Report
HIGHLIGHTS
April 2017

Volcanic Eruptions and their Repose, Unrest, Precursors, and Timing

Recent and ongoing eruptions in Alaska, which have prompted warnings to airliners and fishing ports, serve as a reminder that volcanic eruptions are fairly common. There have been more than 50 volcanic eruptions in the United States alone in the past 31 years. These eruptions can have devastating economic and social consequences, even at great distances from the volcano. Fortunately many eruptions are preceded by unrest that can be detected using ground, airborne, and space-borne instruments. Data from these instruments, combined with basic understanding of how volcanoes work, form the basis for forecasting eruptions—where, when, how big, how long, and the consequences.

At the same time, monitoring data provide key insights into how volcanoes work. We broadly understand why and where volcanoes exist, how the magma feeding the volcano is generated and evolves, and how magma that erupts is distributed over Earth's surface. Yet our understanding is incomplete. What controls whether magma will erupt? What processes initiate eruptions? How quickly does magma rise to the surface? Which types of unrest are precursors to eruption rather than a return to dormancy? Which volcanoes are most likely to erupt in the coming decades?

Major improvements in understanding and forecasting are possible through enhanced monitoring combined with advances in experimental and mathematical models for volcanic processes. In the United States, fewer than half of the 169 potentially active volcanoes have even one seismometer to detect the small earthquakes that signal underground magma movement. Only three have continuous gas measurements—gas matters because it drives eruptions.

A new report from the National Academies of Sciences, Engineering, and Medicine provides guidance to the scientific community on how to improve forecasts of volcanic eruptions.

GRAND CHALLENGES IN VOLCANO SCIENCE

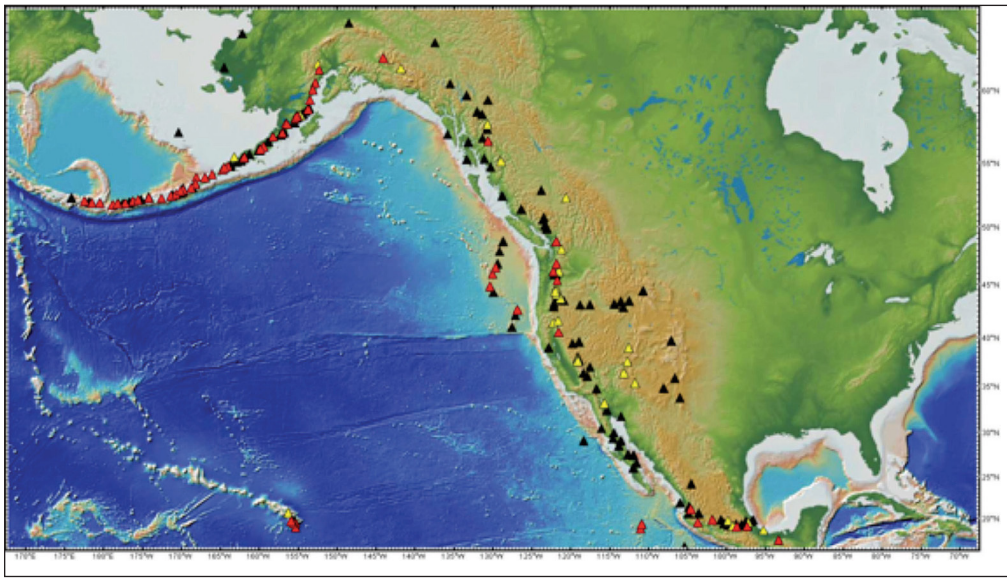
The key science questions, research and observation priorities, and new approaches highlighted in this report can be summarized by three overarching grand challenges that would substantially advance the field. The title of this report reflects **the first grand challenge** in volcano science: to document and understand the repose, unrest, precursors, and timing of eruptions during the lifecycle of volcanoes. At present, our understanding is biased because the necessary observations are available for only a few volcanoes. Moreover, activity at these volcanoes represents only a small fraction of the diversity of eruptions on Earth.

A lack of monitoring hampers forecasting, because most eruption forecasts are based on recognizing patterns in data. Models of volcanic processes provide a basis for closing observational gaps and hence could help improve forecasting. **A second grand challenge** is to develop quantitative models for the processes that govern volcanic eruptions

and to use these models to forecast the size, duration, and hazard of eruptions.

A third grand challenge is to develop a coordinated community of scientists who will make this happen. Foremost this requires effective integration of the complementary research and monitoring roles of universities, the U.S. Geological Survey, and other government agencies. In addition, volcano science draws on a large number of disciplines (e.g., geology, geophysics, geochemistry) and approaches (e.g., remote sensing, high-performance computing), and vehicles are needed to support interdisciplinary research and training, including community collaborations and education at all levels.

Although these grand challenges are large in scope and require great effort, achieving them would yield new understanding of how volcanoes work and their consequences, and improve volcano eruption planning and warning for all of society.



Map of volcanoes in the United States, Canada, and northern Mexico that have been active in the past 10,000 years, including those that have erupted since 1800 CE (red triangles), in the period of 0 to 1800 AD (yellow triangles), and earlier (black triangles). SOURCE: Data from the Smithsonian Institution's Global Volcanism Program Holocene database (Venzke, 2013)

COMMITTEE ON IMPROVING UNDERSTANDING OF VOLCANIC ERUPTIONS

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For More Information . . . This Report Highlights was prepared by the Board on Earth Sciences and Resources based on the report *Volcanic Eruptions and Their Repose, Unrest, Precursors, and Timing.* The study was sponsored by National Academies of Sciences, Engineering and Medicine's Day Fund, the National Aeronautics and Space Administration, the National Science Foundation, and the U.S. Geological Survey. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authoring committee and do not necessarily reflect those of the sponsor. Copies of the report are available from the National Academies Press, (800) 624-6242; **http://www.nap.edu**.

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