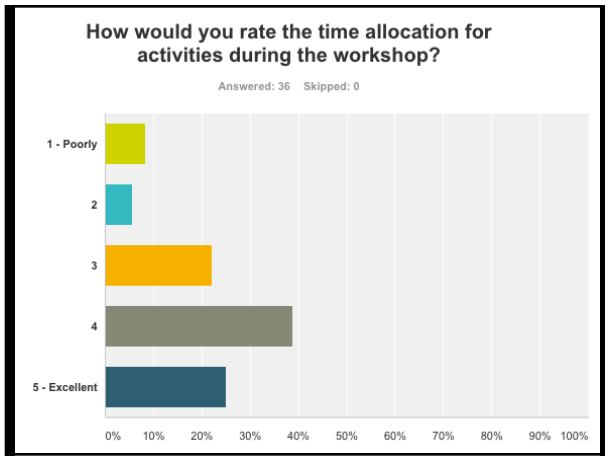












Open-ended feedback

What workshop activities did you most enjoy about the workshop? Why?

"The combination of motivational talks and technical details was ideal. Great questions and open discussion."

(10 similar responses)

"Meeting with the speakers during coffee breaks was enjoyable. It is nice to ask questions face to face."

(6 similar responses)

"Discussion of new/upcoming methods and applications discussion sessions."

(5 similar responses)

What workshop activities were the most useful for your research?

"The different technique talks were very useful in helping me decide what techniques I could use on my research."

(11 similar responses)

"Application talks"

(3 similar responses)

"U/Pb technique"

(7 similar responses)

What can we do to help improve similar workshops in the future?

"Less lecture, more "hands-on" activities"

(8 similar responses)

"More student-student and student-instructor facilitated interaction!"

(6 similar responses)

"Perhaps polling students on the methods they use and are interested in using well before the workshop (when planning the speaker line up, e.g.). This may hone in best on participants' needs."

(3 similar responses)

Appendix 4 Survey Results

Names of people and institutions have been removed.

4.a Student Surveys

1. What are the new scientific collaborations/relationships facilitated by the EarthScope Geochronology project?

- *My thesis adviser and I have developed a new relationship with the (U-Th)/He lab at ….*
- *As a … University Grad student I was able to travel to … and work with Dr. … and Dr. …. Not only I was able to work with them while at …, but our relationship continues go grow as we keep working with the project. We have had some unexpected outcomes that we are still trying to work around of, and we have frequent Skype conferences and many emails back and forth were discuss new ideas and ways of solving the issues that come up. I think without this grant, the bridge between … and … would not exist. Scientists not directly involved in the project have helped and collaborated in its improvement as well.*
- *This project facilitated a new collaboration between the research groups of Prof. … (Metamorphic Processes, …) and Prof. … (Geochronology, … University). Prof. … has also involved one his graduate students, …, who has also been serving as a lab mentor for me.*
- *I was able to receive help/coauthorship from the lab host, …. I also got to know her students, who I met up with at the AGU Fall meeting.*
- *… may encourage future students to visit the University of … lab for future work*
- *This funding served to solidify a collaboration between Dr. … of the …Geochronology Center, Dr. … and myself (University of …), and Dr. … of …. We had been trying to establish this collaboration for some time prior to receiving the AGeS grant. Our collaboration with Dr. … was very fruitful, and he was active in all stages of project planning and development. The results of our work will be submitted shortly, and we anticipate continuing to work with Dr. … in the future.*
- *This grant provided the opportunity for my adviser (…) and I at … to begin collaborating with the laboratory of … at …. We have several overlapping research interests and given the relatively short distance between our universities, we envision future collaboration on a diverse set of projects.*
- *The EarthScope project allowed me to stay at the geochronology facility at … and …, where I got in contact with PI of the facility but also other students and postdocs actively working with the instrumentation. This lead to engaging discussion and helped me to establish scientific connections.*
- *New collaborations with … and … at … as well as graduate student …. I am anticipating new fruitful interactions with people at the … short course during which I am processing my samples.*

2. Was there adequate discussion and/or mentorship leading up to the lab visit to maximize the efficiency and scientific outcomes of your project?

- *For the most part yes. Some of the sample preparation was unclear to me. But it was cleared up soon after I started working in the lab.*
- *There was communication about what to expect and how I should mount my samples prior. The pricing for lab usage using the Earthscope rate wasn't very clear. The amount of analyses per hour wasn't what I was led to believe.*
- *Absolutely -- I visited the lab several times (even before conducting fieldwork) and received excellent guidance. Dr. … graduate students also provided indispensable help in the lab.*
- *… and … have been very helpful so far. It is great!*

- *Yes. … has always been clear regarding procedure, methodology, and expectations in terms of data collection, processing, and interpretation.*
- *Yes.*
- *Yes, Dr. …, as the … manager, helped me with the preparation of my samples to ensure that upon arrival I was able to start picking and packing the apatite grains. For which I had to do heavy mineral and magnetic separation of all samples and have a subset of the best apatite grains already separated. Once I arrived to … , Dr. … showed me the lab procedures for picking and packing grains and I was able to process all the samples we planned for in the allocated time.*
- *Yes. Dr. … and I had several discussions via email and phone about sampling strategy and sample preparation*

3. What are the new scientific skills or knowledge that you have acquired during your work with this project. How will these new skills be useful as you continue your career in the Earth Sciences?

- *I am now well-versed in the collection and interpretation of U-series data. This includes knowledge of sample preparatory chemistry, mass spectrometry, and data reduction. Particularly important among these skills are an understanding of analytical/temporal uncertainties and statistical considerations that go into assessing them. These skills will be vital to conducting geochronologic analyses in the future.I am currently at … doing the geochronological analyses as I type this (currently waiting for columns to clean). I have learned most of the preparation procedures for TIMS-based U-Pb geochronology of zircon, as well as a bit about how the TIMS works. I feel confident that I will continue to learn much more in the coming days. These new skills will be useful for future U-Pb analyses using the TIMS.*
- *I've gained valuable experience working in a clean lab environment and learning the intricacies of thermal ionization mass spectrometry. These skills will be useful should I find myself working on a project in the future where I need to collect geochronological or geochemical data.*
- *I learned how to ablate and partially reduce data. I also learned how a production lab works. These new skills will be useful should I ever use another mass spectrometer in the future.*
- *I learned how to ablate and partially reduce data. I also learned how a production lab works. These new skills will be useful should I ever use another mass spectrometer in the future.*
- *I am still in the middle of everything and haven't started the labwork yet. I am acquiring new skills in how to sample OSL samples during the night when there is not enough sand to use the conventional methods I am also learning a bunch about the Geology of the Yellowstone area.*
- *Every day I am learning more about thermochronology. Although I had a basic understanding of the method, going through all the steps from picking/packing samples, analyzing the U-Th(He) ages … and overcoming obstacles in the lab protocols, have given me a much more broad and deep understanding of thermochronology. Currently, I am still working on improving the technique of double characterization of apatite (U-Th)/He and 87Sr/86Sr), hence why have mainly analyzed apatite standards (Durango) and not all the unknowns. Moreover, throughout this project I was able to deepened my knowledge of strontium chromatographic separation and the use of the … Mass Spectrometry that otherwise I don't believe I would have. I needed to improve the separation and the yielding of Sr, U and Th as well as improving the accuracy of the Sr TIMS data.*

- *I have learned about how to collect, pre-process, and analyze OSL data, which is an important tool for future research. I have also learned more about the advantages or disadvantages of dating methods for deposits <200 kyrs old.*
- *I have learned a lot about sample preparation, mass spectrometers, and data processing. More than anything, this program has taught me that, while I value geochronological data and will continue to use it, I do not want to BE a geochronologist, nor do I ever want to manage a lab. Those jobs are not for me.*

4. We understand that you participated in this project to gain new skills in geochronology. Were you prepared to accomplish your project goals?

- *My project goals were accomplished. Though, it is still ongoing.*
- *I think so, yes. I reviewed much of the primary literature, calibrations, etc. before working in the lab. The only part I was missing was the actual mechanics of producing the data, which I learned during my visit to the lab.*
- *May project is not finished yet - samples are still being measured at the facility. The preparation of samples was guided the entire time, I was at the facility and methodology and scientific goals were discussed on a daily basis helping me to achieve my goals.*
- *Yes.*
- *As I said, I haven't started the labwork yet but the combination with the OSL short course seems a perfect setting to acquire these new skills.*
- *Yes, by working closely with Dr. … we have successfully collected a robust data set which addresses our study hypotheses.*
- *Yes*
- *I believe I had enough background and mentoring that I was able to succeed in some of the goals of the project but not all. I was able to improve separation and retention of strontium, uranium, and thorium. I was able to obtain the 87Sr/86Sr ratio of single grain by TIMS , and also obtain the U-Th/He ages of apatite grains for which the strontium was separated. However, there seems to be a change in the strontium composition of the apatites through the degassing that does not allow to have both U-Th/He ans Sr isotopoc composition in the same grain, and it is a complication that none of the scientists involved in the project had foreseen. I am still working on pinpointing the source of the change in strontium composition, and I am working on new ideas with the other scientists involved.*

5. How far along are you in the project, and if necessary, what plans do you have to continue working with your lab mentor to complete the project?

- *I am in the process of writing my thesis manuscript, and am planning to defend in June and graduate over the summer. I am still waiting for some finalized dates, but have been receiving preliminary results. I am still working with my mentor and her lab to finalize my results and will continue to work as I ready my paper for publication.*
- *I am writing my discussion and will defend within a month. I have everything I need from the lab mentor to finish my project.*
- *I am still in the stage of getting the samples and doing some geomorphic mapping and scouting. I will process the samples starting May 30th during the OSL short course. I will continue collaborating with Joel to write up the results and the plan is also that these preliminary samples may end up in a proposal to get further funding to work in the area.*
- *My project is ~ 80 % finished at this point. I will continue working with my lab mentor until the measurements are completed and we will publish the work together as collaborators.*

- *I am roughly a third of the way into my project. Because I'm located relatively close to my lab mentor, commuting until the project is finished doesn't pose a problem.*
- *In the next few weeks, we will be submitting a manuscript for publication which outlines the results of our work with Dr. … and the …. The Earthscope AGeS program will of course be acknowledged in that publication.*
- *I am in the early stages of my project. The AGeS program allowed me to date preliminary samples. and guide where I will continue to sample. My thesis adviser and I are submitting a grant to continue this project. There will be money in this grant to do more geochronology in the lab I worked in for the AGeS program.*
- *I haven't finished the project yet, but I am actively engaged my mentors at …. As I mentioned before, I am looking for the source of the contamination/change in 87Sr/86Sr of the apatite grains after degassing. I am experimenting with quartz as it is a mineral with low Sr content relavite to apatite. Because all my samples have already been degassed, Dr. … and Dr. … have my unknowns and will dissolve the apatite grains and obtain the U-Th/He ages within the next 2 weeks. This signifies that the unknowns will not have both the isotopic and themochronologic data, and the strontium isotopic composition will be obtained in different set of apatite grains that those used for the U-Th/He ages. However, I am still working on improving the technique and I can use a new set of unknowns for proof of concept if needed.*
- *As stated above, I am currently in the midst of the laboratory work. I plan to continue working with Prof. … on a manuscript to be submitted to a peer-reviewed journal after completing the analyses.*

6. Two themes emerged from the Geochronology Institute (fall, 2014): Can students deal with a) uncertainties in the data and b) data evaluation, presentation, and interpretation. Did you work with your mentor on these issues or is it likely that you will do so as you continue your project? Do you feel confident that you can discuss these uncertainties and your data? Please elaborate.

- *I somewhat worked with my lab mentor. Most of what I encountered during the ablation was explained by the lab mentor. If I were asked about the data reduction, I do not think I could answer with certainty because I really wasn't taught how the data reduction was done at the lab. Most of it was done by the staff, there.*
- *I worked on data reduction and interpretation during my stay at the research facility and continue after my stay. Once all data is collected we planned on a second meeting in person to discuss the publication of the project.*
- *I am sure uncertainties will be a big subject - in fact they already are in the process of sample collection. Unfortunately, sampling is challenging and so we have to take whatever we get. I am sure that … will be thoroughly explaining the uncertainties and how to best assess and report them.*
- *I feel fully confident that I understand and can discuss data uncertainties. Dr. … has been very clear in explaining these concepts.*
- *I do recognize the uncertainty in the date produced. However, I am not comfortable with the math required to propagate uncertainties through the entire data reduction process. I recognize the sources of uncertainty for the (U-Th)/He system. I am also comfortable discussing if a cooling age actually reflects a geologic event, or if it is the product of a complex cooling path. My host PI and I did discuss these topics.*

- *I am currently working with my mentor on both of these topics. I only just received back enough results to evaluate uncertainties and make interpretations. However, I do think i have a good understanding of what uncertainties are involved more generally.*
- *We have not gone as far as data interpretation yet. As our project is a technique development project, there has been a lot of work on improving lab procedures and protocols. Most of our current data collection has been done with standards. However, I will obtain the U and Th concentrations of the unknowns in the next few weeks with the U-Th/He ages, and I will require with the help data analysis that Dr. … and Dr… will be helping me with. Once I have gone through the data processing I know I will feel confident on discussing and communicating the results and ideas to the scientific community.*

7. Were there any costs associated with this project that were not covered by the EarthScope AGeS Program? Were these anticipated? Were they more or less than you anticipated? Did this project provide enough funding for travel, accommodation, etc.? If not, did your home institution provide the extra funding?

- *No.*
- *Not Applicable*
- *There was enough money to cover the ~ 80 % of the analytical costs, the remaining amount was covered my institution. All personal expenses were covered by the EarthScope project funds.*
- *Field work for this project was funded by a separate award. Outside of that, the funding provided by the AGeS program was more than adequate to address our project goals.*
- *The costs for travel were a little larger than anticipated since I ended up traveling from Germany where I now lived. On the other hand I borrowed a car from a student and thus am not dependent on a rental vehicle. I have not done the final finances but I am anticipating to have enough funds to cover everything except for food expenses.*
- *In the proposal I wrote, I specifically stated that I had yet to collect the samples I was planning to analyze. Fortunately, I had other funding to do field work to collect the samples. The AGes program explicitly states that the funds are not for field work. My funding for field work came from other small grad student grants.*
- *Yes, there were some costs associated with the project that were not covered by the Earthscope Program. This consisted of Laser-Ablation isotopic and trace element analyses done at University of …. Such analyses are extremely useful as reconnaissance data for the TIMS-TEA analyses I am performing here in ….*
- *The EarthScope grant did not fully cover all of the costs associated with the project. The majority of the funds were used for lab fees and collecting the U-Th/He data. I had a GSA grant and a … University grant that help cover the remaining costs. I did not have any unexpected costs.*
- *Since I did not receive the full value that I had originally budgeted, I ended up paying for some costs out of pocket to ensure that I could process all of the samples I was planning on. I had already allocated other funding to other uses, and did not use it for travel etc. for the geochronology component. Overall, the funding was sufficient, I just opted to use as much money as possible to sample dates instead of stipend, travel, etc. I ended up collecting more samples than I had originally budgeted for.*

8. What would you describe as innovative in your research?

- *I would describe my pairing the ages with field relationships and modelled compositions as adding to a growing method of forward modelling of partial melts with the aid of geochronology.*
- *In this project we are trying to develop a double characterization of apatite, combining thermochronology and isotopic composition of accessory mineral as a provenance tool in Modern environments. Potentially, this technique will be a more robust provenance tool that some of the ones we currently use like rare earth patterns, U-Pb zircon ages, whole rock geochemistry, etc. Moreover, zircon is a widely used mineral in provenance analysis, and we believe that apatite has a higher potential of showing bedrock source because it is less likely to survive multiple recycling histories, thus complicating the dispersal paths of the sediments.*
- *Our project is the first assessment of Quaternary uplift in the southern Yellowstone and the snake river plain area and will test hypotheses about the pattern of uplift in one of the most important tectonically active regions of the united states. The ID-TIMS-TEA method allows to simultaneously monitor the age and geochemical evolution of zircons crystallized from melts evolving in what appears to be an in-situ fractionating magma chamber. Thus allows to put an absolute age on fractionation in the upper crust of an magmatic arc - this has profound implications on the nature of the plutonic-volcanic connection and speed to continental crust formation.*
- *The approach outlined in our AGeS proposal, and implemented in by our collaboration has resulted in what we believe to be the longest, direct quantitative paleoseismic record that has ever been documented. By using syntectonic calcite veins to collect this record, we have also conducted a paleoseismic record which is sensitive to the role of fluids in the seismic cycle.*
- *My research integrates thermochronometry with geodynamics and continental rheology. Few geodynamicists look at rocks. Few thermochronologists make lithospheric strength profiles. I do both.*
- *There have been very few OSL studies in glacial or glacio-fluvial deposits, especially for as many samples as I have gathered. I am also trying to compare the intermediate geomorphic record to the short-term interseismic deformation record near the Cascadia subduction zone, which hasn't really been attempted.*
- *The TIMS-TEA analyses in this project combine the extremely high precision of TIMS geochronological analyses with trace element analyses (TEA) on individual distinct domains of zircon and monazite, thereby allowing us to link monazite and zircon growth to petrologic processes. The extremely high-precision U-Pb dates allow us to constrain the timescales of these petrologic processes. This project will be the first of its kind as applied to Archean (ultra)high-temperature metamorphic rocks, as well as the first TIMS-TEA analyses on both zircon and monazite from the same sample. These analyses will constrain the timescales of processes involved in the Archean (ultra)high temperature metamorphism of the Superior Craton, and, when combined with other methods (Phase equilibria modelling to determine pressure-temperature paths, Sm-Nd and Lu-Hf garnet geochronology), ultimately elucidate the geodynamic mechanisms for (ultra) high temperature metamorphism during the Archean evolution of the Superior Craton.*

9. How would you describe the interdisciplinary nature of your research?

- *This research combines cutting-edge techniques in isotope geochronology with metamorphic phase equilibria modelling*
- *No response*

- *In this project are involved a variety of disciplines of geology. For example, we are using thermochronology, geochemistry, and geochronology to better understand sedimentary processes like provenance analysis, which it is interdisciplinary on its own. Provenance analysis is used for paleogeographical reconstructions, crustal and basin evolution, among others. I believe this project not only is interdisciplinary, but it is of broad impact.*
- *I am generally interested in plate margins including continental crust. Rheologic heterogeneity and progressive deformation make plate boundaries in continental crust diffuse and complicated compared to oceanic margins. Reconciling the evolution of continental fault systems requires an interdisciplinary approach. The fault system I study contains exhumed mylonites, active fault scarps, inverted thrust-top basins, and cross-cutting igneous rocks. I use thermo/geo-chronology, geologic mapping, thin sections, structural analysis, metamorphic petrology, basin analysis, and landscape analysis to reconstruct this fault system through geologic time and couple the evolution of this fault system to tectonic events.*
- *I am combining elements of geomorphology, tectonics, modeling using GPS, and glacial geology to tell a coherent story.*

10. Was this a successful project for you? You can define success as you wish. What are your thoughts and/or analysis of the experience?

- *I am not done with my project.*
- *We shall see…*
- *This was a highly successful project. Our work has provided new data which address previously unanswered, fundamental questions regarding the role of fluids in intraplate seismicity, an issue of great societal relevance. We will soon be submitting this work for publication in a high profile journal.*
- *This has been a very successful project. The project for which Earthscope provided funding has been successful thus far and we have already discussed future collaborations on research.*
- *So far the project was a success for me, especially the stay at the research facility helped me a lot to establish research connections and learn hands-on the methodology.*
- *I think it was a successful project. At a personal level, because I was able to meet other scientists, work at a different laboratory, and learn more about thermochronology. In a scientific level, although the outcome might not be what I excepted at the beginning, it is important to experiment and develop new scientific knowledge. I will try to publish the technique paper and make it available to the scientific community, so that other scientists can improve upon my idea idea.*
- *I have not yet finished my project. But as of now, yes, I would say it has been successful because I can answer a few questions about the relationship between short and intermediate term deformation and provide more data for future research in the Olympic Mountains.*
- *So far, yes it is a success. Ages from the rocks I dated supported my hypothesis. I have preliminary interpretation(s) for the ages and I look forward to collecting more data.*
- *My experience has been great thus far.*

11. Would you participate in this project again? Would you recommend this program to other students? Why or why not? Please elaborate.

- *Yes, I would recommend the project to other students and would myself participate in it again. It is a unique opportunity to insights into another lab and establish research connections, which might lead to further collaboration.*
- *So far I totally would and I also would recommend the program to others. I think I have been very lucky in getting into a nice group of very supportive people.*
- *Yes, I would participate in the program again and I would recommend this program to other students, because it is an opportunity to receive outsiders' insight on a crucial pillar of a project. It is also a way to build relationships between the student, the institutions they represent, and the institutions they come into contact with.*
- *I would absolutely participate again as well as recommend other students to participate in the program. I believe it is very important to encourage grad students to learn more than the techniques/methods that our advisers know. EarthScope has given me possibility to learn a new technique, and not just be a data user, which allows a deeper understanding of the method. Also encourages interdisciplinary and inter-university collaboration, that is not that easy to achieve, and this is a good way to build bridges among scientists. Also, this program has given me the opportunity to obtain the second ad third chapter of my thesis that otherwise I wouldn't have been able to.*
- *Yes, I would participate in the program again and I would recommend this program to other students, because it is an opportunity to receive outsiders insight on a crucial pillar of a project. It is also a way to build relationships between the student, the institutions they represent, and the institutions they come into contact with.*
- *I would absolutely participate in the project again, and I have indeed recommended the program to many other students. It was very clear from the beginning of the process that the primary goal of the program was to foster new collaborations and ultimately aid participants in developing new skills and conducting high impact science.*
- *Yes, Yes, Yes. The AGeS program has been a good way for me to get my PhD off the ground. Due to this program, I have traveled to new places, learned a bunch, and made new connections. Aren't those the reasons to become a geologist? Also, I feel ownership over the data I produced, which is great. Thumbs up.*
- *Yes and yes. The amount of money awarded is significant enough to allow students to perform relatively costly geochronological analyses that they (or their advisors) may not necessarily be able to afford. Having enough money to do the science that you want to do is crucial for earning a graduate degree in geosciences. With NSF funding becoming progressively more competitive to receive, professors may not have the funding to support the science that their students wish to undertake, particularly with regard to the expensive and time-consuming process of isotope geochronology. The AGeS program is vital for allowing students to do geochronology-based projects.*
- *Yes, I would participate in this project again. I thought it was a great way to accomplish an ambitious geochronology goal that would have been hard to do without a relatively large sum of money, such as from an NSF grant. Most other sources of funding are smaller, and may not provide enough to cover a project of my size. It was also great to have a mentor which was dedicated to helping out. I would definitely recommend this to a student. I also liked being a part of the analysis process.*

12. If you have submitted something for presentation, did you acknowledge the project in the context of EarthScope science goals? If so, would you elaborate with the wording?

- *I have presented a talk at GSA in 2015 and at … University in 2016 and I used the following statement plus the NSF and EarthScope logos: "This material is based upon work supported by the National Science Foundation under Grant Nos. EAR-1358514, 1358554, 1358401, 1358443, and 1101100 (EarthScope National Office). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. Thanks to the EarthScope program for its support."*
- *We will be presenting this work at the upcoming AAPG Annual Meeting, the GSA Structural Geology and Tectonics Forum, and the GSA Annual Meeting. As previously mentioned, we will also be submitting this work for publication shortly.*
- *I think my project fits well in the EarthScope science goals - I am not sure I understand this questions correctly. My project focuses on understanding the timescales of in-situ fractionation in a shallow level magma chamber. And thus ultimately the formation of the continental crust.*
- *I acknowledged Earthscope in the following way: "This material is based upon work supported by the National Science Foundation under Grant Nos. EAR-1358514, 1358554, 1358401, 1358443, and 1101100 (EarthScope National Office). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. Thanks to the EarthScope program for its support."*
- *I've yet to give a presentation including AGeS data. But I plan to submit an abstract to GSA. For this presentation, I plan to include the lab PI of my host institution as a coauthor and credit the AGeS program with wording similar to- 'support for (U-Th)/He cooling ages on samples XX is provided by the EarthScope AGeS program'*
- *Not yet, but I will certainly do so.*
- *Not Applicable*
- *I have not submitted anything for presentation yet.*
- *I submitted a poster and used the provided acknowledgement sent out by Ramon Arrowsmith.*

13. Have you submitted any abstracts for a scientific meeting based on the data? If so, what are the titles, meeting, etc.? What might be submitted for presentation in the future? NOTE: We will request a final report to be submitted at the completion of your project with the latest data at the end of 2016.

- *Yes, the title submitted at the 2015 GSA annual meeting was: ISOTOPIC-THERMOCHRONOLOGIC CHARACTERIZATION OF APATITE AS A NEW PROXY FOR PROVENANCE ANALYSIS I will potentially be presenting the new data at the next GSA and or the finalized technique method.*
- *Not yet, will for GSA '16*
- *Not Applicable*
- *I am planning to submit an abstract to the AGU Fall meeting 2016.*
- *Not yet.*
- *Already submitted: Geological Society of America Annual Meeting in Nov. 2015,Title: RE-EVALUATING THE WHITE MOUNTAIN MAGMA SERIES THROUGH HIGH-PRECISION ZIRCON U-PB GEOCHRONOLOGY AND TRACE ELEMENT GEOCHEMISTRY: A PRELIMINARY REPORT, Co-authors: Paul Olsen, Blair Schoene, Jill VanTongeren, Jacob Setera, and Sidney Hemming I plan to submit an abstract for*

either the GSA annual meeting or AGU that will detail the further progress for this study. Once I complete this project, I plan to submit the results for publication. No

- *I have not submitted anything for presentation yet.*
- *AGU Fall meeting 2015: Fluvial Record of Active Deformation Along the Canyon River Fault in the Wynoochee River Valley, WA Poster number: T33C-2944*

14. Is there anything else you would like to tell us?

- *I appreciate having been awarded and I hope you continue with the program.*
- *The proposal I submitted stated that I will make 2 trips to the field and host lab during my time in the AGeS program. Interaction with the grant PIs has made it seem like this is a 1-year program. It has been unclear to me if there is a time limit on the program. This isn't a big deal, I'd just like to emphasize that it is time consuming to do field work, sample preparation, travel to lab, and process data- especially if the student has other responsibilities (coursework, teaching, mentoring, etc.). It would be useful to make a timeframe for the program known to to participants and applicants. Besides that, this program has been a tremendous help. I'm very appreciative.*
- *So far things are good - just challenging to find the samples I need but I have one more week to go into the field.*
- *I appreciate having been awarded and I hope you continue with the program.*
- *This grant was a life-saver for my project, I'm not sure I would have answered the questions I wanted to without it. It's perfect for students who want to ask questions about poorly studied regions that are not funded by a large NSF grant.*

Appendix 3 b Home Institution

1. Is this a new collaboration for you? Have you or your students previously published with scientists from the laboratory where these analyses are done? Do you have ongoing collaborations with the scientists in this laboratory? Does this project represent new directions in your own research?

- *Yes, No, No, Yes*
- *1.a. We made the first step toward collaborating by obtaining a couple of dates with an earlier, small, student grant. b. These early dates provided proof of concept, but were insufficient to publish. c. Through this grant and a subsequent award, we now have an ongoing collaboration with the scientist in this lab we have been working with. d. This is a new direction in my own research, and we are exploring further innovative applications to continue the collaboration.*
- *Yes, No, No, Yes. I have not worked with very low thermochronometer systems; my prior research with geochronology has focused on crystallization and high-T cooling histories of metamorphic and igneous rocks. Travel to the … laboratory represented a new collaboration, and neither the student nor I had used the laboratory previously. I have no on-going collaboration with the laboratory. The project did not represent a new direction for my own research, but was rather a long-standing project for which I had a student in the right place at the right time to pursue the funding opportunity.*
- *This is a new collaboration, though with a scientist I have known for several years. It represents a new direction for me and will hopefully mature into a longer term and productive collaboration.*
- *I have been involved with peripheral aspects of related projects, but the overall project is new to me as is zircon geochronology. I am building cross-disciplinary collaborations with several geochronologists in the process. It definitely represents a new direction for my research.*
- *Yes, new collaboration. Never previously published ith them. Yes, collaboration still ongoing. Yes, a new direction of research.*
- *This is a new collaboration. No published papers with this lab. We now plan to continue to work with this lab. And this particular technique is new for us.*

2. Was the laboratory responsive and timely in helping you and the student plan and prepare for their visit?

- *Yes, very much so.*
- *While the … (…,…. …Lab) is very heavily used they have been very cooperative and responsive. Student has switched to … for … from …, because the later was oversubscribed and he has ties with …, which has a new and functioning lab. All concerned have been responsive and timely in helping the student and I plan and prepare for our visits.*
- *The proposed work included both bulk and in situ dating. The student was to be involved with the latter. However, we knew going in that the (parent and daughter) isotope content would determine the feasibility of the in situ work. It turns out that it was not possible, so the student did not visit the lab. However, the lab was very responsive in (a) working with us to determine how to most effectively utilize funds originally set aside for in situ work, (b) informing us when issues such as building renovations delayed analyses, and (c) working with the student every step of the way as he prepared samples and helped with data analysis.*

- *Yes, the lab manager (a staff person) communicated quickly and efficiently with my student. During the preparation stages the … laboratory was helpful in providing information as to what to do. We applied to do much of the preparation work independently, especially the grain mounting and imaging, which could be done much more efficiently and cost-effectively in house. However, the standard grains that we were asked to include in our grain mounts were very late in being delivered, which meant that a lot of the prep had to be rushed and compressed into a very short space of time. There were also delays and time-lags in the provision of a complete dataset to the student, and responding the student inquiries as to aspects of the data in the period of time after the visit. Some of this I think could be attributed to the student, but in other cases emails with specific questions seeking input on aspects of the dataset were not returned or acknowledged in a timely manner.*
- *Yes. They were very responsive and timely in the planning.*
- *Yes - very responsive host laboratory.*
- *Yes, the laboratory was excellent in helping to prepare for the visit (in terms of logistics/scheduling and in terms of helping us to maximize the sample preparation that could be done before the visit).*

3. What are the new scientific skills or knowledge that the student acquired during the work on this project?

- *My student developed an in-depth understanding not only of this radioisotopic system, but also of general issues involved in everything from sample preparation and analysis to data interpretation. He did not anticipate doing this type of work when he began his PhD research; geochronologic analysis is now a key piece of his long-term research plans.*
- *TIMS-TEA geochronology and the required lab work for sample preparation. Also learning about zircon geochemistry.*
- *The student learned a great deal about both the practical side and the scientific side of acquiring and interpreting age data. First, he found out how difficult it can be to separate small mineral grains from fine-grained rocks (he did that at his home institution). Second, he learned that finding very high quality grains to do U-Th He on requires careful imaging and picking (he did that at the lab). And third, when he received the first batch of data, he found out how valuable that can be in helping him decide what the next steps to take are, specifically which samples to analyze next and what thermochronometers would be best to use for those samples. We had planned that he would do the analyses in two batches separated by at least 9 months because there are no existing ages in this area, so we really didn't know what the possible ages might be (somewhere between 35 Ma and 2 Ma was our range). With the first four samples analyzed he will now target future separations and ages on a second suite that will cover a broader range of thermochronometers and spatially wider area.*
- *The student's perception of what they learned is based on the data collected, but my hope is that they gained greater appreciation of the work and effort required to construct and execute a successful, analytical-methods based, project.*
- *The student gained both technical knowledge of how the data are acquired (i.e. details of sample preparation, analysis and interpretation) and an extremely high resolution dataset that we can now interpret in light of other aspects of his project.*
- *Student is learning context of EarthScope and in particular learning interpretation of zircon geochronology in the context of large scale tectonics, particularly plume - rift*

dynamics.

4. Have you discussed with the student the uncertainties associated with the data collected and how it impacts their interpretation and the overall research project? Do you think the student understands and can discuss these uncertainties?

- *Yes. Do you think the student understands and can discuss these uncertainties? Yes, for more the most part. He is still learning the system and hasn't completed his analyses, so it will continue to be an ongoing process. We went over the data table together and he explained to me what he knows of it, and then I asked him questions on things I didn't understand (not having used this system before), which caused him to go back to the literature and also to talk to other people in our dept. who run mass spectrometers to make sure he understand exactly how the data are acquired.*
- *Yes, we have talked about uncertainties in the data (and are actually still working through some various interpretations based on these uncertainties). Because … is writing up her thesis as a manuscript, she is working through all of this in her discussion.*
- *Student and I discuss this on a regular basis. He not only understands the uncertainties he is making original contributions in that area.*
- *Yes. Although this is not a single conversation and our conversations will continue. We have not yet received all of the data back from the lab. Once we do the "uncertainty" discussion will continue, particularly in regards to the geologic context and interpretation*
- *Yes – there were several unexpected quirks in the data that were unexpected and the value and interpretation of the data has been interesting. One case of uncertainty in a dataset was a book-keeping error, which was a useful teaching moment in itself. Discussing the accuracy and precision of the data and deciding which units could be considered contemporaneous based on the data, and which ones may be assigned to different events, all of which must be considered within the terms of field relationships has also been a positive aspect of the project.*
- *We have had discussions about the data, their uncertainties and their integration into the broader research project. The student certainly understands the uncertainties associated with the new data and is aware of the fact that they allow us to address specific questions that would otherwise be inaccessible. The student discussed at length with their host mentor about sources and magnitudes of uncertainty in the new data, and will continue to discuss this with me.*
- *Yes - we have had extensive discussion about systematic and random uncertainties. I am confident should could discuss this at meetings etc.*
- *He has discussed uncertainties with both me and our geochron collaborator. My student has presented his work at national meetings, and in those venues, clearly explained and discussed uncertainties with others. He gets it.*

5. Are you working with the student on interpreting their geochronology data in the context of their overall project? Do you think the student understands and can discuss the interpretation of this data? If you are not at this point in the project, do you intend to discuss this?

- *These discussions are ongoing. Additional aspects of the project must be completed before true integration of data is possible, but it is already clear to both the student and myself that the data collected through this new collaboration are going to be extremely useful in addressing our broader objectives. The student has relatively sophisticated understanding of the data and will be capable of detailed discussion the dataset and its implications upon completion of other geochronological and numerical modeling aspects*

of his project.

- *Yes – working with the student on interpretation. Unsure if the student fully understands complexity of the dataset, or its implications. The results have been reviewed and have been appropriately processed, but consideration of whether the student has the hoped for fuller understanding will only be achievable when the Discussion section of the thesis is completed.*
- *Yes and Yes. The student is preparing for his PhD qualifying exam which is in one week, and thus the timing of his receiving this first round of data (about 2 weeks ago) was very good, as it gave him something very specific to talk about with regards to planning the rest of his PhD research.*
- *Yes, again, because … is writing up her results in a manuscript, she is working through these interpretations along with her thesis committee.*
- *We are beginning to dicuss this as we get our first data. We will have extensive discussions by the time most of the data are collected.*
- *Student is gaining expertise very rapidly. Student is adept at discussing the interpretation of this data in depth. The short answer is that my student has written the first, complete draft of a paper that we collectively (with our lab collaborator and another colleague involved in the research) intend to submit to Nature.*
- *We've started the discussion. But as noted above it will not fully take place until all data is returned from the lab. Dating is still in progress.*

6. What would you describe as innovative in this research project?

- The broader project aims to address the processes and timescales of crustal metamorphism possibly associated with early plate tectonics. The new collaboration has yielded dramatically high temporal resolution than previous techniques have permitted, and is likely to allow us to pinpoint timing of metamorphism with sub million year accuracy. This will allow us to describe how 'thermal fronts' swept through the region of interest.
- The innovative part of this project is that we are comparing river incision and slip rates at 10,000-100,000 yr time scales to deformation (and uplift) at the decadal scale (along the Cascadia subduction zone and constrained by GPS).
- Not really innovative, but we do hope to address a long-standing question that lots of researchers have dabbled in, but to date, an internally consistent dataset that covers the Mesozoic history of the region is still lacking – this project will address some of that need.
- The TIMS-TEA technique is "innovative" although has been previously used. But the combination of the technique plus the geologic setting in which it is being used is fairly innovative. Of course this depends somewhat on whether the project is successful.
- To my knowledge no one has ever attempted to determine a U-Th/(He) cooling age AND determine the 87Sr/86Sr ratio of the same apatite grain. Such combined data sets should prove extremely powerful in many different studies.
- Placing the geochronology of this long studied and extensive magmatic series on a new state of the art footing and relating that to the emplacement of the giant Central Atlantic Magmatic Province, both of which may be linked by linked plume processes.
- This is a new application of this particular geochronologic technique. It also addresses two different (though related) problems that have not previously been approached using geochronology.

7. How would you describe the interdisciplinary nature of this project?

- *There are two levels of interdisciplinary benefits for the students. First, this specific project involves 3 other collaborators in the fields of geochronology and thermochronology, in addition to the institution that the student received funds for. The student is in charge of presenting his data and discussing his interpretations with them, in addition to his doing the structural geology and mapping. He is also contacting people who do thermal modeling of the upper crust in response to tectonic exhumation and erosion, and also having to consider Pliocene to recent climate change and those affects on erosion rates. In a more indirect but also important way, the student is learning about a very wide range of disciplines that also use the same method, as he has been working in a very busy lab at a major institution where they are running analyses and working with people in many different fields of earth sciences. Thus spending several weeks in this lab each year over two years exposes him to science he would not otherwise encounter. It is inter-disciplinary from the perspective of merging high-temperature geochemistry, geochronology with structural geology and tectonics.*
- *This project is interdisciplinary because it involves collaboration between a geodesist/modeler (…at … College), a tectonic geomorphologist (home institution), and a geochronologist (… at …), and of course, a … MS student.*
- *It sits at the nexus between earthquake geology, geochemistry (particularly focused on diagenetic processes), and geochronology. Most important is the fact that it has changed the way my student and I think about these integrated systems.*
- *It spans geochronology, geophysics, classic structural geology, and tectonics.*
- *Extremely interdisciplinary. The project involves sedimentology, geochronology, isotope geochemistry and thermochronology. With more time we would expand to single crystal chemistry as well.*
- *It combines geochronology, with petrology, geochemistry, and modeling.*

8. Were there any costs associated with this project that were not covered by the EarthScope AGeS Program? Were these anticipated? Were they more or less than you anticipated?

- *Yes, the field costs of collecting the samples, which I knew would be in the range of ~$4000 or a bit more. We anticipated this when the student wrote the proposal, but we were fairly certain he would generate enough funding from other sources to cover it, and we had a shared helicopter with the State Survey. The field expenses turned out to be about what we were anticipating.*
- *Yes, there were a number of field costs, which were covered primarily from GSA graduate student grants, as well as internal grants. Also, I covered …'s summer salary from my startup. These were anticipated costs, and represent the price of doing business (without a funded NSF proposal…)*
- *Yes, there were additional costs that were not covered by AGeS. No, they were not expected, but grew out of our increased understanding of the system through field, petrographic, and geochemical analyses, and as we obtained the dates. Fortunately, we were successful in obtaining additional funding from another source.*
- *No – the funding from EarthScope AGeS covered all of the costs incurred by the geochronology component of the student's project, including sample preparation, characterization, travel and analysis.*
- *Travel was more expensive than anticipated. I had to cover some travel costs beyond that covered by AGeS.*
- *Costs are on target. Student has additional small grants augmenting the AGeS project,*

- *Yes, there was additional costs. They were not fully anticipated - but not bad. Overall it was still a good deal with the Earthscope funding. We certainly would not done the project without the latter funding.*
- *The costs were approximately as anticipated.*

9. Was this a successful project for you and/or the student? You can define success as you wish. What are your thoughts and/or analysis of the experience?

- *Yes, I would say that this has been highly successful as both an educational experience for the student and in yielding new and potentially very important data. It has worked best by plugging in to an existing project that should provide a strong framework within which the new data can be integrated.*
- *I think it is fair to say that it was successful beyond our wildest dreams (as indicated by our high target for publication). We fundamentally did not expect the rich temporal record that emerged during the course of this project. The result has changed both my student's research trajectory and my own, and firmly established an ongoing research collaboration for us both. It has been a great experience.*
- *Very successful, no just scientifically but in terms of increasing future collaborations as well.*
- *The project is ongoing and I don't think we will know the definitive answer for another year, but I would say it already is a success in the sense that the student has learned how to do totally independent research. He wrote the proposal, contacted the lab, collected the samples, decided which ones to analyze first (he and I consulted quite a bit on that, looked over rock samples, map data, etc. for awhile), and then set up the plan for mineral separation and analysis. I have been fairly hands-off, and he has discovered it can be a long hard process to get a few dates. My response to him so far has been "welcome to the world of science research. If it were easy more people would do it!" But seriously, having the student take the initiative on many aspects of the process is good because it also makes it more rewarding for him when he gets results. This first batch of ages were not what he was expecting, but they are very high quality and have given him much to think about. I have seen him mature very significantly from during this step from a M.S. to a Ph.D. student (he was finishing his M.S. when he wrote the proposal, and these results are the first thermochronometry data for his Ph.D. project).*
- *The project was somewhat successful for us both, in that some new data was generated, but we are uncertain as to whether it has clarified, or further confused, our understanding of crustal evolution the Great Basin region, and the East Humboldt Range.*
- *Yes, absolutely. … received enough support from the AGES program to fund her suite of samples, and she will be using those ages as a major part of her MS thesis. The award was timely and will allow her to finish her degree in two years and submit a first-authored publication from her work. I was also able to establish a new collaboration that will likely continue on as we build from …'s initial sample suite.*
- *Ongoing, very productive and exciting. It is highly rewarding to have a student that can successfully formulate and carry out their research plan independently as this student has.*
- *It will be - but the extent is still unclear. Getting high precision ages directly linked to geochemistry provides a powerful dataset to test models. Plus this is providing direct*

access (and motivation) for my group to interact with the scientists in the geochronology lab. It has also motivated us to think about Earthscope themes.

10. Would you participate in this project again in the future? Why or why not? Please elaborate.

- *Yes it is intellectually exciting and has promise for excellent results.*
- *Yes, most definitely. I had the chance to learn how a low-T thermochronometer system that I was not familiar with works, by following what my student is doing, and most importantly I have seen the benefits for my student. In addition, the project was a great success in terms of the overall benefits/dollar spent. With these funds in place the student has generated an additional $30,000 from USGS Edmap program for the next year, which will allow him to collect the remaining samples and acquire additional age data that is in a different lab then where he has been working.*
- *Absolutely. I plan to follow encourage my future students to submit proposals to the AGES program.*
- *Yes. One of my other students has submitted another Earthscope proposal. Both the monetary support, plus access to new techniques being developed in labs that we haven't previously collaborated with before, are both very valuable scientifically. Plus the new training and access to new scientists are valuable to the students.*
- *Definitely! I look forward to having a new student participate in the program.*
- *Absolutely. Why? Because I've long been interested in the temporal evolution of fault and shear zones, and this experience has made me aware of a broader range of approaches to getting there.*
- *If I had the right project, and it was compatible with the EarthScope goals, AND, I can demonstrate due diligence in publishing the data collected from the first award, then yes, I would submit to the opportunity again.*
- *Yes, I would participate in the future. I see this as a very good way of increasing the educational breadth of my students and an efficient way of obtaining very high quality data through a top-class laboratory. I could foresee the connections being built through this program maturing into more extensive collaborations.*

11. Have you submitted any abstracts for a scientific meeting based on the data collected in this project? If so, what are the titles, meeting, etc.? What might be submitted for presentation in the future? (We will ask for a final report from the student at the end of 2016.)

- *Not yet, although the student is likely to by the end of 2016.*
- *No abstract yet - can't until all data is received. But both several abstracts and a paper are already planned.*
- *National GSA meeting 2015. Title: ISOTOPIC-THERMOCHRONOLOGIC CHARACTERIZATION OF APATITE AS A NEW PROXY FOR PROVENANCE ANALYSIS We will likely submit an abstract to the 2016 GSA meeting.*
- *Kinney, S.T., Olsen, P.E., Rasbury, T., Kent, D.V., Jaret, S., and Anders, M.H., 2015, New zircon U/PB age constraints for the Agamenticus complex of southeastern Maine. Geological Society of America Abstracts with Programs. v. 47, no. 3, Paper 54-10.*
- *Kinney, S.T., Olsen, P.E., Schoene, B., Vantongeren, J., Setera, J., Hemming, S.R., 2015, Re-evaluating the White Moubtain Magma Series through high-preceision zirocon U-Pb geochronology and trace element geochelistry: A preliminary report.Geological Society of America, Abstracts with Programs, v 47(7),*

https://gsa.confex.com/gsa/2015AM/webprogram/Paper270062.html.

- *Williams, R. T., Goodwin, L. B., Mozely, P. S., and Sharp, W.D., 2015, U-series dating of syntectonic calcite veins constrains the time scales of the elements of the seismic cycle in an intraplate normal fault, American Geophysical Union Annual Fall Meeting (San Francisco, CA).*
- *Williams, R. T., Goodwin, L. B., Mozely, P. S., and Sharp, W.D., 2015, Diagenetic controls on fault-zone architecture and permeability structure in normal faults: Temporal constraints on the distribution, recurrence, and duration of fault-zone fluid migration, Geological Society of America Abstracts with Programs, v. 47, p. 445. Randy will also be talking about his work at an AAPG meeting later this Spring.*

12. If you have submitted something for presentation, did you acknowledge the project in the context of EarthScope science goals?

- *Yes.*
- *Yes*
- *Yes - we specifically mentioned this was work done as part of the EarthScope project.*
- *Will acknowledge, in future abstracts (e.g., AGU), but at the time of submission of the two the outcome of the proposal was uncertain.*
- *Support from AGeS was explicitly acknowledged.*
- *Not yet, but we will.*
- *Nothing submitted yet.*
- *Not Applicable yet; EarthScope will be acknowledged when we do.*

13. Is there anything else you would like to tell us?

- *Good program: hope it continues. You might think about ways to get people in the geochronology Earthscope program to interact with other parts/disciplines in Earthscope.*
- *Over all the program is great. It would be wonderful if just a little more money was available for the student's adviser to also visit the host laboratory as well as more funds for travel costs.*
- *Very satisfying process and results!*
- *The program is a terrific opportunity for students and I strongly encourage NSF continuing this. The benefit/cost ratio is extremely high, especially compared to other NSF programs (I have been on a number of panels). My main suggestion would be that the program should give the students more than 15 months or so to complete the project. The way it is framed, as a "new initiative", by the time the student receives these funds they will need more than that time to collect samples, process them, go to the lab to analyze them, and then ideally return to the lab to do a second round of analyses.*
- *Generally the project has been quite helpful, and we greatly appreciated the flexibility in being able to budget to have sample preparation and sample characterization done locally.*

  On the other hand, we found the laboratory estimation of budget needs to be grossly over-exaggerated. Based on input from the lab, we set aside a significant amount of funding, but the actual sum of money billed for completion of the work was significantly lower, which means that perhaps we should have scheduled to prepare more samples, or, we could have submitted a lower budget, which may have enabled more proposals to benefit from the funding allocation.

  Lastly, the laboratory administrators did not seem to be aware of the program, and perhaps it was because it was the first year, but guidelines of how the funding was to be

distributed could have been clearer. Personally, I thought that the laboratory would have been aware that my student was visiting using EarthScope support, but the people the student interacted with did not appear to know anything about the project or the proposal. Then, when invoices were issued to me for the student's work, I forwarded them on to the *EarthScope offices. However, EarthScope wrote back and asked me to work with the labs to have new invoices issued billing the Earthscope project directly. It seems to me that the administration of funding could be streamlined a little bit.*

- *I'd love to see the AGeS project extended. It is one of the best approaches I've seen to promoting interdisciplinary training and thinking for graduate students (who represent our future workforce). It also helps establish productive collaborations for student's advisors, which maximize opportunities for future cutting edge research.*
- *Thanks for the support and for establishing this excellent program! I hope it continues to be fruitful.*

Appendix 4c Laboratory responses

1. Is this a new collaboration for you? Have you previously published with scientists from the student's home laboratory? Do you have ongoing collaborations with the scientists in the student's home laboratory? Does this project represent a new direction for your lab?

- *This is a new collaboration between myself and the home advisor. The research project represents a new project, but the application of the technique is standard.*
- *Yes this is a new collaboration. I have not published or worked with the student's advisor before.*
- *This was an entirely new collaboration for the … lab. No … personnel had worked with either the student or her home supervisor in the past. In addition, the research included a new and significant variation on our existing methods.*

2. Was the student's home institution responsive and timely in helping you and the student plan and prepare for their visit?

- *Yes, although I mostly dealt with the student. I have had very little contact (none?) with their home dept or the student's advisor.*
- *Yes, as far as I know. I mostly worked with the student on preparing for their visit, but I did communicate with the advisor about the best avenues and techniques for sampling.*
- *Yes, the student's visit was very easy to arrange and her preparation prior to the visit was very good.*

3. What new scientific skills and knowledge did the student acquire during your mentoring of this project? Is there additional preparation that you would like a student to have prior to a future project? Do you consider this training a standard part of a collaborative project like this one?

- The student learned how to process the samples in my lab. They also learned proper sample collection and more about the technique and how to interpret the results.
- During our interaction the student learned how to prepare samples for (U-Th)/He analysis and how to better plan thermochronology sampling and research. She also became much more proficient at interpreting thermochronology data. Because of the novel nature of the project that includes a method development aspect, we have discussed the data on a variety of different levels, including very fundamental problems of measurement blanks and normalization routines. The student was as prepared as we expect a typical user to be, but has delved into the details of the method in much more detail than most users. For collaborative projects like this one we consider training to the degree necessary for data interpretation to be standard.
- The student learned how to collect and process samples for dating. They also learned how to interpret the results and what goes into the uncertainties in the method.

4. Did you work with the student to discuss the uncertainties associated with the data collected? Do you think the student understands and can discuss these uncertainties? If you are not at this point in the project, do you intend to discuss the topic of uncertainties?

- *Yes, uncertainties were discussed during the formation of the research plan, and are now being discussed as we start to collect and interpret her data. The student has a strong analytical background already, so this was not a difficult topic.*
- *I have been reporting the results of our analyses to the student in increments as more data come back. I have repeatedly discussed the uncertainties in the result and what is incorporated in the error calculation. I have also sent the student more in depth papers on*

the dating method and discussed problems specific to difficulties related to problems with the mineral properties of their samples. While the student probably cannot fully describe all of the nuances of potential problems with the application of the applied dating technique, I think they can describe them in general terms. The student is probably also able to describe the sources of error and uncertainty in the age results.

- *Yes, I have discussed what influences the reported uncertainties and what factors can influence the results. I think they understand the uncertainties fairly well.*

5. Are you working with the student on evaluating, presenting, and interpreting their geochronology data? Do you think the student understands and can discuss the interpretation of this data? If you are not at this point in the project, do you intend to discuss this?

- *Yes, we are discussing the interpretations of their results and I am helping them with their thesis write up. The student is very capable of interpreting the age results and it applying them to their research to create an great story.*
- *Yes, we have had multiple video conference conversations about the results at each stage of analysis, both before and after her visit to the lab. Typically the student, her advisor at her home institution, and two of us at CU are involved with these discussions. We have used these talks to both interpret data and plan the next stages of the analysis. The student has been very responsive and has a very good command of the data and its meaning.*
- *Yes, I am helping the student to interpret their data and will be helping with the presentation of the data for their thesis.*

6. Were there any costs associated with this project that were not covered by the Were EarthScope AGeS Program? Were these anticipated? Were they more or less than you anticipated?

- *I had offered a reduced rate for the analysis, which I commonly do when students come to my lab to process their samples. But I usually limit the number of samples the student can run at that rate, because it does not fully cover my costs of running the lab. For the AGeS program I must not have put a limit on the number of samples a student could run, or perhaps the student collected more samples than originally proposed. I think that they used their travel expenses in the grant to cover more analyses. In short, my lab maybe took on more reduced rate samples that I originally expected from the project, leading to some extra expenses on my end. And the student may have had extra expenses for travel as they didn't use the grant funding dedicated to travel and instead directed that money to analyses.*
- *No, all costs were covered.*
- *Because the method we were trying was new, we have adjusted the number and type of analyses throughout the experiment. However, the proposal was written with this in mind, and the funds allocated to the student are sufficient to cover the analytical costs without altering the goals of the research.*

7. Has this been a successful project for you, your lab, and/or the student? You can define success as you wish. What are your thoughts and/or analysis of the experience?

- *So far yes. We have learned a great deal about this new method. The data is still coming in, but every step so far has been very educational and will help guide future research.*

- *Yes this has been a fun and fruitful relationship and I think the student and I both benefitted from this project.*
- *This has been a successful project on all accounts - with regard to the data generated and my relationship with the student.*

8. Would you participate in the EarthScope AGeS program again in the future? Why or why not? Please elaborate

- *Yes! It's a great opportunity for me to interact with students and forge collaborations with new colleagues.*
- *Yes. This has been a fruitful experience on all counts.*
- *Definitely. This has been an excellent opportunity for the lab to interact with new scientists, and try a new variation on our typical method. The student was motivated and organized, and the research has been very useful.*

9. Have you submitted with the student any abstracts for a scientific meeting based on the data collected in this project? If so, what are the titles, meeting, etc.? What might be submitted for presentation in the future?

- *Not yet. We are now just getting the final results, but I expect that the student will present at GSA or AGU in the coming year.*
- *Not yet. We are just now getting the final results calculated, but I expect that we will present results in upcoming GSA/AGU meetings.*
- *Bonich, M.B., Samson, S.B., Flowers, R.M., Metcalf, J.R., and Fedo, C.M., 2015, Isotopic-thermochronologic characterization of apatite as a new proxy for provenance analysis: National GSA meeting, Baltimore, MD, November 2015.*

10. If you have submitted something for presentation, have you acknowledged the project in the context of EarthScope science goals?

- *We have not submitted anything yet, but we will credit ES when we do.*
- *We are unclear, this was an oral presentation. These goals will certainly be acknowledged in any written reports.*
- *We have not submitted the results for publication or presentation yet, but will definitely credit the EarthScope AGeS program for funding.*

11. Is there anything else you would like to tell us? Lab participation in the program is critical to its success, so we also welcome suggestions for how the program can be improved.

- *NA*
- *None*