New Science Education Initiative Brings Seismology into the Classroom

Prince Galitsin's invention of the electromagnetic seismograph in 1914 revolutionized the young science of seismology. Now, the venerable research instrument is proving to have an equally powerful impact—in the arena of public education. Over the past 5 years, a number of initiatives have extended the boundaries of seismology research outside the ivory towers of research institutions and into America's schools, museums, and teaching colleges. These initiatives are built on the premise that educational seismology offers a special opportunity for capturing students' innate curiosity for natural phenomena in the world around them, and that this curiosity can be used to teach a wealth of fundamental principles of physics and Earth science. These school-based seismograph stations, now numbering in the hundreds, are demonstrating a growing potential to contribute both to science education and scientific research.

A new national initiative, the U.S. Educational Seismology Network (USESN), is striving to bring together these diverse programs of educational seismology under a single umbrella. USESN's primary goals are to provide a mechanism for coordination of individual efforts, to provide common technical and educational resources that will enhance all of the educational seismology programs, and to be an advocate for educational seismology.

Networks of seismographs have always been the principal tool of the seismology research community for the study of Earth's interior, the earthquake process, global and regional tectonics, seismic hazard, and nuclear test monitoring. Until recently, however, both the seismographic instruments and access to the seismic data were off limits to the broader education community, limited by both cost and technical expertise. Several recent developments have changed that situation and created opportunities for schools to participate in research activities. New, research-quality seismographs are now available at a cost affordable for many schools, and improved data acquisition and data analysis software make recording digital seismic data possible and reliable in a school setting. In addition, new data communications technologies permit near-real time transmission of seismic data—and comparison of data from various locations—via the Internet. These school-based seismographs (Figure 1) provide teachers and students with the opportunity to participate in the research community in a variety of formats and at many levels, including station operation, basic investigations of seismic events, and collaborative research with other schools or with research scientists.

The opportunities for seismology research in schools couldn't have come at a better time. A series of blue-ribbon panels, beginning with the landmark report "A Nation At Risk" [National Commission on Excellence in Education, 1983] and concluding with the recent Glenn Commission report "Before It's Too Late" [National Commission on Mathematics and Science Teaching for the 21st Century, 2000], have focused increasing attention on reform of the nation's science and mathematics education system. They have emphasized growing concerns about the teaching of mathematics and science in America's K-12 classrooms, the growing needs for a scientifically and technically literate population, and possible approaches for reforming science teaching in America's classrooms. This reform is centered around four principal themes:

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- improved preparation for future science teachers
- improved access to science education for all students
- the need for more in-depth, inquiry-based learning in classrooms
- and improved access to technology

Many of these reform ideas are codified in the National Academy of Sciences' "National Science Education Standards" and the American Association for the Advancement of Science's "Benchmarks for Science Literacy" which set a series of new standards for science literacy in America's K-12 schools. Those standards, which are being adopted as part of educational reform in individual school systems and in statewide education initiatives, could profoundly affect the teaching of science and mathematics across the country.

Seismology is well situated to play an important role in this educational reform movement; by its nature, seismology is interdisciplinary and has important applications to human society. Teaching with a focus on seismology permits teachers to introduce fundamental concepts from Earth science, physics, and mathematics in the context of real-world problems; allows students to apply advanced technology for data access, analysis, and visualization; and lends itself to critical thinking and problem solving.

To explore opportunities for this emerging movement of educational seismology, a group of 25 scientists, education scholars, and practicing teachers gathered at a November workshop to...

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Fig. 1. Students from Northview High School in Brazil, Indiana, examine data from a school seismograph station. (Photo courtesy of Jeff Sayers.)
explore the educational and research implications of the deployment of seismographs in schools. The group explored a diverse range of issues affecting the educational seismology movement, including technical issues associated with the acquisition, management, and analysis of school seismograph data; curricular issues associated with the development of educational materials that support the seismic networks; linkages with other education and outreach efforts—such as those associated with the Incorporated Research Institutions for Seismology (IRIS), Earthscope/USArray, and the Advanced National Seismograph System; and assessment of the needs, successes and failures, and modes of improvement for existing and planned educational seismology programs in the United States.

The group concluded that the growing opportunities for educational seismology call for increased coordination and cooperation between programs. On that basis, the group proposed the development of USESN, a new consortium of scientists and educators whose mission is to promote the use of seismographs and seismic data for science education. USESN seeks to provide an organizational structure for coordinating the numerous educational seismology activities that are developing across the country.

This project has emerged out of several independent educational seismology initiatives, whose collective efforts to develop a national school seismograph network are shown in Figure 2. These include: 1) the Princeton Earth Physics Project (PEPP), which links 10 university-based regional networks, currently serving 80 schools nationwide; 2) Micheseis/Ohioseis, which has built a network of 18 school-and college-based stations in Michigan, Indiana, and Ohio; 3) the South Carolina Earth Physics Project (SCEPP), which is in the process of developing a 50-station educational seismic network in South Carolina; 4) the Los Angeles Physics Teachers Alliance Group (LAPTAG), a network of eight stations in the Los Angeles area; 5) a number of smaller, local-area educational seismic networks that are developing across the country; and 6) the Public Seismic Network (PSN), an informal network of amateur seismologists that includes stations at a number of schools. A similar effort has been mounted by the IRIS Seismographs in Schools program, which brings low-cost, demonstration seismic instruments into the school setting. The goal of USESN is not to supersedes these initiatives, but rather to serve as an organizational umbrella, a provider of support services, and an advocate for such efforts.

In particular, USESN seeks to promote the installation and effective use of educational seismographs and seismic data; disseminate high-quality curricular materials and educational services that promote the use of seismology in science education; and provide an organizational framework for coordination and advocacy of educational seismology across the country.

The initiative is comprised of four principal components:

- Provision of technical support, by coordinating technical support for participating schools, developing a "seamless data archive" of high-quality seismic data from school seismometers and developing effective tools to access these data as well as those from research data repositories; facilitating data sharing between schools, through development of data exchange criteria and easy-to-use data transfer mechanisms; and developing "technical aids" for participating teachers, such as a "Buyer's Guide" for acquisition of new instruments, installation and operation manuals for seismic equipment, and high-quality software installation tools and users' guides for seismological software.

- Dissemination of educational materials, through a new clearinghouse for seismological curriculum modules linked to the Digital Library for Earth Science Education (DLESE); development of new curriculum modules that support national and state science standards and promote inquiry-based science teaching; facilitating connections between the research and education communities through workshops for preservice and inservice teachers, student-teacher symposia, and other forums for student research; and exploration of new mechanisms for interschool collaborative projects, including development of high-quality web-based communication systems.
• Coordination with other Earth science initiatives: USESN will seek to collaborate with education and outreach programs connected with other major Earth science initiatives, focusing initially on activities connected with IRIS, DLESE, the Earthscope initiative, and the USGS Advanced National Seismograph System (ANSS).

• Assessment of existing and planned initiatives will include formative evaluation of the needs for educational seismology projects, followed by ongoing evaluation of the effectiveness of the educational seismology projects in the classroom environment.

One of the concrete outgrowths of the workshop was the creation of a "white paper" on educational seismology. The document, bearing the title "Shaking up America's Classroom: A Vision for Educational Seismology in the United States," summarizes the mission, vision, and goals of the consortium, outlines a series of efforts needed for technical improvement of the educational seismic networks, development and dissemination of educational materials, assessment of educational seismology programs, and linkages with other national initiatives in science education. Interested readers may obtain copies of the document from the USESN Web site: http://www.indiana.edu/~usesn/. At this stage, the consortium is still in its formative stages. The group welcomes the participation of any interested persons from the educational and research communities.

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