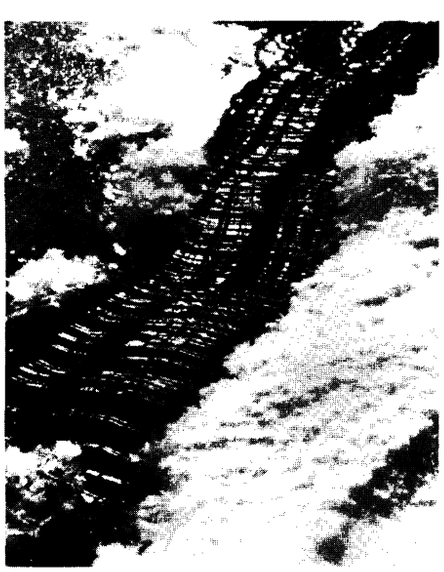
are impressive both for the thoroughness with which the data are covered and for the skill with which they are interpreted. The coverage of magnetism in the region is particularly thorough, the result of a long-term effort by several institutions, primarily the U.S. Naval Research Laboratory. The documentation of the "zebra-stripe" patterns of magnetic anomalies with closely spaced flight profiles should be impressive even to those outside the geophysical community.

The waters of the Nordic seas, their ice cover, and the atmosphere above are the subjects of renewed field investigations either in progress, such as the Marginal Ice Zone Experiment (MIZEX), or planned, such as the Greenland Sea Project. On these subjects the review chapters provide a basis for future research. Several chapters touch on the fascinating question of the importance of this region to global climate. Cold, deep waters formed in these seas flow outward to influence the ocean at locations far from their origin. A systematic description of the water masses and a thoughtful discussion of their formation is given by James Swift. Deep-water formation is important since the ocean, with its high heat capacity, acts as a thermal buffer on climate. We need to know how this deep water is formed and at what rate. The process is particularly difficult to study since it is likely to be highly episodic. As yet, no observation has been made in the Greenland Sea of a water column with uniform properties from top to bottom that would indicate vertical convection, although it has often been speculated that deep convection occurs there.



"Formation of new sea ice in a narrow (3-cm) lead." [Courtesy of Arnold M. Hanson; from *The Nordic Seas*]

The reader interested in obtaining a background on the role played by physical disciplines in the study of the Nordic seas will find this a most useful book. He or she will not, however, find chapters either on marine biology, which is of considerable interest because there are rich fisheries in these seas, or on marine geochemistry, although some of the new results with radioactive tracers are discussed in the chapter by Swift. Finally, the reader will find that the chapters differ in their timeliness, apparently owing to the length of time taken for preparation of the volume. An earlier but virtually identical version of one chapter was published in 1981 as a review article in a scientific journal. At the other extreme, an attempt has been made to bring the collection up to date with an appendix on MIZEX results for 1983–84, although more complete analyses of those data will undoubtedly appear later.

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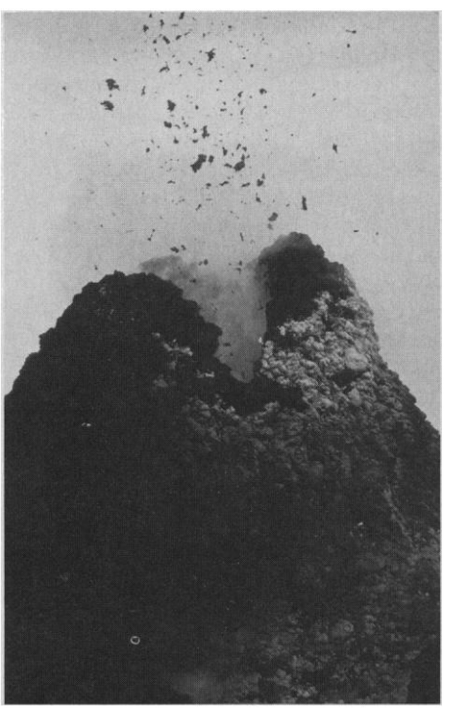
An Active Volcano

Mount Etna. The Anatomy of a Volcano. D. K. CHESTER, A. M. DUNCAN, J. E. GUEST, and C. R. J. KILBURN. Stanford University Press, Stanford, CA, 1985. viii, 404 pp., illus. $55.

This ambitious book contains a largely successful attempt to synthesize our understanding of Mount Etna, one of the most active and accessible volcanoes in the world. The authors, all from the United Kingdom, represent one of the many research groups involved in long-term study of Etna. The book covers the volcanic and cultural history of the Etna area, the types of volcanic products produced by Etna, the internal anatomy of Etna as determined by geodetic and geophysical study, the petrology of Etna, with an emphasis on magmatic processes, and the hazards of the volcano and the human response to them. The book is profusely illustrated. The line drawings are relevant and well reproduced. The black-and-white photos are relevant but are not all as sharp as one would like.

An interesting and useful history of volcanic activity at Mount Etna and its relationship to the cultural history of Sicily is contained in chapters 1, 2, and 3, which include a useful table of references to early accounts of Etna activity, a table summarizing all historic eruptions of Etna, and a table showing stratigraphic correlations of volcanic activity back to about 300,000 years before the present. Extensive reference is made to a modern geologic map and memoir concerning the geology of Etna prepared by Romulo Romano and colleagues. Etna is in a very complicated tectonic setting, and there is disagreement about the interpretation of the pre-Etnean tectonic history of the region. The authors try to treat all of the alternative hypotheses, with the result that sections on the geologic and tectonic history are confusing and are longer than necessary.

Chapter 4, "Volcanic processes and products," is a good account of the surface volcanic features of Etna. Chapter 6, "Petrology and magmatic processes," goes into too much detail about partially understood petrologic processes. It could more profitably have provided a clear overview of what rock types are present and how they are related to magma chambers and melting zones. The chapter begins with a discussion of isotopic geochemistry, and it is not until a third of the way through the chapter that a table showing the range of major oxide chemistry in the Etnean lava series appears. It was surprising to me that there has been so little emphasis on the study of single eruptions of Etna. Apparently, the 1981 eruption is the first for which a complete set of samples was collected at the different vent



A hornito approximately 6 meters high expelling fragments of lava. When degassing at the vent of a volcano is on a relatively small scale, spatter ramparts build up along the sides of the fissure system and hornitos of various sizes and shapes are commonly formed. Though hornitos typically range up to about 6 meters in height, the two largest hornitos on Etna are each some 30 meters high. Known as the Due Pizzi, they are now slowly being buried by lavas. [Photograph by J. E. Guest; from *Mount Etna*]

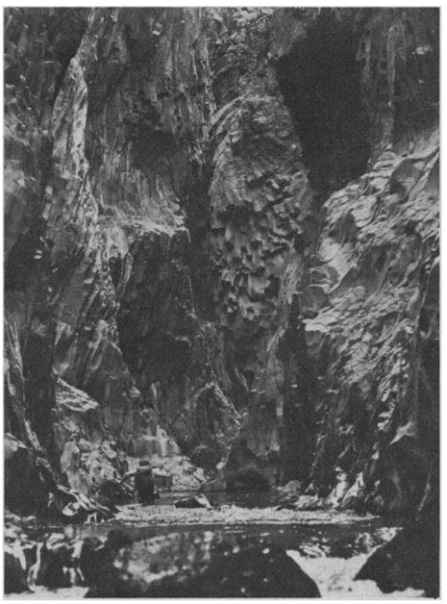
locations, along with timed sequences of samples at each vent. Experience in Hawaii shows that this type of study often holds the key to unraveling the processes involved in the overall petrogenetic evolution of the volcano.

Chapter 7, "Internal plumbing," begins by telling the reader how a volcano can be studied through measurement of the ground deformation related to eruptive cycles, using studies at Kilauea as a reference. The principal conclusion is that ground deformation at Etna does not fit the Kilauea model and, specifically, that a shallow storage region is absent beneath the summit of Etna. There is no reference to joint interpretation of petrologic, geodetic, and seismic data to define magma storage and transport paths. Again, Hawaiian experience has shown that these studies need to be tied together to give an adequate picture of the volcanic plumbing. Seismology is sadly neglected here. It would have been useful to have tables summarizing the location, depth range, and frequency of different types of earthquakes associated with volcanic activity.

Chapters 8 and 9 give an excellent account of the history of both volcanic and seismic hazards in the Etna area. Lives have been lost in the area, most recently in 1979; the Etna Volcano Observatory was destroyed in 1971; and significant property loss has occurred during all recent flank eruptions. The most recent large eruption, in 1983, destroyed and threatened property and resulted in a major effort at lava diversion. Chapter 9 is an outstanding summary of volcano hazards from historical, political, and personal perspectives. The enumeration of possible responses to volcanic eruptions, and consequences of those responses, will be useful to readers who live in any active volcanic region.

My main objection to the book is that the authors alternate between a textbook style and a narrative one. For me, the narrative style is the one appropriate to a book about a volcano and its history. Definitions of terms, equations, and geologic principles would be better left to a textbook. The extreme example of this is chapter 5, "The rheological behaviour of basaltic lavas," which seems totally out of place in this book. The chapter mentions Etna as a site where direct measurements of the physical properties of magma have been attempted, but otherwise it is a treatise on rheology that belongs in a book on that subject. The lack of an immediate geographic reference is annoying. (The first index map showing Mount Etna's location is on p. 66 in chapter 3.)

Despite its limitations, I recommend the book for inclusion in all earth science libraries. It provides a comprehensive and useful overview of Mount Etna and is a good starting point for students interested in more detailed treatment of the geology, petrology, and volcanic hazards associated with an active volcano.



"Well-developed columnar jointing in a thick flow filling a valley at Gole dell'Alcantara at the foot of Etna." The flow followed the river Alcantara to the sea from an eruption at the Moio cone on the northern flank of Etna. Tens of meters thick, it has been exposed by valley downcutting to show the spectacular jointing that has become a tourist attraction. [Photograph by T. J. O. Sanderson; from *Mount Etna*]

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Karst

Karst Geomorphology. J. N. JENNINGS. Blackwell, New York, 1985. x, 293 pp., illus. $49.95; paper, $14.95. Second edition of *Karst*.

Karst is a peculiar landscape created in limestone and gypsum by chemical dissolution of the bedrock. Karst landscapes are characterized by closed depressions, deranged surface drainage, and caves. Closed depressions, from small sinkholes to closed basins many kilometers in diameter, collect runoff and divert it to subsurface routes. Tributary streams often sink at the contact with the soluble rocks only to re-emerge great distances away as gigantic springs that may give birth to full-blown rivers. In between there may be only a pock-marked landscape with no surface drainage at all. Caves are fragments of underground solution conduits, and their integrated length may reach many kilometers. Groundwater in karst is also a peculiar thing—a mixture of water stored in pores, rock fractures, and other small openings and water flowing in the pipes and channels of the conduit system where velocities are comparable to those of surface streams.

J. N. Jennings's *Karst Geomorphology* purports to be a second edition of his 1971 volume of similar title. The new book is a complete rewrite of the old. The number of pages is approximately the same, and the subjects covered are the same, but nearly every word of the text has been rewritten and much new material is included. More than half of the figures are new. About two-thirds of the 600-entry bibliography is post-1971, an important consideration because there has been much research over the past decade on the surficial geomorphology and hydrology of karst. The original Jennings book was one of the first works in English on karst, and it served as an important reference for much of the new research.

The book is intended for the advanced undergraduate or beginning graduate student in geology or geography. The strong point of the book is its global view. Jennings has been everywhere and seen everything. His examples of karst phenomena range from West Virginia to Australia to New Guinea to Yugoslavia to his native Yorkshire to Kentucky to the Caribbean to South China to the Malay Archipelago to northern Canada. Every area of the earth where karst occurs seems to be represented by a bit of text or a photograph.

The book is written in the traditional descriptive style of the geomorphologist, which is an unfortunate way to treat a subject in which chemistry plays such a dominant part. The chemistry of carbonate dissolution gets only a couple of pages in spite of the very large and recent literature on both equilibrium reactions and the dissolution kinetics of limestone and dolomite. One searching for the latest detail on chemical processes or the latest work on mathematical modeling and statistical morphometric analysis of karst landforms will find very little of it in this book.

There is a curious mind-set that seems to be common to most karst geomorphologists, who love landforms and caves from exotic locales but don't notice the karst in their own backyards. In the urbanized carbonate terrains of the United States, undermining of highways and foundations by soil piping, sinkhole collapse, reservoirs that refuse to hold water, basement flooding in sinkhole areas, contamination of carbonate