



On

the Cutting Edge

Professional Development for Geoscience Faculty



**Evolving Themes,
Enduring Impact**

Leading the Way

Participants in the programs offered by *On the Cutting Edge* are doing more than keeping pace with developments in geoscience education. They are taking the lead.



Founded by a grant from the National Science Foundation Division of Undergraduate Education and sponsored by the National Association of Geoscience Teachers, *On the Cutting Edge* set out in 2002 to improve the quality of professional development opportunities for geoscience faculty in the U.S. Within four years, a third of the nation's 8,000 geoscience faculty were aware of its services, approximately one-fourth had used its resource-rich website, and over 800 faculty, post docs, and graduate students had attended one or more of the 23 workshops the program organized.

On the Cutting Edge helps current and future college and university educators:

- Stay up-to-the-minute with geoscience research and pedagogical methods
- Put cutting edge information to effective use in their classrooms, laboratories, and fieldwork
- Network with colleagues in the geosciences and related disciplines
- Better prepare for and manage their academic careers and become leaders in the geoscience community

CONNECTING PEOPLE, IDEAS

On the Cutting Edge works to improve geoscience education by offering **workshops that keep faculty up to date** with emerging and important aspects

of both their rapidly evolving discipline and geoscience pedagogy, providing **online services** that vigorously support the collection and circulation of workshop ideas and the continuing development of workshop themes and resources, and **fostering an active cohort of leaders** to disseminate cutting edge content and model exemplary practices in instruction and course design.

Each year *On the Cutting Edge* offers integrated, synergistic workshops that explore:

- Emerging themes in pedagogy and content
- Techniques for teaching upper division courses in the discipline
- Course design
- Preparing for an academic career
- Teaching, research, and career management for early career faculty

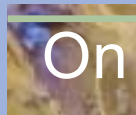
Organizers draw upon the perspectives of leaders in geoscience education and suggestions from members of the geoscience community in choosing topics, which have ranged from “Geology and Human Health” to “Design Principles for Creating Effective Web-based Learning Resources.”

Workshop participants have come from all 50 states, more than 400 different institutions (two-year colleges, four-year colleges and universities, and institutions granting advanced degrees), and different career stages. Women and racial/ethnic minorities have attended *On the Cutting Edge* workshops at rates (45% and 6%, respectively) that are considerably higher than their proportions in the field of geoscience education, where 15% are women and 2% are racial/ethnic minorities.

On the Cutting Edge also offers online tutorials and workshops at professional meetings that reduce costs and travel obligations for faculty while expanding the audience for emerging topics.

SPREADING THE WORD

Cutting edge information is just a click away from geoscience educators, thanks to the *On the Cutting Edge* website. In 2005, the site received



On the Cutting Edge

visits from more than 250,000 different IP addresses. Research suggests that there are at least 6,000 intensive users of the site annually, of which approximately 2,000 are geoscience faculty in the U.S. Intensive users visit the site six or more times in a single year.

The website provides support for workshops and follow-on activities. It also provides the means to disseminate workshop content widely and effectively. Its growing collection of resources for teaching undergraduate geoscience includes:

- Instructional materials and activities
- Datasets, interfaces, and tools
- Pedagogical resources
- Course development and management resources
- Assessment instruments
- Primary sources and bibliographies
- Visualizations of earth processes

REMARKABLE RESULTS AND REACH

At the end of each *On the Cutting Edge* workshop, participants are asked to rank their overall satisfaction on a scale from 1 to 10. The average result has been 9.0, “highly satisfied.” Significantly, almost 10% have participated in a second workshop.

Participants identify three major benefits of the workshops they have attended: acquiring new content that can be easily used in their teaching, networking with other participants, and the chance to “get away from the office” and focus on the scholarship of teaching and learning.

On the Cutting Edge assessments indicate that satisfaction and benefit often accrue to more than workshop participants. More than 60% of those responding to phone interviews said the workshop they attended had a positive impact on their students, and 28% described specific department-wide results from their participation.

Finally, the website gives the program incredible reach, offering geoscience educators around the world new ideas for courses and resources that specifically support teaching and scholarly activity.

EVOLVING THEMES, ENDURING IMPACT

Emerging Topics	4
Teaching the Core	6
Course Design	8
Career Management	10

FOR MORE INFORMATION, CONTACT

Heather Macdonald, *rhmacd@wm.edu*,
College of William and Mary

Cathryn Manduca, *cmanduca@carleton.edu*,
Carleton College

David Mogk, *mogk@montana.edu*,
Montana State University, Bozeman

Barbara Tewksbury, *btewksbu@hamilton.edu*,
Hamilton College

CREDITS

On the Cover, Main Image: The Manicouagan Impact Structure in Quebec, Canada. Lake Manicouagan and Lake Mushalagan surround the central uplift of the crater, dated at 214 million years. The original diameter of the crater was 100 kilometers. Glacial advances have scoured the crater to its present form. (From the USGS Landsat 7 Project)

This material is based upon work supported by the National Science Foundation (NSF) Division of Undergraduate Education under Grants No. 0127310, 0127141, 0127257, and 0127018. Opinions, findings and conclusions or recommendations expressed herein are those of the authors and do not necessarily reflect the views of the NSF. *On the Cutting Edge* is sponsored by the National Association of Geoscience Teachers (NAGT) and is part of the Digital Library for Earth System Education (DLESE).

Emerging Themes

Geoscience education is in the midst of phenomenal change: Our rapidly evolving understanding of the Earth system is altering what we teach, research on learning is providing new guidance for how we teach, and information technology is developing exciting new ways of teaching and doing research.

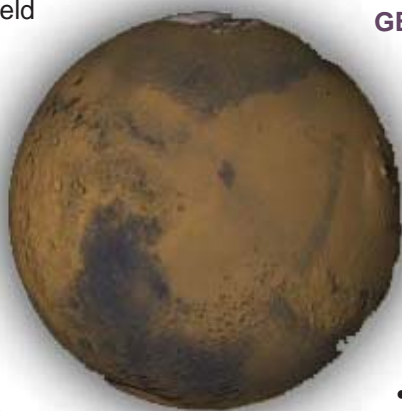
The emerging themes workshops of *On the Cutting Edge* put these topics on the fast track — moving them from areas of isolated early activity by leaders in the field to widespread implementation in undergraduate geoscience courses. Multi-day workshops bring together educators from a variety of institutions from around the country. They serve both as discrete learning opportunities and as catalysts for ongoing synergistic action. They are the starting point of a multi-year trajectory of work on these themes.

WORKSHOP GOALS

On the Cutting Edge offers two emerging themes workshops each year, one on a new geoscience research topic and one that brings a new aspect of pedagogy into the curriculum. All of them:

- Encourage participants to **share and develop their expertise** on the subject.
- **Document the state of the art** by answering questions such as these: What is happening at the forefront of this topic? What are the best examples of effective practice in geoscience education?
- **Develop a vision for forward progress** that considers the barriers, missing pieces, opportunities, and actions needed to make broad adoption possible, including identifying priority issues and needs.

- **Develop an action plan.** This often includes directed outreach to other groups, such as organizing a one-day follow-on workshop at a professional meeting and/or topical sessions at geoscience conferences.
- **Produce products supporting wider implementation** that can be disseminated on the *On the Cutting Edge* website, including examples of how content is currently taught,



GEOSCIENCE AREAS, NEW AND CLASSIC, FEATURED AT ON THE CUTTING EDGE

- **Biocomplexity**
- **Geology and Human Health**
- **Geochemistry**
- **Hydrogeology**
- **Mineralogy**
- **Ocean Systems**
- **Petrology**
- **Rates and Time**
- **Structural Geology**

tutorials, workshops, or short courses on the topic, reference lists, journal articles or topical volumes, goals and syllabi collections, teaching resources and online classroom materials.

On the Cutting Edge seeks out a diverse group of participants balanced by gender, geography, institutional type, academic position and experience, and disciplinary interest. In reviewing applications, workshop conveners also consider attributes such as the breadth, type, or level of their expertise and their willingness to participate in follow-on activities.

CUTTING EDGE RESULTS

Bringing together people with diverse expertise and diverse points of view to address critical issues in geoscience has produced incredible results. Emerging themes workshops have fostered exciting, ongoing interdisciplinary collabora-

On the Cutting Edge

tions between faculty from geoscience, cognitive science, other sciences, and education.

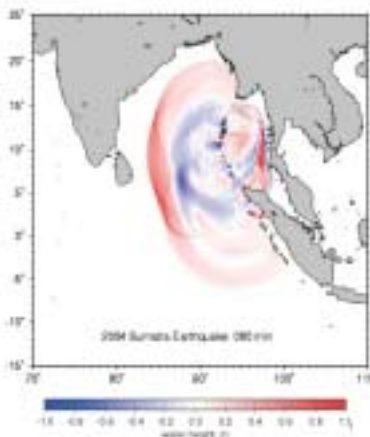
Another major contribution of emerging themes programming at *On the Cutting Edge* is the impetus it has given to the development and use of online resources such as collections of visualizations. Visualizing the Earth, its processes, and its evolution through time is a fundamental aspect of geoscience, and the site offers not only collections of visualizations on geoscience topics but tips on how to pick good visualizations and how to use them in class. In 2005, the site's visualization collections received visits from more than 200,000 different IP addresses. Whether the subject is paleo-climate or tsunamis, hurricanes, and other newsworthy topics, geoscience faculty are learning that their first stop for accurate and involving information and animations should be serc.carleton.edu/NAGTWorkshops/.

Page Four: Mars, adapted from an animation of the Scientific Visualization Studio at the Goddard Space Flight Center. **Below:** Within days of the Southeast Asia tsunami, *On the Cutting Edge* created an online collection of links to related resources, including (left) a segment of an animation created by the Active Fault Research Center, in Tsukuba, Japan, and (right) before and after IKONOS satellite photos from spaceimaging.com.

EMERGING THEMES WORKSHOPS

- **Discoveries from Mars: Using a Planetary Perspective to Enhance Undergraduate Geoscience Courses**, Arizona State University, Tempe, AZ
- **Teaching Public Policy in the Earth Sciences**, American Geophysical Union, Washington, DC
- **Teaching About the Ocean System Using New Research Techniques: Data, Models and Visualization**, University of Washington, Seattle, WA
- **Geology and Human Health**, Montana State University, Bozeman, MT
- **Teaching Geoscience with Visualizations: Using Images, Animations and Models Effectively**, Carleton College, Northfield, MN
- **Teaching Biocomplexity in the Geosciences**, Montana State University, Bozeman, MT
- **Understanding What Our Geoscience Students Are Learning: Observing and Assessing**, Carleton College, Northfield, MN
- **Design Principles for Creating Effective Web-based Learning Resources in the Geosciences**, University of Michigan, Ann Arbor, MI

[For the current workshop schedule, visit: serc.carleton.edu/NAGTWorkshops/workshops.html]



Teaching the Core

One of the program's major successes has been its increasing ability to engage research scientists in thinking about the way they teach core courses. In upper-division "Teaching X" workshops like "Teaching Structural Geology in the 21st Century" and "Teaching Sedimentary Geology in the 21st Century," up to 70 participants share ideas and experiences that they can put to immediate use in their classrooms and field exercises.

Like all *On the Cutting Edge* workshops, these programs:

- Give participants time to interact
- Emphasize practical applications — how workshop topics can be applied in the classroom and in the field
- Give participants time to work on specific tasks that connect the topic to their teaching
- Make sure that participants leave the workshop with specific plans for future action

What do "Teaching X" participants take away from their workshop experiences? New, exciting, easily used content for their courses — and new and exciting professional contacts. Like those who participate in emerging themes workshops, "Teaching X" participants point to networking as one of the major benefits of attending a workshop.

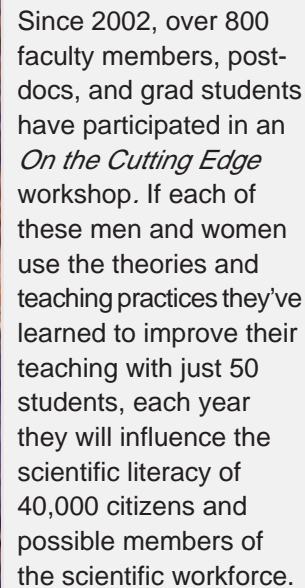
Using phrases like "eye opening" and "a seismic shift," they also report significant changes in their attitudes about teaching — from a focus on "what am I teaching" to "what are my students learning" — as well as an increased recognition of the importance and utility of using cognitive science and research on learning to guide their teaching. Faculty draw on vocabulary acquired during their workshops to communicate

effectively about teaching not only with colleagues on campus but also at meetings of professional societies. They also report an increased awareness of and/or motivation to publish teaching activities.

A WEB OF CONNECTIONS, CREATIVITY

The *On the Cutting Edge* website helps participants prepare for both emerging theme and "Teaching X" workshops. It also serves as a repository for the work they do there, making related material available to participants and to geoscience faculty, K-12 teachers, students at all levels, and others interested in geoscience topics. The ever-growing site contains more than 1,000 web pages, 40 topical collections, and 1,500 cataloged resources, including hundreds of community-contributed teaching activities.

The website also offers a number of practical, logistical aids — from pointers on field trip safety to a registry of analytical equipment designed to help researchers, instructors and students gain access to technology they need in their scholarly work.



Since 2002, over 800 faculty members, post-docs, and grad students have participated in an *On the Cutting Edge* workshop. If each of these men and women use the theories and teaching practices they've learned to improve their teaching with just 50 students, each year they will influence the scientific literacy of 40,000 citizens and possible members of the scientific workforce.



On the Cutting Edge



A SAMPLING OF WEB RESOURCES ABOUT HYDROGEOLOGY

Online Activities

- Geothermal Energy and Geysers
- Melting Glaciers, Gravels and Groundwater
- Mixing Oil and Water: Comparisons with Petroleum Migration
- Service Learning and Local Hydrogeology
- Soda Bottle Hydrology
- Using Data from the Arsenic Problem in Bangladesh
- Water and Mud: Linking Hydrogeology and Landscape Change
- Western Water Law Project

Workshop Working Groups

- Resources for Teaching Field Methods and Developing Long-Term Project Working Group
- Case Studies in Hydrogeology

“I really enjoyed being able to talk about teaching techniques, what material the ‘experts’ in that field teach to their students, and good examples to use in class and lab. ... I’ll be revising my course a little every time I teach it.” — Participant in Teaching Structural Geology workshop

“I have seen a dramatic improvement in my courses. Firstly, both the students and I enjoy the class significantly more. Secondly, I feel the students retain more information at the end of the semester.” — Participant in Teaching Structural Geology workshop

“I came into this conference knowing two or three people in hydro. I leave knowing many, many of whom are new friends and several of whom I plan to do some research with.” — Participant in Teaching Hydrogeology workshop

EVALUATING IMPACT

A comprehensive evaluation program helps *On the Cutting Edge* assess and better address the expectations and needs of workshop attendees. “Road checks” at the close of each workshop day facilitate mid-course corrections. Surveys at the end of each workshop identify areas of strength and weakness as well as immediate impacts attributable to the workshop. Follow-up online surveys and telephone interviews gather information about how different types of workshops impacted teaching practices and how participants disseminated what they’ve learned.

The results? More than 80% of those interviewed by phone pointed to the workshop they attended as the source of specific active learning techniques that they incorporated in their teaching.

Charting the Way: Course Design

A course design process for anyone who's ever said, "I really should do something about this class, but I don't even know where to start" — offered in a variety of helpful and effective formats ...

***On the Cutting Edge's* annual four-day, face-to-face course design workshop draws together 30 to 40 faculty members to work on designing or redesigning courses that will be taught during the following academic year. The same practical and intellectually interesting guidance is available in a four-day online virtual workshop and via a web-only tutorial created to help faculty who are working independently as well as faculty developers working with campus groups.**



An effective and innovative course should do more than provide students with a strong background of knowledge in a field. It should also:

- Enable students to use their strong backgrounds to solve problems
- Focus beyond the final exam to add to students' future lives, abilities, and skill sets and prepare students to think for themselves in the discipline after the course is over

On the Cutting Edge has helped hundreds of faculty members design courses that meet these

criteria. In a follow-up survey of workshop participants, 90% of respondents indicated that they had followed through to teach the rigorous, goals-based, innovative course that they first began to develop at the workshop. Furthermore, 80% of respondents said that they found the design process so useful that they followed it again when designing or redesigning another course.

The course design process can be transformational – both for the participant and for his or her department, college, or university. One attendee wrote, "Our department is very fortunate. Four of the six full-time faculty members in our department have taken this workshop. We are in the midst of major curriculum changes as a result." Another was so impressed by the online tutorial that he enlisted a cross-discipline team of faculty at his institution to take the course together.

While the workshop was originally designed for geoscience faculty, the tutorial provides examples from many disciplines, including those outside the sciences, and offers an easy-to-apply strategy for designing courses in any discipline. The website offers a complete description of how *On the Cutting Edge* runs course design workshops, including links to all the materials needed, a detailed schedule, and tips for adapting or adopting the workshop format.

ONLINE COURSE GOALS, SYLLABI SERVE AS SPRINGBOARDS TO FURTHER INNOVATION

The *On the Cutting Edge* website also serves as a springboard for continuing course innovation.

Using an online form, faculty can forward their course descriptions, teaching and learning goals, and syllabi to the website, where they can be shared with other geoscience educators. Courses that have been submitted include "Coastal Geology," "Environmental Geology," "Geochemistry," "Geology of the National Parks," "Global Warming: Fact or Fiction?," "Historical Geology," "Marine Sediments: Source, Sinks, and Significance,"

On the Cutting Edge



“Physical Geology,” and “Sedimentology and Stratigraphy.” Contributors include faculty from Bowling Green State University, DePauw University, Georgia Southern University, Illinois Valley Community College, Kutztown University, Mount Holyoke College, Oberlin College, Savannah State University, Sullivan County Community College, University of St. Thomas, Utica College, Western Washington, and Wittenberg University.

“I’ve designed this course using everything I learned at the workshop last summer, and I’ve thrown my comfortable, well-used teaching style and methods out the window. We’re now in week 5, and I’ve got to tell you, it is one awesome class!” — Participant, Course Design workshop

“ I re-designed the entire course and I feel that it was a great success. The course had become an on-going discussion about methods, content, philosophy of science, how to do research, all rolled up into one. It was exciting. The students were fired up. Their books had actually been USED. Binding cracked. Covers and pages dog-eared. It was great. The students were using terminology and asking questions I’d never heard from my prior courses....” — Participant, Course Design workshop

Course Design

http://serc.carleton.edu/NAGTWorkshops/coursedesign/index.html

On the Cutting Edge - Professional Development for Geoscience Faculty

Designing Effective and Innovative Courses

Topical Resources

Cutting Edge > Course Design

Search
Go

Cutting Edge

- Course Design
- Course Design Tutorial
- Faculty professional development
- Course Goals/Syllabus Database
- Course Submission Form
- Workshop 06
- Workshop 05

Biocomplexity
Career Prep
Climate Change
Early Career
Field Experiences
Geochemistry
Geology and Human Health
Mineralogy

Designing Effective and Innovative Courses



Have you ever said to yourself, “I really should do something about this course, but...”? This web site is designed to provide practical and effective help for faculty members interested in designing or redesigning a course.

Related Links

- [Starting Points: Designing an Earth System Course](#)
- [Starting Points: Using an Earth History Approach](#)
- [Observing and Assessing Student Learning](#)

Are you interested in having us offer a course design workshop at your institution? If so, please contact Barbara Tewksbury at btewksbu@hamilton.edu.

NEW!! Try Our Online Course Design Tutorial

This [tutorial](#) was developed as a web-only version of the popular On the Cutting Edge workshop on effective and innovative course design. While the workshop was originally designed for geoscience faculty, the tutorial provides examples from many disciplines, including those outside the sciences, and offers an easy-to-apply strategy for designing courses in any discipline.

Career Preparation and Management

One of the explicit goals of *On the Cutting Edge* is to foster the next generation of geoscience educators and develop the leadership needed to ensure the overall health and vitality of geoscience education. Exciting and intense



workshops filled with practical advice and information and sessions at professional society meetings are igniting/reigniting the interest of

graduate students and faculty in teaching and student learning and helping them manage their academic careers. Workshops are also the means by which *On the Cutting Edge* is identifying future leaders and developing a network of people who are willing and able to offer workshops, develop web resources, and take the lead in creating future professional development opportunities in geoscience.

PREPARING FOR AN ACADEMIC CAREER

Offered each year to more than 50 participants, this two-to-three-day workshop is designed specifically for graduate students and post-doctoral fellows who are interested in pursuing academic careers. Faculty and administrators advise participants on ways to become more effective teachers and stronger candidates for academic positions and be more likely to succeed in academic jobs. Workshop highlights include a panel of faculty from a wide range of institutional types talking about their jobs and a panel focused on the academic job search. Each participant takes home ideas to improve his or her teaching and develops a personal action plan.

ASSISTING EARLY CAREER FACULTY

Each year, 35 to 45 faculty in their first four years of full-time teaching gather for four days at the College of William and Mary in Williamsburg, VA, to discuss teaching methods, managing research programs, and career planning.

At early career geoscience faculty workshops, participants share ideas for teaching courses and consider successful strategies for maintaining an active research program and advising/supervising undergraduate and graduate research students. As they develop a support network with colleagues nationwide, they also explore ways to balance teaching, research, and service responsibilities.

As always, the website links participants and other beginning faculty to a rich array of helpful information about everything from time management and grant writing to active learning methodologies and assessment techniques.

DEVELOPING LEADERS

On the Cutting Edge workshops develop campus leaders. More than 75% of attendees interviewed by phone indicated that a significant outcome of their participation in a workshop was the expansion of their sphere of influence. Following workshop participation, they said, they contributed more to cross-discipline activities at their institu-



On the Cutting Edge



tions, pursued grants related to workshop outcomes, developed outreach programs for local community education and pre-service and in-service science teacher programs, and presented or published in areas of geoscience education.

In addition to helping identify new leaders, workshops also help them prepare for larger roles — by providing opportunities to serve as workshop co-conveners, invited speakers, and working group leaders and to create or review online materials that bring workshop content to the full geoscience community.

READY, SET, GROW!

On the Cutting Edge is poised to not only continue but also expand its contributions to professional development opportunities for geoscience educators. In the years to come, it plans to increase workshops and distance-learning options, catalyze the development of new learning materials, further develop its web resources, and implement a development program for training workshop and community leaders. For information on how to become involved, email one of the contacts noted on page 3 or visit the program website at serc.carleton.edu/NAGTWorkshops/.

“The list of ‘questions you should be prepared to answer’ was tremendously helpful in prepping for interviews. Topics covered in the teaching-oriented part of the workshop probably made the difference for me getting the job I did (and also helped in my first sojourn as Instructor of Record last summer).” — Participant, Preparing for an Academic Career

“This workshop really shaped the way in which I operate as a college teacher. The first thing I do in designing new courses is to develop goals and objectives with higher order thinking skills in mind. I incorporate active learning even in my larger classes and continue to develop new exercises to incorporate this style of learning into my classes and labs.” — Participant, Early Career workshop

“I would recommend [this workshop] to any early career faculty regardless of institution type or background. My History of the Earth class has improved ... I have used three new methods I learned about at the short course (gallery walk at first class; students moving to simulate plate tectonics; small group research panels in lab), each of which has worked well. I’ve mentioned how I enjoyed the conference and how useful I thought it was to many young colleagues as well as my department chair and others.” — Participant, Early Career workshop

“Meeting other faculty in my position did a lot to relieve the stress of feeling that one is all by oneself in struggling with teaching and research. Personal discussions with the leaders were very helpful. And of course, the binder full of ideas is gold.” — Participant, Early Career workshop

On the Cutting Edge

QUICK CLICKS TO CUTTING EDGE WEB RESOURCES

ON THE CUTTING EDGE HOME PAGE

serc.carleton.edu/NAGTWorkshops

CURRENT WORKSHOP SCHEDULE

serc.carleton.edu/NAGTWorkshops/workshops.html

GEOSCIENCE TOPICS AND EMERGING THEMES

BIOCOMPLEXITY — serc.carleton.edu/NAGTWorkshops/biocomplexity

CLIMATE CHANGE — serc.carleton.edu/NAGTWorkshops/climatechange

GEOLOGY AND HUMAN HEALTH — serc.carleton.edu/NAGTWorkshops/health

GEOCHEMISTRY — serc.carleton.edu/NAGTWorkshops/geochemistry

HYDROGEOLOGY — serc.carleton.edu/NAGTWorkshops/hydrogeo

MINERALOGY — serc.carleton.edu/NAGTWorkshops/mineralogy

OCEAN SYSTEMS — serc.carleton.edu/NAGTWorkshops/ocean

PETROLOGY — serc.carleton.edu/NAGTWorkshops/petrology

PUBLIC POLICY — serc.carleton.edu/NAGTWorkshops/publicpolicy

RATES AND TIME — serc.carleton.edu/NAGTWorkshops/time/abouttime.html

SEDIMENTARY GEOLOGY — serc.carleton.edu/NAGTWorkshops/sedimentary

STRUCTURAL GEOLOGY — serc.carleton.edu/NAGTWorkshops/structure

TEACHING RESOURCES

ASSESSMENT OF LEARNING — serc.carleton.edu/NAGTWorkshops/assess

COURSE DESIGN — serc.carleton.edu/NAGTWorkshops/coursedesign

TEACHER PREPARATION — serc.carleton.edu/NAGTWorkshops/teacherprep03

TEACHING IN THE FIELD — serc.carleton.edu/NAGTWorkshops/field_experiences

USING DATA — serc.carleton.edu/NAGTWorkshops/usingdata

VISUALIZATIONS — serc.carleton.edu/NAGTWorkshops/visualization

WEB DESIGN — serc.carleton.edu/NAGTWorkshops/webdesign

CAREER MANAGEMENT

PREPARING FOR AN ACADEMIC CAREER — serc.carleton.edu/NAGTWorkshops/careerprep

EARLY CAREER FACULTY — serc.carleton.edu/NAGTWorkshops/earlycareer

