

# A Multifaceted Outreach Model for Enhancing Diversity in the Geosciences in Buffalo, NY

Philip J. Stokes

Department of Mining and Geological Engineering, University of Arizona, Tucson, AZ 85721-0012

Gregory S. Baker

Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996, gbaker@tennessee.edu

Jason P. Briner

Department of Geology, University at Buffalo (SUNY), Buffalo, NY 14260, jbriner@buffalo.edu

Dara J. Dorsey

Earth Sciences and Science Education, Buffalo State College, Buffalo, NY, 14222 dorseydj@BuffaloState.edu

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## ABSTRACT

Startling national statistics continue to illuminate the need for increasing the number of underrepresented minority students graduating with degrees in the geosciences. With increasing minority populations in the U.S., diversity becomes a key issue for the sustained success of college geoscience departments. The under-funded Buffalo Public School system struggles to provide quality science education to underrepresented students, which leads to few minorities pursuing STEM (Science, Technology, Engineering and Math) degrees in local colleges and universities. The Buffalo Geosciences Program (BGP) was created to provide opportunities for these underrepresented groups to participate in geoscience activities in Western New York. Our current program model (through many modifications) has now resulted in success of this objective by offering science education and outreach programming to a broad variety of public institutions at the primary, secondary, and postsecondary grade levels. During these interactions, students are made aware of geoscience career options and encouraged to pursue internships through the BGP. The ultimate (and attained) goal has been to produce minority geoscience undergraduate majors in colleges and universities.

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## INTRODUCTION & MOTIVATION

Analysis of data from U.S. schools shows that the national student body encompasses larger percentages of minorities than ever before (Milner, 2005). Colleges and universities strive to improve student diversity for many reasons. Institutions with diverse campus populations expand the educational experience for students, reinforce a sense of community, and foster individual student growth. Across campuses nationwide, minority groups as a whole have higher attendance and a stronger presence than in the past. However, student diversity is a continued weakness in the STEM (Science, Technology, Engineering and Math) fields.

In New York, there exists a statewide achievement gap in overall student performance. According to Deck-Miller, 2005, African American and Hispanic high school graduates in New York State are 4 years behind their white peers in math and reading abilities. Compared to white students, far fewer minority students graduate from high school on time in New York State (Table 1). The New York State earth science curriculum is particularly challenging for high school students. Statewide classroom topics include earth history,

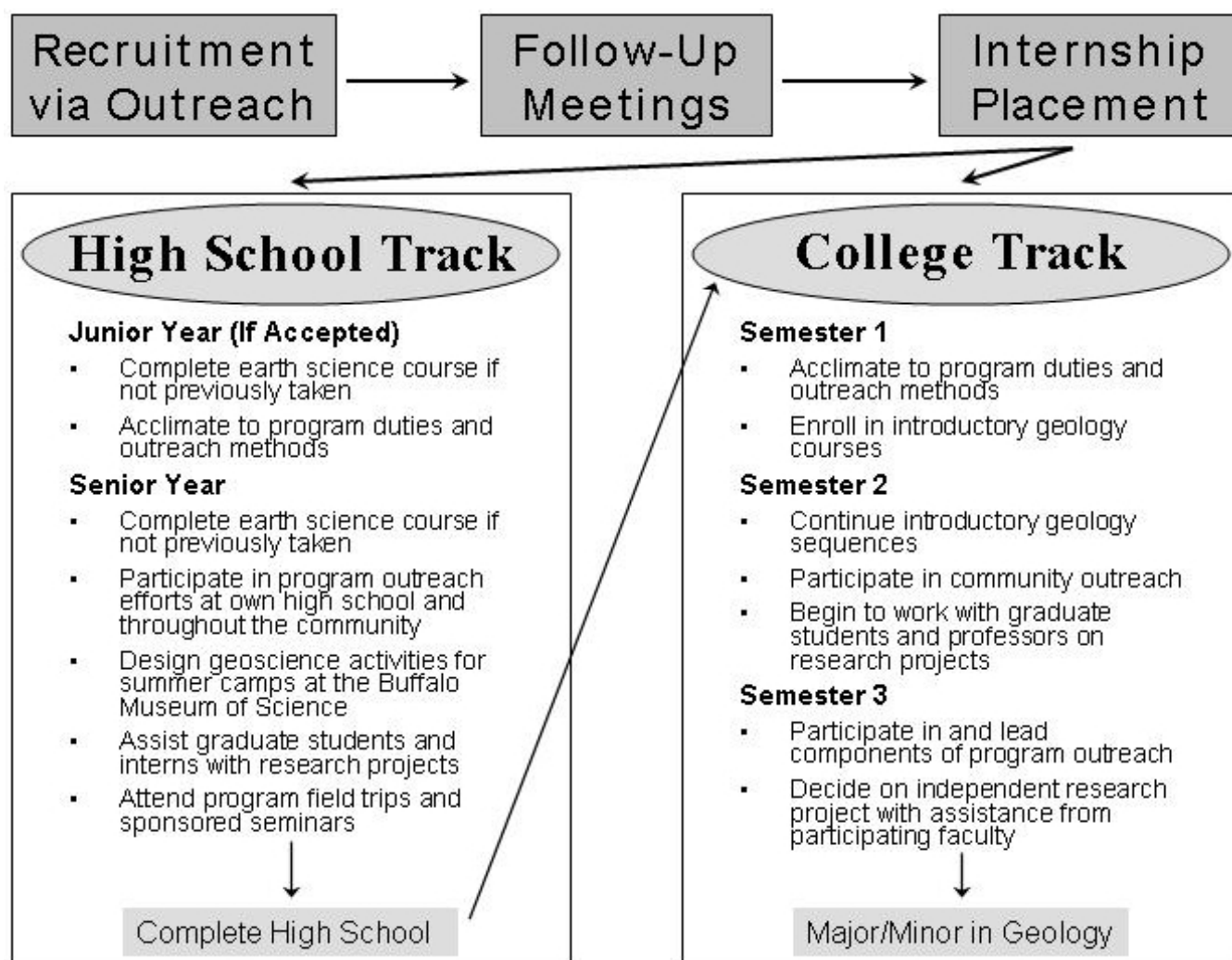
geologic mapping, rocks and minerals, surface processes, earthquakes, plate tectonics, meteorology and climate, and astronomy. To graduate in New York State, all high school students are required to pass the Earth Science Regents exam with a minimum score of 65 on a 100-point scale (NYSED, 2005b). In the Buffalo Public Schools, the passing rate is 57% for the Physical Setting/Physics exam, 51% for the Living Environment (Biology) exam, 41% for the Physical Setting/Chemistry exam, and 31% for the Physical Setting/Earth Science exam (NYSED, 2006). This implosion seems to deter Buffalo Public School students from attending science classes and pursuing STEM degrees at local colleges and universities.

Nationally, few Bachelor's Earth Science degrees are awarded to minority students. Out of a total of 23,084 degrees awarded between 1996 and 2001, only 1,273 (5.5%) were awarded to minorities (NSF, 2004). The disparity resonates in Western New York, where minorities make up 74% of the current enrollment of 37,000 Buffalo Public School students (NYSED, 2005c; Buffalo Public Schools, 2005;), and yet only 16% of the total number of all Bachelor's degrees in Buffalo-area colleges and universities are awarded to minority students (BSC, 2003 and SUNY-AB, 2005a). Only about 2% of Bachelor's degrees in the geosciences are awarded to minority students at local colleges and universities (BSC, 2004 and SUNY-AB, 2005b).

Education experts agree that outreach is an effective strategy for increasing public involvement and interest in the geosciences (e.g., Andrews, et al., 2005; Kean, et al., 2005; Rosendhal, et al., 2004; and Stokes, et al., 2005). This outreach can be geared towards regional environmental themes (e.g., Abolins, 2005) for greater success in an urban setting. The Buffalo Geosciences Program (BGP) has developed a strong outreach presence in Western New York, with a focus on the Buffalo Public School system. Bower (2002) identified the importance of scientific outreach as a method to change the cognitive way that participating groups view the Earth sciences.

The BGP was instituted in 2001 through a grant from the National Science Foundation, the Opportunities for Enhancing Diversity in the Geosciences (NSF-OEDG) program. The specific NSF directorate emphasizes efforts to increase the opportunities for underrepresented groups to:

- Participate in informal geoscience education programs
- Become involved in formal pre-college geoscience education programs
- Pursue bachelor, master, and doctoral degrees in the geosciences
- Enter geoscience careers



**Figure 1. Flow chart showing the path followed by most student interns. BGP internships begin with recruitment at outreach presentations and continue through high school and college. Eventual progress leads many student interns to declare a major or minor in geoscience at their respective colleges.**

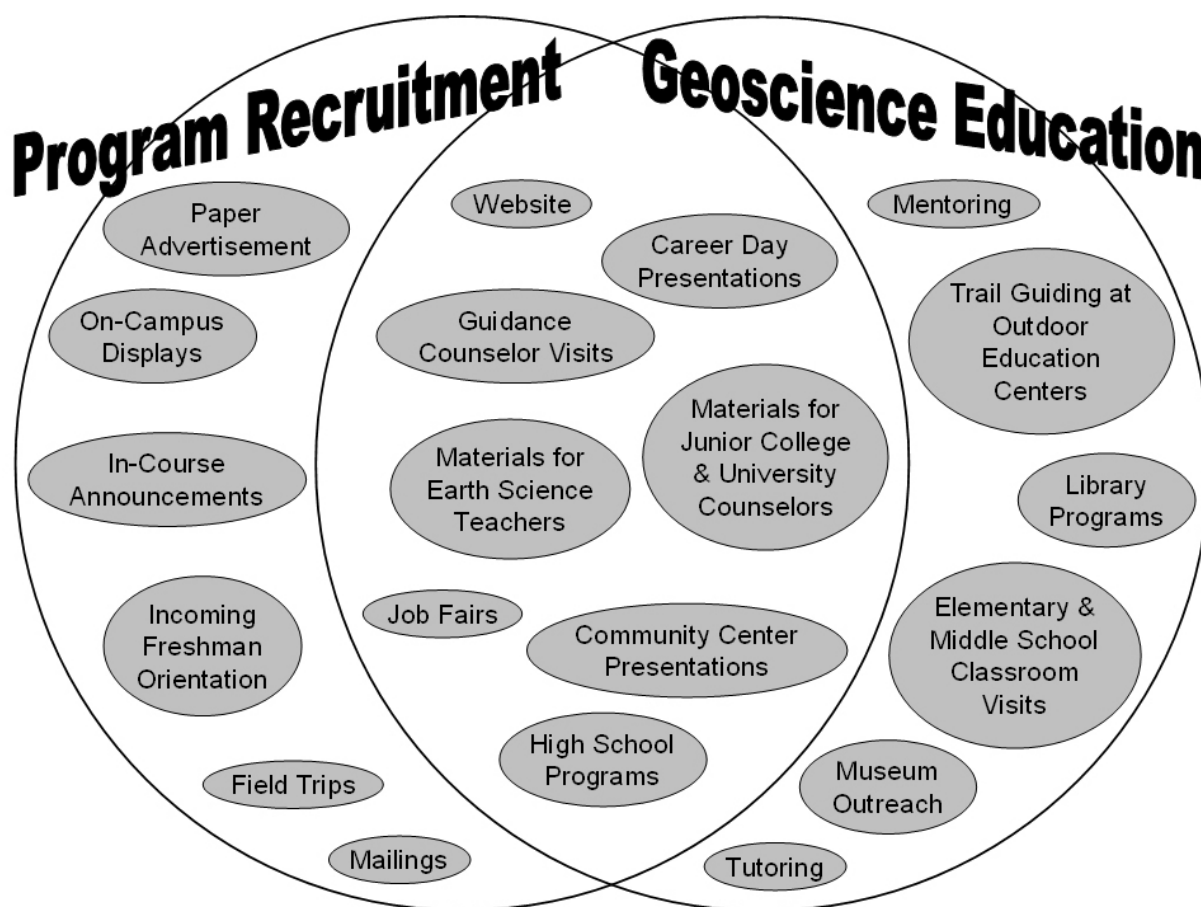
Group	Percent
Asian	68.8%
African-American	45.4%
Latino	42.0%
White	81.0%
English as a Second Language	34.5%
Students with Disabilities	59.7%

**Table 1. Percentage of 9th graders from the freshman class of 2000 graduating with a New York State Regents or local diploma (NYSED, 2005a).**

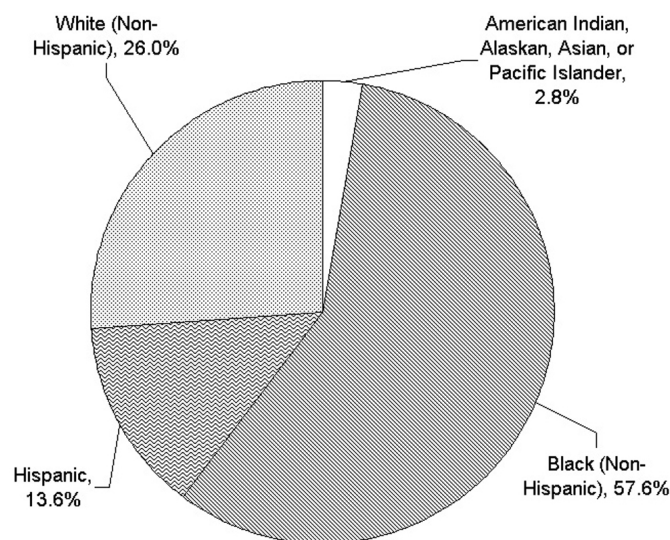
The BGP is founded on collaboration between three academic institutions in Western New York: The State University of New York at Buffalo (UB), Buffalo State College (Buff State), and the City Campus of Erie Community College (ECC-City). The objective of the consortium is to attract and retain underrepresented minority student groups into their respective geoscience departments and to promote the geosciences to diverse public audiences. Students from local high schools,

ECC-City, Buff State, and UB receive outreach programming and are recruited at their own institutions. Students in local middle and elementary schools also receive outreach presentations to supplement the long-term impact of increasing awareness of the geosciences. Rather than influencing underrepresented students to consider majoring in the geosciences, recruitment commences by encouraging students to enroll in introductory geology courses within the consortium. Once students are enrolled, they become eligible for paid internships, seminars, and other "perks" exclusive to the BGP. These perks include student desk space in research labs, free tutoring, weekly seminars, research guidance from departmental faculty and staff, trips to national and regional conferences (frequently Geological Society of America), and Dell laptop computers that can be borrowed from the program. Many students continue taking additional geology courses and eventually major or minor in geoscience fields at Buff State or UB (Figure 1).

**BGP Components** - The Buffalo Geosciences Program has three main vehicles for achieving its objectives: outreach, education, and research (Figure 2).



**Figure 2. Buffalo Geosciences Program outreach as designed for purposes of program recruitment, geoscience education, or a combination of both.**



**Figure 3. K-12 race/ethnicity demographics of the Buffalo Public School System for the 2004-2005 school year. Total enrollment is 36,806 students. Data from NYSED, 2006.**

Community outreach has been an integral part of facilitating program growth and increasing underrepresented student enrollment in the consortium geoscience courses and departments. Geoscience education is often symbiotic with outreach activities, though the two are distinct in terms of application to target groups. Some community outreach presentations, such as those at ECC-City, focus mainly on career options and undergraduate student recruitment with only a minor geoscience education component. Others, such as presentations for primary grade students at Buffalo Public Schools, focus mainly on science education. Although geoscience careers are mentioned in primary grade presentations, the main goal of elementary school outreach is to generate student interest in learning more about the geosciences.

The third component, geoscience research, involves enlisting underrepresented minority students to assist university faculty and graduate students with scientific field and laboratory work. The BGP research component aims to promote a greater appreciation of the scientific method while encouraging underrepresented students to develop their own research ideas based on existing projects with the Geology Departments at UB and BSC. Often, BGP provides funds for student interns pursuing research topics in this manner. The goals of the research component include student recruitment into geoscience bachelor's programs as well as student participation at national conferences and workshops.



**Figure 4. Outreach participants at the Buffalo Museum of Science constructing thermometers for the "Weather: With A Little Latitude" presentation.**

Outreach and geoscience education activities take place at numerous locales in urban Buffalo and within the Western New York community. The Buffalo Public Schools (Figure 3) represent the ideal audience for BGP outreach efforts. Although some classrooms have posed disciplinary challenges to the presenters, most students are extremely enthusiastic towards visitors. Seldom do BGP presenters leave a classroom without the contact information of students interested in learning more about the geosciences. A number of high school outreach presentations result in new student internships each year.

Since its establishment in 2001, BGP personnel have participated in numerous outreach activities in the region, but only now (four years later) has the program developed a strong presence and is known as a point of contact for outreach and education in the region. We found that word-of-mouth proved to be more significant in promoting the program than other types of public relations (e.g., flyers, news articles, etc.). Anecdotal accounts from students in the program and self-assessment reveal that there is often a certain amount of time needed to establish recognition via word-of-mouth. At present, the BGP is routinely contacted by members of the educational community (teachers, science museum staff, etc.) and requests are made for the development of outreach programming to suit the educational nature of the institution/facility.

All outreach programs are now developed by underrepresented minority students working as paid interns (both undergraduate and high school students) for the BGP. The interns' goals are to communicate with local outreach facility staff, research specific topics of interest, create lesson plans, and present the material



**Figure 5. BGP offers hands-on fossil activities and visual displays at Penn Dixie's annual Earth Science Day event.**

directly to public audiences. The more senior interns generally spend the most time researching ideas and creating lesson plans, while the less senior interns provide ideas and feedback while assisting with others' presentations.

#### **Current BGP Outreach Initiatives Include -**

- Buffalo and Erie County Public Libraries: BGP interns develop and host geologic mapping and paleontology activities in connection with the showing of William Smith's Geologic Map of England at the central branch library. Outreach presentations are common at libraries throughout the community, especially on such themes as fossils, paleontology, and climate change. Typical audiences include parents and primary grade children.
- The Buffalo Museum of Science: Interns present a rotating series of geoscience-themed topics in 1-hour presentations to visiting audiences on weekends (Figure 4). Presentations focus on current issues in geoscience including earthquakes & tsunamis, volcanoes (and related disasters), space exploration, climate change, and atmospheric science (weather). Audiences are usually comprised of parents with elementary and middle school children from the Buffalo Public Schools.
- ECC-City Campus: BGP interns work with college faculty to make students aware of hazard mitigation careers and to recruit urban students into introductory geology courses. Outreach consists of display tables at student gatherings (career fairs, open houses, etc.) and presentations to incoming college freshmen.
- Buffalo Public High Schools (grades 9-12): Visits are made to local high schools to discuss important geoscience topics, promote careers in the geosciences,

Group	2001	2002	2003	2004	2005
Elementary school students	0	0	0	0	1080
Elementary school teachers	0	0	0	0	115
Middle school students	0	0	0	15	200
Middle school teachers	0	0	0	3	3
Middle school guidance counselors	0	0	0	5	4
High school students	0	120	1500	1450	850
High school teachers	0	4	15	37	12
High school guidance counselors	0	6	20	20	8
Junior college students	12	28	50	300	1500
Junior college faculty	1	2	15	4	10
College or university undergraduate students	180	200	250	5000	3200
College or university faculty	2	2	3	21	8
Other adults	0	0	0	0	88
<b>Total Participants</b>	<b>195</b>	<b>362</b>	<b>1853</b>	<b>6990</b>	<b>7078</b>

**Table 2. Total number of participants in Buffalo Geosciences Program outreach efforts from 2001-2005.**

and recruit potential students into the program. The most frequently requested topics by teachers are climate change, environmental waste cleanup, and paleontology. Most audiences consist of 9th and 10th grade students and include students with special needs.

- Other Buffalo Public Schools (grades 2-8): Interns give hands-on inquiry-based science presentations to elementary and middle school students (Figure 5). Outreach at this level includes references to geoscience careers, but is more focused on encouraging participants to appreciate the scientific method and raise awareness of current issues in science.
- Penn Dixie Outdoor Education Center: BGP interns serve as summer trail guides to help visitors dig for and identify fossils, identify species, and interpret geologic history. Interns also give outreach and careers presentations to school groups from the Buffalo Public Schools and participating schools from the surrounding suburbs.
- Mentoring of Science Students: Interns work with students from the Buffalo Public Schools at local community centers to explore various topics in the geosciences. The mentored students range in age from early elementary to early middle school. Topics vary widely as well, and can include math, chemistry, physics, and biology, as they become incorporated into the inquiry-based learning process.
- Geologic Field Trips: With direction from BGP faculty and staff, students from ECC-City Campus, BSC, UB, and select local high schools attend field trips to interesting and exciting geologic sites. BGP covers all field trip costs, as many student participants would not have the means to attend otherwise.

Occasionally, an outreach location will require additional training of its staff for challenging geoscience concepts, and for this purpose BGP interns have designed a series of short lesson plans related to previously presented outreach efforts. These lesson

plans strictly follow New York State science standards and include required materials lists and background information necessary to facilitate the particular geoscience activity. Lesson plans are formatted so that future educators can select from numerous activities to spur scientific inquiry among their students (e.g. Williams et al., 2004).

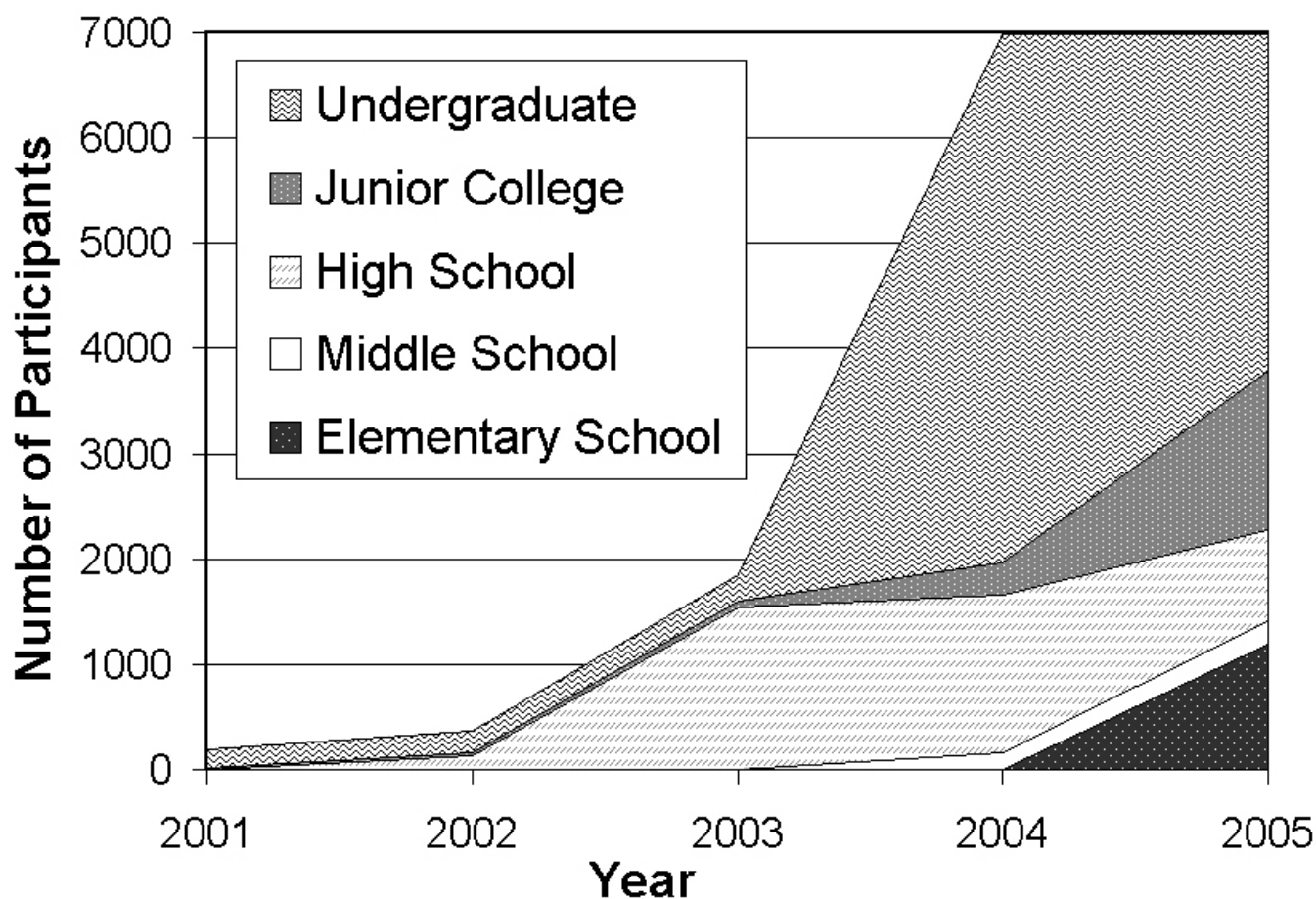
Each component of outreach is adapted for both a specific audience participants and with a unique purpose for implementing BGP goals (Figure 2). For example, outreach created for high school students is aimed at encouraging students to consider majoring in geoscience fields and for intern recruitment into the program. Conversely, outreach programs designed for elementary and middle school audiences have no impact on immediate college enrollment patterns, but will be a useful primer for stimulating younger students to think about the geosciences when they reach the secondary and postsecondary levels of their education.

Outreach presentations generally include two modules: a primary interest-building activity, and a secondary careers promotion. In the primary module, the audience is engaged in a lecture and discussion about geoscience topics relating to current events. While topics are predetermined, the audience usually sets the tone and pace of the presentations. An active dialogue between presenter and audience participants is the most effective way to get students interested in the geosciences. In the secondary module, the audience receives information about careers in the geosciences and majoring in geology or earth science education at local colleges and universities. Both modules include references to current research investigations (at UB and Buff State) and demonstrations involving student use of real geologic equipment.

## ASSESSMENTS

Preliminary introspection of BGP outreach efforts has revealed promising results, both qualitative and quantitative. An "outreach participant" is defined as anyone who has attended a BGP presentation or participated in BGP-sponsored community programming, with at least one hour of contact time





**Figure 6. BGP volunteer Elizabeth Thomas watches an elementary school outreach participant “Making an Earthquake” with UB geophysical research equipment.**

**BUFFALO GEOSCIENCES PROGRAM**

*“Promoting diversity in the Geosciences by providing unique opportunities to underrepresented students”*

**Pre-Presentation Survey**

1. I have a good understanding of how scientists do research.
2. I consider myself to be well skilled in conducting scientific research.
3. I've wanted to be a scientist for as long as I can remember.
4. I have a good understanding of beginner level earth science.
5. I'm uncertain about what course of study is needed to become an earth scientist.
6. I am considering majoring in the earth sciences.
7. I'd enjoy a career in the earth sciences.
8. I'm NOT certain I could ever become an earth scientist, even if I tried.
9. I think I could handle the coursework required to become an earth scientist.
10. I don't know much about possible careers in the earth sciences.
11. I plan on taking math courses that would prepare me to major in a science.
12. I have a good idea of what archaeologists study.
13. I have a good idea of what geologists study.
14. I have a good idea of what geographers study.
15. I have a good idea of what geoscience is.
16. My family would be supportive if I decided to become a scientist.
17. I would enjoy going hiking or camping.
18. I enjoy hands on scientific activities.
19. I enjoy reading nature and travel books and magazines.
20. There are not as many female scientists as there are male scientists.
21. Most scientists are white males.

**Figure 7. (Left) Director Jason Briner points out features at Glacial Grooves State Park in Ohio as part of a two-day trip for BGP interns and potentially new student recruits.**

from BGP staff and interns (i.e. those only receiving brochures or short discussions are not included). From 2001 to 2004, the number of outreach participants increased from a few hundred to approximately 7,000 participants annually (Table 2). The total number of outreach participants in 2005 remained the same as in 2004, but the target audience was diversified to include a larger component of elementary and middle school groups (Figure 6). The broadening of outreach was designed to extend exposure of the community to the BGP and provide a vehicle for student interns in the program who have aspirations for teaching in public school classrooms. Also during the two-year period, outreach efforts were expanded to include more teachers, counselors, and educators in presentations and in the distribution of geoscience-themed literature.

Frequently, Buffalo Public School teachers invite the BGP to conduct outreach in their science classrooms as a way to expand their science curriculum. The BGP presentations consistently receive high praise from school faculty and administration. Actual comments from presentations show that students have a "new view of sciences," "improved interest in geoscience," and "increased interest in becoming a geoscientist because [we] changed [their] mind." The BGP has a healthy

Survey Question	Before % Yes	Before % No	Percent Change
Q06	14.9	23.0	8.0
Q10	49.4	39.3	-10.1
Q15	29.9	80.3	50.4
	n = 87	n = 61	

**Table 3. Before and after results of questions from an outreach survey given to 10th grade Earth Science students at the Charter School for Applied Technologies in Buffalo, NY. Included questions are 6 - I am considering majoring in the Earth Sciences, 10 - I don't know much about possible careers in the Earth Sciences, and 15 - I have a good idea of what Geoscience is.**

working relationship with many local schools. Frequently, BGP personnel are invited back as guest speakers to the same classroom in the same semester or on an annual basis.

Self-assessment indicates that outreach is successful in making high school students aware of the geosciences and increasing their interest in geoscience careers. Outreach participants are queried separately before and after presentations (Figure 7). Post-presentation surveys are identical to pre-presentation surveys with the addition of four questions to gauge the quality of the presentation. Results typically show that awareness of geoscience issues, interest in geoscience issues, and interest in majoring in geoscience all increase significantly, while negative stereotypes about gender and race limitations in science tend to decrease. For example, participants in an hour-long presentation at the Charter School for Applied Technologies showed increased interest in majoring in geoscience (+8.0%), improved awareness of geoscience careers (+10.1%), and greater knowledge of geoscience issues (+50.4%). See Table 3 for additional details.

The realization of our successful outreach component has been an increase in the enrollment of underrepresented minority students into geoscience degree programs at UB and Buff State. As of fall 2005, four underrepresented minority students are enrolled with the Geology Department of UB, and fourteen underrepresented minority students are enrolled with the Department of Earth Science and Science Education at Buff State. Prior to 2001, there were no recorded minority students enrolled in the Department of Geology at UB, and only six underrepresented student majors in the department at Buff State. Although the total numbers are relatively small, this 300% increase over a period of five years is a significant success, and every person counts.

## CONCLUSIONS

The BGP fulfills the specific and conceptually challenging objectives established by the National Science Foundation to increase underrepresented minority student participation in the geosciences. Over the past five years, the BGP has reached a diverse group of students in the primary and secondary levels of the Buffalo Public Schools. Outreach to students at local colleges and universities is increasing the number of minority students enrolled in their departments, while outreach to young local audiences is increasing general student interest in the geosciences. Key elements of the

BGP outreach include both the broadness of the audiences served and also the number of participants reached per year. Having underrepresented minority students give presentations to Buffalo Public School audiences has increased the effectiveness of BGP outreach efforts. The number of underrepresented minority students enrolled in UB and Buff State departments is at an all-time high, and is expected to increase as long as outreach continues to successfully reach high school, junior college, and undergraduate audiences. In the near future we can expect to herald the graduation of these students from their respective Bachelor's programs and into geoscience careers.

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