# Next Generation Science Standards: A call to action for the geoscience community

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How do we ensure the health of our geology departments with a steady stream of majors and build an informed public prepared to make important decisions on geoscience issues? The Next Generation Science Standards (NGSS) are a critical step, and they require the support of geoscientists nationwide.

The NGSS demonstrate an expanded emphasis on earth-science topics (such as natural resource distribution, human impacts on climate, and geologic history) compared to previous standards (NGSS, 2012; National Research Council, 1996). The NGSS present a rare opportunity to significantly improve K–12 earth-science education nationally because they (1) include up-to-date, timely topics important for public decision making; and (2) increase the rigor and prominence of earth-science content in K–12 classrooms. However, adoption of the NGSS requires state-level legislative action. Without support from geoscientists at the state level, the implementation of NGSS nationwide is threatened.

High-quality K–12 earth-science education is important for recruiting the necessary workforce to meet society's needs. Although recent enrollment in geoscience majors has dropped less than 3% in 2013, there is a predicted shortfall of 150,000 geologists to meet the workforce demands in the next decade (Wilson, 2014). The need to boost enrollment to meet this demand is hampered by the lack of quality K–12 earth-science education. Earth science has the fewest trained teachers at the primary and secondary levels, and only 28% of high-school students take an earth-science class (Wilson, 2014). There is also no geoscience Advanced Placement (AP) course. Despite this lack of earth sciences at the secondary level, more than half of geology graduates report having taken a middle or high school earth-science course (Wilson, 2014), suggesting that those who do have K–12 earth sciences exposure may be more likely to pursue geoscience majors.

High-quality K–12 earth-science education is important for geoscience literacy. The public is facing challenging and complex decisions about geoscience topics, such as fracking and carbon emissions. Inadequate K–12 earth-science education leads to misunderstandings about the process of science and uninformed speculation about the causes of earthquakes, volcanoes, landslides, climate change, flooding, massive storms, and droughts—obfuscating and politicizing the impacts of natural disasters on public safety (Smith, 2006). The structure of the NGSS, which infuses science practices and content, has the potential to substantially improve public understanding of the challenges we face as a population with respect to natural disasters, natural resources, economics, and ecological systems. Improved geoscience literacy will lead to an improved response to critical geologic issues, such as the costs and benefits of geologic resources, resource development and consumption, and local and national economic well-being (Smith, 2006).

The structure of the NGSS effectively links the content to the practice of geoscience. Built upon the Framework for K–12 Science Education (National Research Council, 2012), 26 states collaborated to create the first set of standards to be adopted by multiple states. The NGSS present a new opportunity for the geosciences because they have an expanded emphasis on earth science (Wysession, 2014) and are built directly upon a set of geoscience literacy documents developed by the scientific community (Wysession et al., 2012). An important feature of the NGSS is the integration of three dimensions: (1) Disciplinary Core Ideas, (2) Crosscutting Concepts, and (3) Science and Engineering Practices. For example, students must demonstrate that they can "analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems" (NGSS, 2012, HS-ESS2-2). This performance expectation demonstrates how the science practice of *analyzing data to support the claim* is applied to the relevant *earth systems* Disciplinary Core Idea and connects the Crosscutting Concept of *feedbacks* across the science disciplines. This structure requires teachers to engage students in the process of science, rather than presenting geoscience as a set of facts.

The NGSS development process involved stakeholders from science, science education, higher education, and industry and several rounds of public feedback were sought before publication. Numerous groups and associations strongly support the NGSS, including the American Geophysical Union, the Geological Society of America, the National Academy of Science, and the U.S. Army, as well as energy, technology, and insurance companies (NGSS, 2014a, 2014b). This demonstrates the importance of the NGSS for developing the scientifically literate population necessary for continued national and economic stability and success.

## CHALLENGES

The adoption of the NGSS by individual states has been slow for numerous reasons, including the lack of federal incentives and an emphasis on the Common Core State Standards Initiative (Heitlin, 2014). However, the greatest controversy is focused on the earth-science standards because they include politically controversial topics: climate change; costs and benefits of exploration, development and use of natural resources; and evolution,

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geologic time, and origin of the universe (Workosky, 2014). The very substance of the controversy presents an opportunity to engage students, teachers, and lawmakers in understanding how geoscientists study complex issues and engage in scientific argumentation (Dolphin and Dodick, 2014). The expanded emphasis on earth-science topics and the integration with the practices of science featured in the NGSS have the potential to change misperceptions by increasing the quality and complexity of earth-science content in public schools.

A major hurdle to state-level adoption is the requirement that state legislatures understand the importance of the NGSS, vote for adoption, and allocate resources to support their implementation. Earth science is not currently a mandated part of the science curriculum in many states and is assessed inconsistently across the country (AGI, 2013). The current lack of earth science in K–12 schools means that fewer teachers are prepared to meet the expectations of NGSS. Likewise, many schools currently suggest that students skip earth-science courses in favor of taking AP science courses. Therefore, the expanded focus on earth science presents a great challenge to local area schools even in states adopting the standards. One of the model course maps for implementation proposed in the NGSS suggests that Earth and Space Science Standards be infused into biology, chemistry, and physics courses (NGSS, 2014c, Appendix K). This would require substantial professional development resources to train current biology, chemistry, and physics teachers to teach earth-science content.

## SOLUTIONS

What can you do to ensure quality K–12 earth-science education?

1. **Promote the adoption of the NGSS in your state to local lawmakers and popular media.** Check here to learn about NGSS in your state: http://ngss.nsta.org/latest-news/. Major legislative battles are taking place in many states due to push-back on controversial earth-science–relevant topics. Write letters to your lawmakers urging them to support the statewide adoption of NGSS. Write articles for local popular press, or hold a local science café through your institution's STEM outreach office. Stress the importance of the NGSS for preparing an informed public to make decisions about natural resource use, climate change impacts, and natural hazards.
2. **Urge your state commissioners of education to provide adequate resources for teacher training to meet the Earth and Space Science Performance Expectations in the NGSS.** Many local and regional school districts are struggling to adapt to curricular changes as a result of statewide adoption. The resources they need include earth-science content training, curriculum development training, classroom materials, computers, and strategic planning for implementing earth science either as a stand-alone course or infused into their physics, chemistry, and biology courses. The needs and resources of each district vary substantially; however, all schools need teacher training to understand the earth and space science standards and how to best meet the standards within the context of their school districts' curriculum.
3. **Utilize broader impacts of funded projects to provide content knowledge training to regional teachers.** Teachers in your area need a boost in their earth-science knowledge to meet the expectations of the NGSS. Specific challenges relate to understanding how the process of science can be different in the earth sciences as compared to other sciences and how to present politically charged issues, such as climate change, earth history and evolution, and natural resource use (such as fracking). Resources to facilitate your efforts are available through the following organizations and curricular repositories: National Association of Earth Science Teachers, Museum of the Earth, SERC, On the Cutting Edge, and the Geological Society of America, to name a few. Likewise, you can partner with colleagues in a college of education or STEM outreach office to help use the content you provide and to develop appropriate lessons for K–12 classrooms.

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