

Geoscience Policy Recommendations for the New Administration and the 115th Congress

This set of policy recommendations outlines ways to achieve our shared national interests where the geosciences play a significant role. The policy proposals build on the consensus document *Geoscience for America's Critical Needs: Invitation to a National Policy Dialogue*, which was developed for the 2016 election.

Geoscientists gather and interpret data about the Earth and other planets, providing the data, tools, and expertise to help solve some of America's greatest challenges. The policy proposals laid out in this document are centered around five high-level thematic areas:

- **Enhancing national and homeland security**
- **Increasing economic prosperity**
- **Securing resources and strengthening national infrastructure**
- **Supporting strong and resilient communities, and**
- **Growing a dynamic workforce**

This report highlights the shared priorities of nine professional geoscientific societies that represent some 250,000 members and are members of the Geoscience Policy Working Group. We in the geoscience community offer to share our scientific expertise and perspectives as you craft national policies to build a strong and competitive nation.

The societies listed below do not necessarily endorse or have expertise on every recommendation in this report.

Signed: American Association of Petroleum Geologists, Association of American State Geologists, American Geophysical Union, American Geosciences Institute, American Institute of Professional Geologists, Consortium for Ocean Leadership, Geological Society of America, National Ground Water Association, Soil Science Society of America.



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POLICY PROPOSALS

ENHANCE NATIONAL SECURITY

1. Support and enhance the nation's strategic Earth observational infrastructure and invest in the interpretation and preservation of this data.
2. Prioritize natural hazards research and monitoring to minimize risk to people and infrastructure.
3. Invest in America's icebreakers to maintain our military and economic capabilities in the Polar regions.
4. Invest in research to promote the development of innovative technologies for water reuse, water recycling, and managed aquifer recharge.

INCREASE ECONOMIC PROSPERITY

1. Support robust energy research and develop solutions to reduce potential environmental impacts of energy extraction and generation.
2. Support and invest in regional ocean planning initiatives to protect and encourage responsible production of our ocean's natural resources.
3. Support agricultural and aquacultural data collection, analysis, and application for efficient and sustainable food production.
4. Gain a better understanding of soil properties and their relation to valuable ecosystem services.
5. Identify alternative uses, or storage options, for produced waters, carbon dioxide, and other energy waste streams.
6. Define the composition, structure, and geologic processes of the Earth's crust.

SUPPORT STRONG COMMUNITIES

1. Improve communication to mitigate the impact of natural hazards on people, buildings, and infrastructure.
2. Invest in soil microbiome research as a new frontier connecting biology, medicine, and agriculture.
3. Assess and improve the operation of deep injection wells to ensure community safety.

SECURE RESOURCES AND STRENGTHEN OUR NATIONAL INFRASTRUCTURE

1. Examine mineral commodities from discovery to disposal to ensure stable supply chains for our infrastructure and economy.
2. Mitigate the high risk associated with nuclear waste.
3. Invest in water infrastructure to ensure access to safe and cost-effective drinking water for all.
4. Support collection and dissemination of water monitoring data.

GROW A DYNAMIC WORKFORCE

1. Support strong federal investments in basic geoscience research to train and develop future geoscientists.
2. Invest in a vibrant and dynamic STEM-focused workforce to increase our global competitiveness.
3. Establish infrastructure to support robust aquaculture systems to create new jobs and business opportunities.



ENHANCE NATIONAL SECURITY

Geoscience information and research enhance American national security. Geoscience supports energy independence by enabling the identification and responsible extraction of energy from new domestic sources, increases the country's position in global trade by monitoring changes in Earth's systems to help us chart safe and efficient routes by land, air, and sea, and keeps communities safe by helping them prepare for and respond to natural hazards like wildfires and floods.

1. Support and enhance the nation's strategic Earth observational infrastructure and invest in the interpretation and preservation of this data.

Satellites and other Earth observing systems provide data used to protect our national security, allow businesses to make informed economic decisions, and protect Americans from the devastating impacts of severe weather.

- » Increase funding for key Earth and ocean observing satellite systems and data monitoring tools, including satellites within NASA, NOAA, and USGS; USGS's extensive streamgauge network; and NSF's Ocean Observatories Initiative.

Long-term datasets, such as those collected by NASA, NOAA, NSF and the USGS, are critical to providing the baseline information that planning agencies and communities need to make informed decisions about critical resources, natural hazards, water, and trade routes. These Agencies have the resources and expertise to efficiently collect, manage, and disseminate large and complex datasets that protect property and critical infrastructure and contribute to public health and safety.

Responsible Authority: NASA, NOAA, NSF, USGS

2. Prioritize natural hazards research and monitoring to minimize risk to people and infrastructure.

Natural hazards research helps communities prepare for and be resilient to disasters like earthquakes, tornadoes, hurricanes, space weather, and floods if and when they strike.

- » Increase funding for the USGS Natural Hazards Mission Area, which conducts targeted applied research to monitor and assess the likelihood of natural hazards.
- » Increase funding for NOAA's National Weather Service and National Severe Storms Laboratory, which provide atmospheric, ocean, and weather data to keep communities safe.
- » Increase funding for NSF's Prediction of and Resilience against Extreme Events (PREEVENTS) program, which supports basic research to improve prediction, risk assessment, and resilience in the face of natural disasters.
- » Ensure funding for NASA's Science Mission Directorate, which monitors terrestrial and space hazards.

These federal programs conduct targeted research to better understand and monitor natural hazards. USGS's Natural Hazards mission area also supports NOAA's forecasting responsibilities for solar storms, tsunamis, and volcanic ash-fall events. The National Weather Service and the National Severe Storms Laboratory provide accurate and timely forecasts and warnings of hazardous weather events.

Responsible Authority: USGS, NOAA, NSF

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3. Invest in America's icebreakers to maintain our military and economic capabilities in the Polar Regions.

The Arctic is more accessible now due to changing global temperatures. This increases trade routes and makes available resources previously trapped beneath the ice. As an Arctic nation, a robust fleet of icebreakers is necessary to maintain our presence in the region.

- » Increase funding for the U.S. Coast Guard to acquire more heavy icebreakers to supplement the single active U.S. polar icebreaker commissioned in 1976 and slated for retirement as soon as 2019.

An increasingly open Arctic region will require the presence of government-funded polar icebreakers to support and protect our national interests in emerging trade, tourism, and responsible resource extraction within the region. The United States once commanded a fleet of seven polar icebreakers; now we only have one.

Responsible Authority: U.S. Coast Guard, U.S. Navy

4. Invest in research to promote the development of innovative technologies for water reuse, water recycling, and managed aquifer recharge.

Our nation relies on finite sources of ground and surface water to service communities, irrigate acres of agricultural land, and to power massive hydroelectric dams and critical industries. These water sources are increasingly threatened by environmental factors and increased demand, including drought, development of unconventional oil and gas resources, agricultural by-products, and population growth.

- » Increase funding for groundwater reservoir sustainability research within USBR's Advanced Water Treatment Research Program, the USGS's National Water-Quality Assessment Program, and the USDA's National Institute for Food and Agriculture "Water for Food" program.

Current federal programs help monitor and protect our water resources. They track and develop new technologies to address water quality and quantity, including naturally occurring and manmade contaminants, changing water levels, water usage, and more. Research and investment by the federal government can mitigate the effects of these threats on our fresh water resources and help promote and ensure a sustainable water future.

Responsible Authority: USBR, USDA, USGS



INCREASE ECONOMIC PROSPERITY

Geoscience information supports many different industries throughout the United States. According to the U.S. Bureau of Economic Analysis, the mining and the oil and gas sectors alone contributed more than \$490 billion¹ to the U.S. economy for the first two quarters of 2016. Geoscience information also indirectly supports the transportation sector through the supply of raw materials, the agricultural sector through the characterization of water and soil, and the defense sector through geospatial satellite technology, among other sectors. In 2014, geoscientists contributed \$91 billion to the U.S. gross domestic product; and that number is expected to rise to \$109 billion by 2024.²

1. Support robust energy research, while also developing solutions that reduce the potential environmental impacts of energy extraction and generation.

Energy annually contributes directly and indirectly hundreds of billions of dollars and millions of jobs to the U.S. economy. Protecting and improving our domestic energy resources while minimizing the risks associated with energy development will safeguard our nation's natural resources and secure our energy independence. However, energy extraction and generation also pose possible environmental and health risks. To better understand and mitigate these risks requires further research and improved data collection both off- and onshore.

- » Increase funding for applied and basic oil and gas research at the DOE.
- » Support data collection and research that assess the quantity and location of energy resources, risk assessment and mitigation at the USGS Energy Resources Program and Natural Hazards Mission Area, and the National Science Foundation Office of Polar Programs.

Basic and applied energy research is conducted and supported by government agencies, including the DOE and the USGS. These studies, often conducted in partnership with universities, develop advanced technologies that increase the economic and environmental performance of energy development, which contributes to increased domestic energy security.

Responsible Authority: DOE, NSF, USGS

2. Support and invest in regional ocean planning initiatives to protect and encourage responsible production of our ocean's natural resources.

A strong ocean economy underpins a strong national economy. Coastal and ocean industries contribute \$359 billion³ annually to our gross domestic product. Regional ocean planning processes incorporate input from all stakeholders, increasing certainty in business models and ensuring a robust ocean economy.

- » Support continued implementation of the National Ocean Policy's regional planning component for interested states and regions.
- » Fund ocean-observing programs, including NOAA's Integrated Ocean Observing System program (IOOS), the NSF-funded Ocean Observatories Initiative (OOI), and NASA's Earth Science Division, which provide data necessary for ocean planning to be an effective tool for ecosystem-based management.

The National Ocean Policy's regional ocean planning effort addresses competing and cumulative marine activities, and ensures our ocean remains a sustained, viable resource for all those who depend on it—from the three million workers in 149,000 business establishments³ to those in need of food (20 percent of the animal protein we depend on is from the ocean⁴) to the growing number of people who call the coastline home (163.8 million,⁵ or more than half of the U.S. population). Our nation's interagency ocean and coastal observing programs help us understand and predict ocean conditions and coastal events such as storms, ocean acidity, and tidal wave heights. These programs provide new tools and real-time ocean

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observation information critical to communities and business interests nationwide.

Responsible Authority: CEQ, OSTP, Federal Agencies of the National Ocean Council.

3. Support agricultural and aquacultural data collection, analysis, and application for efficient and sustainable food production, including from the ocean.

The fundamental concept of precision agriculture is collecting data and making decisions based on that data to make producers more efficient, profitable, and sustainable. Better monitoring and management of soil nutrients and moisture can improve crop yields and environmental sustainability.

- » Provide increased funding to the interagency Innovations at the Nexus of Food- Energy-Water Systems (INFEWS) program.
- » Support soil mapping and geological characterization through NASA's Soil Moisture Active Passive (SMAP) satellite and the USDA Agricultural Research Service (ARS) Long-Term Agroecosystem Research (LTAR) Network.
- » Establish a federally supported challenge to develop a safe, sustainable, and scalable aquaculture model able to be deployed in various regions with a variety of commercially viable seafood.

The increased availability of remote sensing and satellite imagery, computing power for data processing, and the development of data-mining tools have revolutionized agricultural production allowing producers to reduce expenses and produce higher yields, while also maintaining environmental stewardship. This, combined with advances in sustainable aquaculture will allow for profitable, sustainable food production for our growing population.

Responsible Authority: NASA, NSF, USDA

4. Gain a better understanding of soil properties and their relation to valuable ecosystem services.

An ecosystem service is any positive benefit that wildlife or ecosystems provides to people. Soil ecosystem services are at the foundation of many of our most valuable natural resources.

- » Provide sustained support for federal research programs that monitor and study the physical, biological, and chemical properties of soil, specifically the NSF's Long Term Ecological Research (LTER) Network and the Critical Zone Observatory program, and NASA's Carbon Cycle and Ecosystems program.

Soil ecosystem services support food production, the filtering and storing of water, decompose waste, and provide raw materials for construction and pharmaceutical industries. As soil is degraded and lost, we lose these services at huge economic cost to society. Understanding soil properties will help protect this critical natural resource, enhance the nation's food security, support resilient infrastructure, and reduce impacts from natural disasters.

Responsible Authority: NASA, NSF

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5. Identify alternative uses or storage options for produced waters, carbon dioxide, and other energy waste streams.

Generating electricity and extracting oil, gas, and other energy sources creates significant waste products. Identifying commercially viable uses for these waste products would boost national prosperity. The development of stable storage options for waste products will improve public health and safety.

- » Support DOE programs that invest in and incentivize research and development to minimize waste streams associated with energy production; to identify productive uses for the waste products; to create safe and stable storage systems to isolate the waste materials.

The USGS estimates that about 14 billion barrels of water are produced annually as a byproduct of extracting hydrocarbons⁶ and the Energy Information Administration calculates that the U.S. electric power sector emitted about 1,925 million metric tons of CO₂ in 2015.⁷ These waste streams offer both a hazard and an opportunity. DOE offices, including ARPA-E, Fossil Energy, and Energy Efficiency and Renewable Energy work on aspects of minimizing the impact of these waste products on the environment and public health while creating wealth from new products.

Responsible Authority: DOE

6. Define the composition, structure, and geologic processes of the Earth's crust.

We rely on the Earth's crust for mineral and energy resources, water supplies, and the soils that produce food. The Earth's surface and subsurface also account for many natural hazards. Understanding the three-dimensional composition, structure, and geologic processes of the Earth's surface and subsurface will strengthen the U.S. economy and save lives.

- » Support geologic studies at the federal, state, and university levels, including geologic mapping through the USGS National Cooperative Geologic Mapping Program; earthquake, landslide, and volcano hazards research in the USGS Natural Hazards Mission Area; studies of the physical properties of the subsurface in the SubTer initiative at DOE; and geologic research at the Geosciences Directorate of NSF.
- » Support the reauthorization of the National Earthquake Hazards Reduction Program aimed at understanding the origins, characteristics and impacts of natural and human-caused earthquakes.

The USGS, often in collaboration with state geological surveys, provides nationwide geological, geophysical, and geochemical information to address societal, economic, and security concerns facing the nation. USGS Natural Hazards programs work with partners to monitor and assess hazards, and to conduct targeted research to improve national, state, and local preparedness, response, and resilience.

Responsible Authority: DOE, NSF, USGS



SUPPORT STRONG COMMUNITIES

Geoscience information supports strong communities by helping to provide ample food and clean water, anticipating and mitigating the impacts of natural disasters, and safely and responsibly disposing of human and industrial waste.

1. Improve communication to mitigate the impact of natural hazards on people, buildings, and infrastructure.

Effective hazards communication helps communities prepare for and respond to natural disasters. A well-informed public is better equipped to address the risks associated with these hazards.

- » Increase funding for the National Weather Service (NWS) to provide information about severe weather systems, storm watches, warnings, and advisories.
- » Increase funding for the USGS Science Application for Risk Reduction (SAFRR) project to link hazard science with decision makers, emergency responders, and the public.
- » Increase funding for FEMA's National Preparedness System and Resilient Nation Partnership Network.
- » Increase funding for FEMA's Hazard Mitigation Grant Program, which helps communities implement hazard mitigation measures following Presidential Disaster Declarations.

Information services from the NWS help communities, emergency responders, and decision makers anticipate and prepare for severe weather events. The USGS SAFRR team partners with federal, state, and local governments, the private sector, academic and non-governmental organizations to improve communication about hazards, risk, and disaster resilience.

Responsible Authority: FEMA, NOAA, USGS

2. Invest in soil microbiome research as a new frontier connecting biology, medicine, and agriculture.

Soil microbiomes are the communities of microorganisms that live in soil. Soil microbiome research helps us understand the link between soil microorganisms and the functions they provide to support plant growth, remediate contaminants, supply industrial and pharmaceutical goods, and contribute to resilient ecosystems.

- » Support research at the interagency National Microbiome Initiative, which includes NIH, NSF, NASA, DOE's Office of Science, and USDA.
- » Fully fund the USDA competitive grants program, the Agriculture and Food Research Initiative (AFRI), to the authorized level of \$700 million.

Numerous industrial processes, such as biofuel production and food processing, depend on healthy microbial communities. Dysfunctional microbiomes are associated with human diseases, local ecological disruptions, such as the hypoxic zone in the Gulf of Mexico, reductions in agricultural productivity, and disruptions in weather and atmospheric conditions. Further interdisciplinary research is needed to manage microbiomes in a manner that prevents dysfunction or restores healthy function.

Responsible Authority: NASA, NIH, NSF, OSTP, USDA

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3. Assess and improve the operation of deep injection wells to ensure community safety.

Injecting fluids, such as the wastewater from oil and gas production, deep into the Earth has been associated with groundwater contamination and induced seismicity. Understanding and avoiding the causes of these problems will reduce the risk of damage to life, property, and water resources.

- » Improve data collection for deep injection wells regulated by the EPA and the states under the Safe Drinking Water Act.
- » Support scientific and engineering studies at the DOE, USGS, and the National Risk Assessment Partnership to reduce the risk of groundwater contamination and induced seismicity.

Research provided by these agencies help energy producers safely and effectively develop domestic energy resources. The National Risk Assessment Partnership, a collaborative effort between DOE and many National Labs, develops tools for predicting and assessing the potential for induced seismicity from fluid injection.

Responsible Authority: EPA, DOE, USGS

SECURE RESOURCES AND STRENGTHEN INFRASTRUCTURE

Geoscience resources strengthen American infrastructure. Our physical, industrial, agricultural, and cyber infrastructure all rely on a secure and steady supply of geoscientific resources, including, sand, stone, and gravel. These resources provide the foundation for roads and bridges; water and soil nutrients sustain healthy crops; and rare earth elements and other critical materials enable the development of cutting-edge technologies that protect American lives.

1. Examine mineral commodities from discovery to disposal to ensure stable supply chains for our infrastructure and economy.

In 2015, U.S. mining and recycling industries produced \$103.6 billion worth of materials. Nevertheless, our country relies on imports for more than half of its apparent consumption of 41 different mineral commodities.⁸ The ability to accurately forecast mineral supply chains will ensure our nation has the foundational materials for everything from roads and bridges to computers to advanced defense systems.

- » Increase funding for the USGS's Energy and Mineral Resources Mission Area and for the Ames National Laboratory's Critical Materials Institute.

USGS's Mineral Resources Mission Area researches how mineral deposits form, the nature and location of deposits, and the environmental issues associated with responsible mineral extraction. It is also the premier source of information on the worldwide supply of, demand for, and flow of minerals and materials. DOE's Critical Materials Institute conducts cutting-edge research on alternatives to critically important materials, including rare earth elements.

Responsible Authority: DOE, USGS

2. Mitigate the high risk associated with nuclear waste.

Large volumes of spent nuclear fuel are currently stored at multiple temporary sites in the United States, and more such waste continues to be generated. A long-term disposal option is still needed for this toxic radioactive waste, and a geologic repository may provide a long-term solution.

- » Invest in geoscience research at the DOE, the USGS, and the NRC to identify and characterize potential sites for an environmentally sustainable, long-term geologic repository for high-level nuclear waste.

The DOE's Office of Civilian Radioactive Waste Management researches sustainable strategies for the disposal of spent nuclear fuel and high-level waste in the United States. The NRC ensures the safe use of radioactive materials for civilian purposes, while the USGS conducts lab and field investigations to support of DOE's waste disposal program.

Responsible Authority: DOE, NRC, USGS

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3. Invest in water infrastructure to ensure access to safe and cost-effective drinking water for all.

Aging infrastructure, drought, and extreme weather events create constraints on the quality and quantity of freshwater resources across the country.

- » Continue funding programs that support access to safe and affordable drinking water, such as the EPA's Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Fund (DWSRF), as well as the USDA's water and waste disposal loan and grant programs.

DWSRF and CWSRF provide financial support to state and local safe water programs, and the USDA water and waste disposal programs provide funding for clean and reliable drinking water.

Responsible Authority: EPA, USDA

4. Support collection and dissemination of water monitoring data.

About 355 billion gallons of water per day were withdrawn from surface sources and subsurface aquifers in the United States in 2010,⁹ of which more than 100 billion gallons per day was used for irrigation.¹⁰ Continuous, long-term monitoring of water resources provides the baseline information we need to assess changes in water quality and quantity. These data serve as a valuable resource for federal agencies, businesses, the general public, and the scientific community.

- » Increase support for USGS Open Water Data Initiative, including water monitoring programs like the National Water Information System, the National Ground-Water Monitoring Network, and the National Streamflow Information Program.

These USGS-led initiatives provide free historical water information to communities throughout the United States. These data provide all types of businesses and communities with information on the quality and quantity of local water supplies which are essential to ensure a sustainable future.

Responsible Authority: USGS



GROW A DYNAMIC WORKFORCE

Geoscience industries directly employ more than 324,000 people in the United States.² These individuals help ensure a clean and sustainable water supply; explore, access and manage energy and mineral resources on land and under the sea; monitor, forecast, and mitigate terrestrial and marine natural hazards; support agricultural soil productivity; research land-sea-atmosphere interactions; and safely remediate environmental contamination and dispose of waste.

1. Support strong federal investments in basic geoscience research to train and develop future geoscientists.

- » Geoscientists contribute to the nation's economic prosperity, national security, and public health and safety. In seven years, 44 percent of the geoscientists currently working in the United States will reach retirement age, creating a shortage of skilled workers.²
- » Increase funding for the Geoscience Directorate and the Education and Human Resources Directorate within the NSF.
- » Increase funding for education and training programs within the DOE, USGS, NSF, NASA, NOAA, and USDA to provide students and early career geoscientists with career development opportunities.

The NSF Geosciences Directorate provides 64 percent of all funding to geoscience graduate students at academic institutions in the United States. Research grants and other federal programs train geoscientists and help ensure our country maintains a highly skilled workforce with the necessary expertise to protect our communities from natural hazards and to discover, explore, and responsibly maintain Earth's natural resources.

Responsible Authority: DOE, NASA, NOAA, NSF, USDA, USGS

2. Invest in a vibrant and dynamic STEM-focused workforce to increase our global competitiveness.

The United States currently leads the world in science and engineering, but China is the second-largest R&D performer and outspends the United States in R&D investments.¹¹ Investing in a skilled workforce will make America more secure and more competitive in an increasingly global marketplace.

- » Invest in programs supported by the DOE, DOL, and other federal agencies to train and transition American workers into the high-skilled workforce of the future.

The science and technology that invigorate our economy advance at a lightning pace. Federal investments in programs, such as the Solar Instructor Training Network at DOE and at the DOL's Employment and Training Administration for displaced workers, help everyday Americans get the training and tools they need to compete.

Responsible Authority: DOE, DOL

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3. Establish infrastructure to support robust aquaculture systems to create new jobs and business opportunities.

Aquaculture is a growing form of aquatic agriculture with the potential to further U.S. food security and job creation. The United States imports over 80 percent of its seafood. Of that, half is sourced from aquaculture.¹² In addition to enhancing food security, aquaculture provides ecosystem benefits, enhances commercial and recreational fisheries, and restores valuable habitats.¹³

- » Increase funding for the Interagency Working Group on Aquaculture within the National Science and Technology Council, and support challenge grants and public private partnerships to improve basic aquaculture data, tools, and research, and develop a skilled workforce.

Funding basic aquaculture research allows the United States to continue to feed and employ Americans and to ensure the United States remains the world leader in this sector.

Responsible Authority: NOAA, OSTP, USDA

LIST OF ACRONYMS

ARPA-E - Advanced Research Projects Agency-Energy

CEQ - Council on Environmental Quality

DOL - Department of Labor

DOE - Department of Energy

EPA - Environmental Protection Agency

FEMA - Federal Emergency Management Agency

NASA - National Aeronautics and Space Administration

NIH - National Institutes of Health

NOAA - National Oceanic and Atmospheric Administration

NSF - National Science Foundation

NRC - Nuclear Regulatory Commission

OSTP - White House Office of Science and Technology Policy

R&D - Research and Development

STEM - Science, Technology, Engineering, and Mathematics

USBR - U.S. Bureau of Reclamation

USDA - U.S. Department of Agriculture

USGS - U.S. Geological Survey

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