Collaborative Education and Research in Crustal Deformation Studies

Sally McGill, *Department of Geological Sciences, California State University, San Bernardino*
Robert deGroot, *Southern California Earthquake Center*
Rick Bennett, *Department of Geosciences, University of Arizona, Tucson*
Joshua Spinler, *Department of Geosciences, University of Arizona, Tucson*

Crustal deformation research offers many opportunities for undergraduate students, high school teachers and high school students to participate in the scientific research process. Collaborations that span multiple levels including research scientists, graduate students, faculty and undergraduate students at comprehensive universities, and high school teachers and their students can be productive and beneficial to all parties. Undergraduates and high school teachers and their students benefit by gaining valuable research experience, and they have the satisfaction of contributing significant new data to publishable scientific research. These participants grow in the confidence that they can become part of the research process and are more likely to pursue further study in the geosciences. Research scientists and graduate students benefit by gaining access to new data that is labor-intensive to collect, and they support undergraduate and high-school-teacher research by processing the GPS data into a form that can be used those parties. Research institutes also benefit from new applicants to graduate school who have prior research experience. Faculty who act as mentors to the high school teachers and undergraduate students further develop their own professional skills in addition to nurturing the development of their mentees. Participants at all levels benefit from a deeper understanding of the Earth and its processes, as does society in general.

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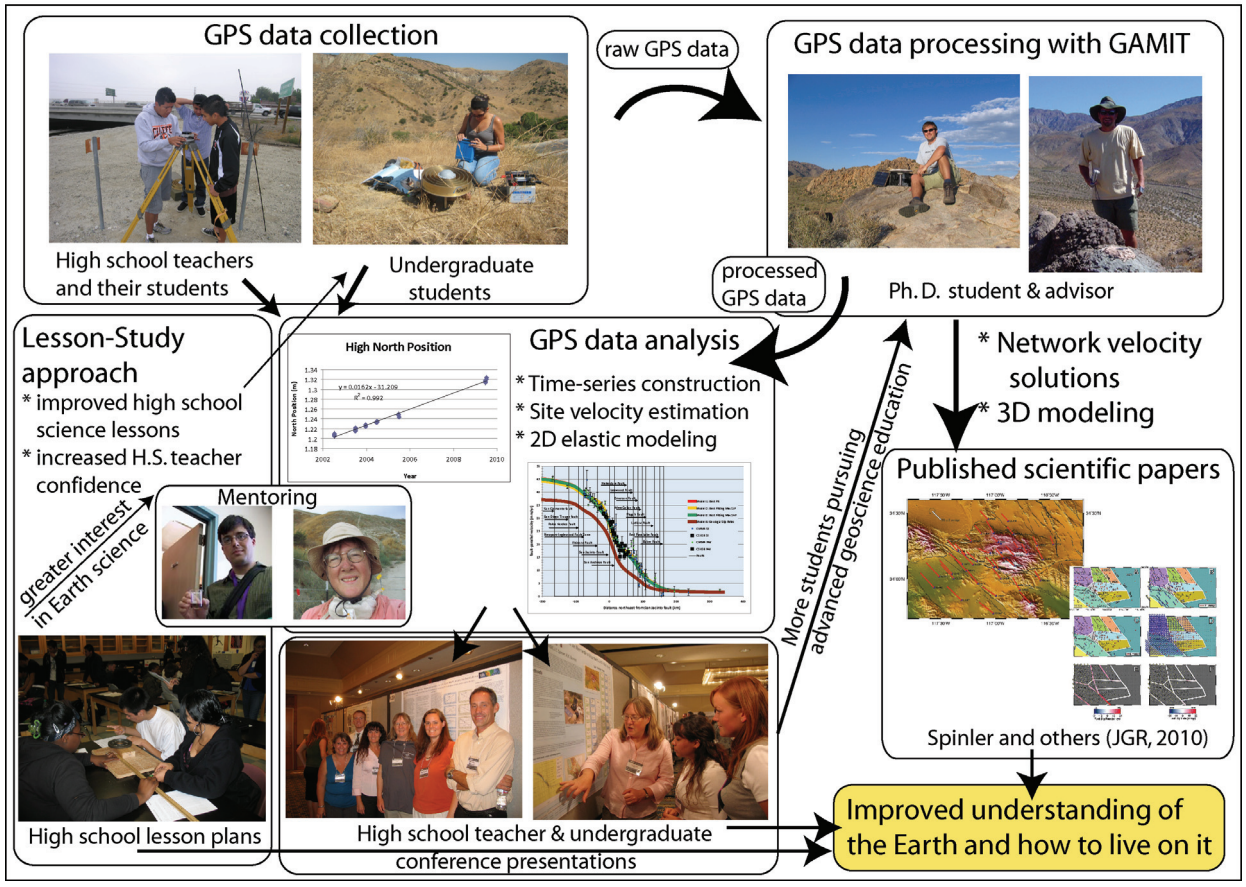

Earthscope funding is supporting campaign-style GPS data collection in the San Bernardino Mountains and vicinity, California from 2009-2011, building upon data collected previously (2002-2008) with other funding from the National Science Foundation and Southern California Earthquake Center. Each year, 7-10 high school teachers, 10-20 high school students and 8 undergraduate students participate in a 2-week long GPS workshop that includes training, data collection and data analysis and interpretation. Participants collect 5 days of campaign GPS data from 25 or more benchmarks in the San Bernardino Mountains and vicinity, where GPS data had previously been sparse. These data are important for understanding the partitioning of slip onto various faults that make up the transform plate boundary in southern California and for understanding differences between geologically and geodetically estimated fault slip rates. Previously published estimates of elastic strain accumulation across the San Bernardino strand of the San Andreas fault from geodetic data are at least two times smaller than slip rates estimated geologically over tens of thousands of years. The GPS data we are collecting will help to better constrain the models in this region.

Each year 5 of the 8 undergraduates who participated in the 2-week workshop used the GPS data they collected for undergraduate research projects that culminated either in conference presentations and/or oral presentations to faculty and students at their home institutions. These students constructed time series, estimated velocities for each site and conducted two-dimensional elastic modeling, systematically testing combinations of slip rates on 11-15 sub-parallel faults that make up the plate boundary. Of the five undergraduates who pursued undergraduate research projects during the first year of the project, one is continuing GPS-related research in a Ph.D. program and three others are currently applying to begin graduate studies in the 2011-12 academic year.

The high school teachers also continued their professional development beyond the two-week summer workshop. They presented their GPS time series and best-fitting models for fault slip rates at the annual meeting of the Southern California Earthquake Center, and each teacher displayed a copy of the research poster in their classrooms. The teachers also worked collaboratively in groups of 2-4 to develop a (or refine an existing) science lesson, related to earthquakes or to the scientific method and to test and improve the lesson using the Lesson Study approach (Stigler and Heibert, 2009). Lesson Study is a professional development process where teachers systematically examine their practice with the goal of becoming more effective. This examination centers on teachers working collaboratively on a small number of Research Lessons. "Lesson Study" is different from "lesson planning" because it focuses on what teachers want students to learn rather than on what teachers plan to teach. In Lesson Study, a group of teachers develops a lesson together and ultimately one of them teaches the lesson while the others observe the student learning. The entire group comes together to debrief after the lesson and often revises and re-teaches the lesson to incorporate what has been learned (Lewis, 2002). In their evaluations of the program, the participating teachers agreed that planning a lesson with other teachers produces a richer, better-designed lesson because everyone brings something to the process. They also felt that Lesson Study could develop leadership in teaching because of the increase in confidence, which encourages teachers to share what they have learned. In the final year of the project, we plan to recruit multiple teachers from each of a few schools, to make it easier to sustain over the long term the teacher communities that we help to develop.

Many other opportunities for collaboration between education and research probably exist within the interdisciplinary EarthScope community. The key is finding the synergisms, where each party has something to gain from the collaboration and something to contribute to it.

References

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Stigler, J. & Hiebert, J. (2009). *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom.* New York, NY: The Free Press.