

**EarthScope AGeS (Awards for Geochronology Student research) Program
Progress Report, June 17, 2016**

NSF EarthScope Grant Nos. EAR-1358514, 1358554, 1358401, 1358443,
and 1101100 (EarthScope National Office)

*Collaborative Research: Earthscope geochronology: A student research and training
program and EarthScope Institute*

Duration: 8/1/14-1/31/17

Total amount of award: \$350,417

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Motivation: Geochronologic data are vital for resolving the timing, duration, and rates of processes in nearly every Earth science field. The mounting demand for geochronologic data by a wide array of Earth scientists and the associated need for training in its acquisition and interpretation are not being met, owing to the cost of subcontracting geochronologic data, the limited support available for existing labs to maintain their facilities, and the lack of straightforward mechanisms to link single-PI labs with those in need of their services. For this reason, the National Academy of Science's 2012 NROES report recommended exploring new mechanisms for supporting the geochronology needs of a broad array of research efforts. This recommendation also more recently led to a 2015 NSF report focused on opportunities and challenges faced by U.S. geochronology (Harrison et al., 2015).

Overview: 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 offers support of up to \$10,000 (typical awards are ~\$8,500) for graduate students to collect and interpret geochronologic data that contribute to EarthScope science through visits to participating geochronology labs. Awards can be used to fund analytical costs, sample preparation, travel to the host geochronology lab, lodging, and other expenses. These funds allow the students to visit the lab for a week or more, participate in sample preparation and analysis, and learn fundamental aspects of the methods, techniques, and theory used in modern analytical facilities. Students can apply for funds to use whichever method is most appropriate for their proposed research project, including, but not limited to, U-Pb, $^{40}\text{Ar}/^{39}\text{Ar}$, Lu-Hf, Sm-Nd, Rb-Sr, U-series, fission-track, (U-Th)/He, ^{14}C , cosmogenic exposure, and luminescence dating.

Program Goals:

- Fostering of new relationships and interdisciplinary, innovative science collaborations between researchers and labs at different institutions.
- Generation of new opportunities for students to learn fundamentals of the techniques, theory, and interpretative 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.

Additional Information:

- Website: <http://earthscope.org/science/geochronology>
- 2016 EarthScope AGeS Program solicitation: http://www.earthscope.org/assets/uploads/misc/ES_AGeS_Solicitation_2016.pdf

Program Assessment

Eriksson Associates, a consulting company with expertise in evaluating the broader impacts of STEM proposals, has been conducting the formal evaluation process. Assessment includes project progress reports, as well as surveys of all funded students, advisors, and labs. A complete interim evaluation report is in Appendix 1. Appendix 2 outlines the assessment goals and metrics. Appendix 3 summarizes the survey results for the EarthScope Institute on “Geochronology and the Earth Sciences”. Appendix 4 includes all 2015 AGeS geochronology project survey results for funded students, their home institution project advisors, and the collaborating labs.

Achievements

EarthScope Institute on “Geochronology and the Earth Sciences”

The EarthScope Institute on “Geochronology and the Earth Sciences” was held on October 17-18, 2014 in Vancouver, British Columbia before the 2014 GSA National Meeting. The short course gathered 16 geochronology experts who introduced 43 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. Appendix 2 reports the participant pre- and post-short course survey results.

The audience consisted of 34 graduate students and 9 faculty who were interested in using geochronology in their research, but have little actual experience with the methods. The speakers included a mix of longstanding leaders in their fields and early- to mid-career scientists. This gathering of geochronology speakers with such a broad spectrum of expertise is unusual, which along with the perspectives and diverse backgrounds of the participants lead to insightful exchanges about how to promote successful interdisciplinary collaborations during the open discussion periods.

Some universal themes that emerged from the discussions 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.

Participating Geochronology Labs

Thirty-nine geochronology labs, covering a wide range of geochronology methods and including 70 senior scientists with geochronology expertise, are now participating in the program. The EarthScope website database (<http://www.earthscope.org/science/geochronology/participating-labs>) that provides a list of these labs interested in new collaborations is an important and unprecedented resource for Earth scientists keen to develop new relationships with geochronology facilities, even if they are not direct participants in the AGeS program. The posted lab plans provide critical information about sample preparation, realistic time frames for lab visits and data acquisition, analytical costs, and the education and training experiences provided for visitors. Any lab in the U.S. or its territories can participate in the program.

2015 and 2016 AGeS Proposals, Review Process, and Awards

The first AGeS proposal cycle with a March 2015 deadline saw 47 proposals submitted by graduate students from 32 different institutions to work in 25 different labs. In addition to a project description, all proposals required support letters from the collaborating geochronology lab and the home institution advisor, as well as a copy of the lab plan. An independent review panel composed of 4 geochronology experts who are otherwise not participating in the program (as labs or advisors or PIs on the project grant) reviewed and ranked the proposals. Ten projects were funded and announced in May 2015, ranging from \$5,273 to \$9,500. Nine of the student lab visits funded during the first proposal cycle are now complete. Interactions with the labs to evaluate, present, and interpret the significance of the data are still ongoing. Six student presentations (listed in Appendix 1) at GSA and AGU in Fall 2015 included new data funded by the EarthScope AGeS program.

Following the first proposal cycle, the criteria for ranking the AGeS proposals were revised based on feedback and discussions with last year's review panel, as well as students, home institution advisors, and lab PI's involved with proposals. All program refinements were guided by input from Eriksson Associates, who is conducting the program assessment and observed the entire review process. Specifically, the proposal guidelines were revised for clarity and to require explicit answers to some elements used in proposal ranking. The review panel was expanded from four to six members to better accommodate the larger than expected number of submitted proposals. New limits were placed on the number of awards to a single geochronology lab in a proposal cycle¹. Following the initial proposal ranking the review panel was asked to additionally evaluate the diversity of techniques, labs, and types of science in the top suite of proposals to ensure breadth in the funded proposal pool.

The 2016 AGeS Proposal Cycle received 40 proposal submissions from 33 institutions to work in 28 different labs by the March 16, 2017 proposal deadline. All proposals were reviewed by 2 panel members and ranked by their mean score. The top 20 proposals were then reviewed and ranked by all 6 reviewers, with 9 awards made.

¹ From <http://www.earthscope.org/science/geochronology>:

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.

Promotion and Community Input on the AGeS Program

We continue to promote the AGeS program and solicit input in a variety of ways. For example, we prepared an “Ideas” paper for the May 2016 “Future Directions in Tectonics” workshop in Madison, WI, that summarized the goals and motivations of the program. Throughout the meeting AGeS was repeatedly highlighted as a program that positively impacted the tectonics community, with a strong desire expressed to see it continued and potentially expanded. In addition, the AGeS program has been featured twice in the EarthScope *Insights* newsletter, in Winter 2015-16 and Spring 2014. The PIs gave an invited talk (Flowers et al., 2015a) primarily focused on the AGeS program at the 2015 AGU meeting, and a poster presentation at the 2015 EarthScope National meeting (Flowers et al., 2015b).

Lessons Learned

Looking forward we plan to further refine the AGeS program and its administration based on lessons learned from its two pilot years. First, the number of proposals submitted each year was greater than we had anticipated, and we budgeted insufficient funds for administrative assistance with gathering proposals, organizing the review panel, and distributing awards to the students and labs. We placed a high priority on separating the PIs with labs participating in the program from the independent review process, so much of the administrative burden fell to Arrowsmith as the only PI without a participating lab. In addition, overlap with the EarthScope National Office at ASU and its ample administrative support was limited to just the 2015 review activity. For the program to continue running efficiently in the future, and especially if it grows further, we will need to request additional funds for administrative support in the next full proposal submitted to NSF. In a similar vein, the proposal success rates in 2015 and 2016 were 21% and 23%, respectively. If the number of proposals submitted increases in the future, then the success rate could drop below 20% and deter participation in the program at its current annual support level.

We also recognize that geochronologic studies may require more than the year timeframe initially designated for the student projects owing to the time-intensive nature of proper sample collection, mineral separation, and careful data acquisition before the data interpretation stage is reached. This is especially true if the lab is to be engaged in the project design at the outset of the study so that optimal samples are collected, which was articulated by lab personnel at the EarthScope Institute as a key part of successful interdisciplinary collaborations. Placing undue pressure on the funded students to complete their projects from fieldwork to data interpretation within a year timeframe runs counter to that goal. This time constraint has been corroborated for the 2015 awards by the evaluation survey.

Summary and Looking Forward

The AGeS program has received an overwhelmingly positive response owing to its success in fostering the development of important new ties between the geochronology and broader Earth science communities. Eighty-seven proposals were submitted during the two funding cycles, each one of which involved new interactions between labs and students, with support letters from the labs required for all submitted proposals. The science associated with the 19 funded projects is either fully underway or about to commence. New research is proceeding even for some of the projects that were not funded, because the proposal writing process helped focus the proposed work, initiated new conversations between the student and lab, and generated joint

enthusiasm for the project. The pool of participating labs has grown to 39, with 70 geochronologists contributing their expertise. Six non-PI geochronology experts dedicated a substantial amount of time to reviewing and ranking every submitted proposal.

Activities remaining under the current grant include completion of the student awardee projects, convening of an AGU or GSA session in Fall 2017 featuring award recipients, continuing to work with our external evaluator (Susan Eriksson) to assess the effectiveness of the program, and submission of a short article to Eos or GSA Today on the program's accomplishments. We currently do not have funds that would allow us to support another year of AGeS projects. We would like to obtain sufficient funds by November of this year to advertise and hold a mid-March 2017 AGeS grant proposal cycle and continue the program's momentum. The next EarthScope science proposal program deadline is November 15, 2016, which is too late to obtain funds for our spring timeline. Depending on our response from NSF following submission of this progress report, our tentative plan is to submit a supplement request for funds to cover a 2017 proposal cycle, followed by a full NSF proposal at a later date to continue the program in subsequent years.

References

- Flowers, R.M., Arrowsmith, R., Metcalf, J.R., Rittenour, T., Schoene, B.S., Hole, J., Pavlis, T., Wagner, L., Whimyer, S., and Williams, M.L., 2015a, Geology, Geochronology, and EarthScope: The EarthScope AGeS program and a new idea for a 4D-Earth initiative: Fall AGU meeting, San Francisco, CA, December 2015 – Invited presentation in session entitled “Crustal structure and evolution across the continental US from 10 years of Earthscope investigations: What have we learned and what are the open questions?”
- Flowers, R.M., Arrowsmith, R., Metcalf, J.R., Schoene, B.S., and Rittenour, T., 2015b, The EarthScope AGeS program: A progress report: EarthScope National Meeting, Stowe, Vermont, June 2015.
- T. M. Harrison, S.L. Baldwin, M. Caffee, G. E. Gehrels, B. Schoene, D. L. Shuster, and B. S. Singer (2015) It's About Time: Opportunities and Challenges for U.S. Geochronology. Institute of Geophysics and Planetary Physics Publication 6539, University of California, Los Angeles, 56 pp.

Links to EarthScope *Insights* newsletter articles on the AGeS program

Winter 2015-16:

http://www.earthscope.org/assets/uploads/misc/EarthScope_inSights_Winter-2015-16.pdf

Insights Fall 2014:

http://www.earthscope.org/assets/uploads/pages/insights_fall_2014.pdf

Appendices

Appendix 1. EarthScope AGeS Program Assessment Interim Report by Eriksson Associates

Appendix 2. Assessment goals and metrics

Appendix 3. Survey results for the EarthScope Institute on “Geochronology and the Earth Sciences”.

Appendix 4. 2015 AGeS geochronology project survey results for funded students, their home institution project advisors, and the collaborating labs.