arctic microbiology will go in the future. It is evident from this volume, however, that the application of new technologies to Antarctic microbiological research will yield even more novel and unanticipated discoveries.

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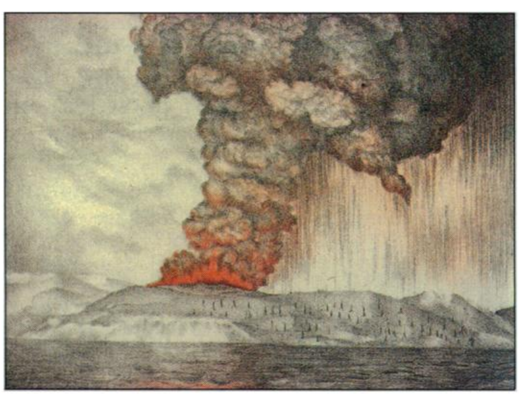
Recipes for Disaster

Volcanoes. A Planetary Perspective. PETER FRANCIS. Clarendon (Oxford University Press), New York, 1993. x, 443 pp., illus. $85 or £50; paper, $42.95 or £25.

Geology 101 instructors always look forward to their lectures on volcanoes. Even the most bored business or communications major becomes attentive when presented with films of molten lava or accounts of fatal eruptions. Similarly, authors of volcano books often have a relatively easy sell, as the normally jaded public snatches up almost any volume with glowing magma or towering ash columns on its cover. Peter Francis's 1976 book *Volcanoes* was one of the first such books targeted specifically to a popular audience. It went on to achieve considerable success, in part because of its accessible style, low price, and lack of competitors.



"Drawing from the Royal Society's report of the eruption on Krakatau [Indonesia], based on a photograph taken by a member of the last party to visit the island, on 27 May 1883. Stumps of trees are shown on the slopes. No photographs exist of the catastrophic phase of the eruption." [From *Volcanoes: A Planetary Perspective*]

Since then, volcanology has made tremendous advances. Exceptionally well documented eruptions at Mount St. Helens, Mauna Loa, Kilauea, and Etna have revealed much about the physical causes of volcanic activity. Equally fruitful has been a growing tendency for volcanologists to collaborate with physicists, engineers, and mathematicians. The Voyager and Magellan space missions returned images of bizarre volcanic features on the outer-planet satellites and Venus, greatly expanding our ideas of what constitutes "normal" eruptive behavior. Ambitious undersea exploration has mapped large stretches of the mid-ocean ridge system, site of the most extensive volcanism on Earth.

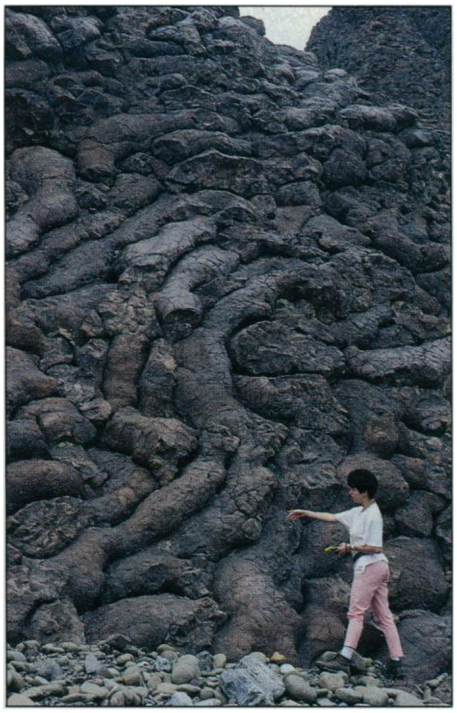
As a co-worker of many of the principal architects of these discoveries, Francis has been in a good position to provide an update of the situation. However, the popular niche his earlier book had filled is now occupied by several worthy successors. As a result, he set a more ambitious goal for *Volcanoes: A Planetary Perspective*—to give a general audience a pleasurable yet detailed review of what makes volcanoes tick. The final product leads the reader on a private field trip around the globe (and solar system), safely exploring volcanoes both notorious and obscure, active and dormant, explosive and effusive, subaerial and submarine. In the end we have a greater appreciation for the myriad ways in which volcanoes threaten society, and also for the challenges faced by researchers who have to recommend strategies to mitigate the effects of future eruptions.

Like many scientists, volcanologists infer general principles from case studies. They then use these principles to help diagnose exceedingly complex pathologies. Most volcanic models are based on a surprisingly small set of observations, so the need for practitioners to be familiar with as many known eruptions as possible is acute. For instance, the deadly class of explosions resulting in such well-known depressions as Long Valley in California and Yellowstone in Wyoming have never been witnessed. In the last dozen years, those two sites, plus highly populated calderas in Rabaul (Papua New Guinea) and Naples, have inflated with either new magma or exsolved gases, causing the ground to rise by as much as 2 meters and earthquake activity to increase dramatically. In all these cases catastrophe was averted as the craters subsided, but owing to our lack of direct experience with this type of eruption we can have little confidence that the danger has truly passed. Francis has worked on dozens of large calderas in the Andes, and his chapter on this topic clearly conveys their gigantic scale and potential for disaster.

Fifteen years ago, a similar state of ignorance existed for another perilous volcanic process—wholesale slumping of mountains to generate debris avalanches. However, in 1980 the violent collapse of Mount St. Helens graphically demonstrated both the dynamics of such events and the deposits they leave behind. Francis has devoted much of his recent career to studying these volcanic landslides. His chapter on "magic carpets and muck" details the controversies surrounding how these features travel unusually great distances (sometimes uphill), their fundamental role in creating the familiar shapes of many volcanoes, and their potential for generating catastrophic tsunamis, which may represent "the ultimate volcanic hazard."

Francis has written a highly personal discourse, focusing on those volcanoes and topics that most captivate him. As a result, even the nonspecialist reader will be left with the idea that volcanoes are not just somber subjects of news stories but also sources of intellectual challenge that call for multidisciplinary solutions. The book's subtitle is somewhat inaccurate. Most of the chapters have little reference to volcanoes on other planets, and the final chapter, "Extraterrestrial volcanism," although thorough, is one of the less innovative. A more appropriate subtitle might have been "A physical perspective," for it is Francis's subtle appreciation of how volcanoes work that really sets this book apart. His discussions of difficult topics ranging from lava rheology to explosive decompression to atmospheric circulation are refreshingly comprehensible. Nonetheless, readers lacking the equivalent of an introductory course in geology may stumble over much unfamiliar vocabulary.

The parts of the book that nongeologists may find most intriguing concern the difficulties posed by restive volcanoes that refuse to exhibit "normal" behavior. Pinatubo's giant outburst in 1991 stands as one of volcanology's triumphs: Tens of thousands of lives and billions of dollars worth of equipment were saved when evacuation recommendations were heeded. Similar suggestions about Nevado del Ruiz volcano made to Colombian officials in 1985 were ignored, leading directly to the deaths of 25,000 people. In these two cases the hazards could be delineated because patterns of seismic and gaseous precursors conformed to existing models. But what does one do when premonitory signals appear in populated areas for months or years without culmination? Such a quandary currently faces Italian volcanologists monitoring the resort island of Vulcano, where even a mild eruption during the summer tourist season would likely lead to over 10,000 deaths. Gas emissions suggesting the ascent of magma have increased rapidly in the last five years, but without a more dramatic manifestation, the local population has been unwilling to leave and political leaders have found little justification for ordering them to do so. In the end, finding ways to communicate with the public about such ambiguous signals is the greatest challenge facing volcanologists. *Volcanoes: A*



"A world-famous outcrop of pillow lavas of Cretaceous age forming part of an ophiolite sequence, Wadi Jizi, Oman." [From *Volcanoes: A Planetary Perspective*; courtesy of D. A. Rothery, Open University, England]

Planetary Perspective can help educate those decision-makers responsible for responding to such situations, while leaving the rest of us grateful that these burdens don't fall on us.

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Radio Days

Beyond Southern Skies. Radio Astronomy and the Parkes Telescope. PETER ROBERTSON. Cambridge University Press, New York, 1992. xii, 357 pp., illus. $75 or £40.

The history of the radio telescope at Parkes in New South Wales and of the Australian radio astronomy community is of special interest for a number of reasons. First, radio astronomy is a science well defined in time, its initial growth arising directly from the radio and radar developments of the World War II period. Second, the Australian group was uniquely placed to move into high gear at the end of the war; with its wide-ranging early successes, it obtained a high profile in Australia, putting it in a strong position to seek further support for the Parkes telescope. Another reason for its success was its loose group structure, in which authority and expertise were spread among many individuals, in contrast with the "great man" syndrome that characterizes many laboratories and can leave an operation without a succession.

The evolution of radio astronomy took different forms in different countries. In Australia the CSIRO (Commonwealth Science and Industrial Research Organization) Radiophysics Laboratory, which developed its own successful radio and radar program during World War II, was given a free hand by its director, E. G. (Taffy) Bowen, to pursue whatever programs of radio research looked most promising. Within several years radio astronomy and cloud physics (including rainmaking) emerged as the most rewarding areas. A staff of skilled physicists and engineers steeped in radio techniques who had already worked together as a team and had the necessary equipment on site broke straight into the field with seminal discoveries of the radio emission from the sun and discrete radio sources. The group quickly became famous.

All the world's other major radio astronomy groups got off to a slower start. In Europe the relevant groups grew around individuals who moved from wartime radio enterprises to the universities. Not only did Europe take longer to recover from the war, the research activity had to be reestablished at new locations, with new instruments and a high proportion of new staff (mainly graduate students). The groups at the Universities of Cambridge and Manchester in the United Kingdom, Leiden in the Netherlands, and Bonn in Germany and at the Ecole Normale Supérieure in France emerged as the most successful. It is possible that radio astronomy in the United States got off to such a slow start because some influential members of the astronomical community at the time who had no involvement with radio during the war and were skeptical about the prewar discoveries of background radio emission discouraged work in this area. Lee du Bridge, head of the MIT Radiation Laboratory, which developed radar in the United States, apparently promoted the idea, although few of his staff went directly into radio astronomy. The Naval Research Laboratory carried the torch for a while but at a level that did not match efforts in Europe. It was not until the early 1950s that radio astronomy gained real momentum in the United States, with significant developments in half a dozen universities. By this time Sir Bernard Lovell had obtained funds for his 250-foot telescope and the foundations were complete.

In the late 1950s the Australian radio astronomy group underwent a major metamorphosis, leading to the decision to construct the Parkes 64-meter-diameter telescope. Strong scientific arguments were advanced for a telescope with a large collecting area, including the diversity of astronomical programs that were possible. Principal among these were radio source surveys for objects that increasingly looked to be at cosmological distances and H-line observations. In addition, the role of serendipity could not be stressed enough. The individual radio astronomy groups—previously bound together by the overarching Joe Pawsey but now operating under strong leaders of their own—could not all support the decision by Bowen to go this route. This resulted in Chris Christiansen and Bernard Mills moving to the University of Sydney, where they not only continued their own first-class work but, even more important, trained the next generation of researchers, who would be vital for the health of the present Australia Telescope National Facility.

Not only did Bowen have to promote the idea, he had to find a financial backer for the telescope. The Australian government could not cover the full capital costs. Not inappropriately, Bowen approached his former American wartime colleagues and eventually obtained grants from the Carnegie and Rockefeller foundations, despite the fact that there was no direct return to American science. The support was matched pound for pound by the Australian government.

The agreed-upon design was for a 210-foot telescope operating to a wavelength of 10 centimeters; hence this instrument would be more accurate than the Jodrell Bank 250-foot telescope completed in 1957, which could just reach the critical 21-centimeter wavelength of neutral hydrogen. Interestingly, Freeman Fox, the firm that did the design study and provided the supervising engineers, also constructed Australia's other great man-made landmark, the Sydney Harbour bridge. Like so many radio telescopes, the Parkes telescope is capable of working at wavelengths considerably shorter than the one prescribed by the original design, enabling it to respond to modern astronomical demands.

When we assess the contributions of the Parkes telescope, it is clear that the unexpected and the unforeseen feature high on the list. Top billing must go to the lunar occultation observation of 3C273, which led directly to the identification of quasars. Without doubt the radio source surveys built up over the first 10 years of the telescope's operation transformed our understanding of the southern sky. The discovery and subsequent mapping of the linear polarization of radio sources, found to be much stronger than previously believed, constituted a major contribution to the astrophysics of celestial plasmas. The detection of pulsars in the southern sky two years after the telescope was completed was another significant