bastian von Hoerner reviews the likelihood of interstellar colonization. Ronald Bracewell stresses that the first advanced civilization could indeed preempt the galaxy. Freeman Dyson takes issue with statements occasionally made by distinguished scientists that interstellar travel is impossible by outlining no fewer than nine ways in which advanced civilizations might accomplish it. Half a dozen other interesting papers elaborate on the ideas sketched above. Hart concludes the volume with a second paper, pointing out the fantastically lucky and improbable path that life on the earth has trod through four billion years of potential disasters quite capable of wiping it out—either forcing evolution to begin again from scratch or totally precluding any future life. In other words, even though havens for life in the universe may be abundant, and even though life may indeed start in many places, the chance of life hanging in there long enough to evolve intelligence and technology may be very slight indeed for any given planet.

For those interested in questions on the grand scale, this slender book is one of the most interesting and important of the decade. Though few of the ideas are original with the volume, to have them collected in one place and so forcefully stated cannot fail to have a profound effect. The pendulum has been given a very hard push back toward at least a neutral point.

Nevertheless the book is quite one-sided. It does not include a single defender, such as Carl Sagan or Frank Drake, of the opposite point of view. Powerful counterarguments *can* be made. For example, there are a group of counterarguments that fall under the heading "absence of evidence is not evidence of absence." Galactic civilizations, of the type that survive suicidal tendencies and develop interstellar travel, may feel no need whatever to latch onto all the real estate in the galaxy, or any more desire to interfere with indigenous life forms than we have to catch every butterfly. Or our science may still be truly embryonic—we may be no more aware of the real currents of interstellar communication than Amazon natives are of the radio waves in which their bodies are bathed.

The recently published survey, *Astronomy for the 1980's*, sponsored by the National Academy of Sciences, considers these questions closely and recommends a modest but long-term program of listening and looking for evidences of intelligent extraterrestrial life, initially mainly in the high-frequency radio band. The survey recognizes that the probabilities of any early detection are small indeed but that the importance of such a discovery would be incalculably great. A further important factor is that low-cost technology now exists to improve over previous searches by factors of a million or more.

Are we alone? We just don't know. We are unlikely to know unless we look long and hard—and maybe not even then. But either way the implications are utterly profound. If we are not alone in the galaxy, can we hope someday to qualify as members of the galactic club despite our human frailties and foolishnesses? If we are alone, we are responsible for keeping this fragile spark alive and offering what should be the blessing of sentient life to countless descendants down through the eons.

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Martian Landforms

The Channels of Mars. VICTOR R. BAKER. University of Texas Press, Austin, 1982. xiv, 198 pp., illus. $39.95.

Perhaps one of the most enigmatic results of the recent exploration missions to Mars has been the discovery of massive and ubiquitous examples of fluid erosion on a planet that currently appears to be bone dry, with an atmospheric pressure typically less than 1 percent that of the earth. Ancient thousand-kilometer-long channels, dwarfing by orders of magnitude any conceivable terrestrial analog, suggest almost unimaginably large flows of water. Even older, widely scattered valley networks, equal in size to or larger than terrestrial canyon networks and of similar morphology, suggest persistent groundwater erosion.

Baker presents a comprehensive review of the controversy surrounding the seeming contradiction between the existence of channels and valleys, which strongly suggest water flow, and the dry and airless surface of Mars. He begins with historical controversies surrounding the study of Mars and takes the reader through the current ones, which concern the origin of the Martian channels. Baker is among those who favor an explanation of the channels that posits a catastrophic flood.

As he points out, 80 years ago another controversy involving a diluvialist hypothesis raged when J. Harlen Bretz suggested that the curious ragged morphology of the Scablands in eastern Washington could be explained by the occurrence of huge catastrophic Pleistocene floods. The Bretz hypothesis was severely criticized by leading geological figures of the day, particularly for its failure to suggest a source for the hypothesized floods. Critics of the hypothesis that catastrophic floods caused the large Martian channels also point to the lack of an apparent source for the floods as a weakness in the argument. In the earlier controversy ice-dammed Pleistocene Lake Missoula was eventually identified as the source of water, and the Bretz hypothesis was recognized as remarkably prescient, considering that synoptic spaceborne imaging was not available to him. Whether the proponents of Martian diluvialism will similarly triumph is still far from clear, as Baker readily admits.

Because Baker's previous comprehensive work on the Scabland problem (*Geol. Soc. Am. Spec. Paper 144* [1973]) was strongly in concert with the work of Bretz, it is not surprising to find him favoring a catastrophic flood as the source of the Martian channels. Nevertheless, his exposition of competing hypotheses, primarily eolian and glacial scouring, is fair and thorough, and his reference to parallel work of colleagues is generous.

Beyond the catastrophic flood controversy, Baker deals competently and completely with the general subject of climatic change on Mars and with the evidence bearing on it that a variety of other landforms may or may not provide. His approach is refreshingly that of an experienced geomorphologist, and the book is distinctly data-oriented, with a profusion of detailed geomorphic maps of Martian and Scabland channels and many page-sized photographs of Martian channels and terrestrial analog features. The only real criticism that can be leveled at the book is that a few pictures are upside down and the labels on some of the illustrations are not polished.

Recently, as a result of the Viking missions to Mars and the Voyager missions to Jupiter and Saturn, there have appeared a spate of popular and technical books of uneven quality that have surveyed the results of the missions generally. In contrast, *The Channels of Mars* is a well-focused and well-illustrated monograph about a fascinating morphological problem written in a lively style by an expert in fluvial geomorphology. Baker's book is a comprehensive summary and a stimulant for those of us studying Martian channels, valleys, and

climatic change, as well as a neat scientific detective story. It should expand the horizons of Baker's more traditionally oriented colleagues.

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Accounts of an Ash Fall

The Time of Darkness. Local Legends and Volcanic Reality in Papua New Guinea. R. J. BLONG. University of Washington Press, Seattle, 1982. xii, 258 pp., illus. $25.

The recent eruptions of Mount St. Helens and El Chichón have drawn attention once again to the power and influence of volcanoes in human affairs. These recent eruptions, however, were smaller than many others that people have seen, and the frequency of big eruptions is greater than many of us imagine. More than 10 eruptions in the past 200 years have exceeded the 1980 eruption of Mount St. Helens in the volume of material erupted. The biggest recorded eruption, at Tambora in 1815, was 100 times larger, and much greater cataclysms have been obscured by the mists of time, known now only from the natural traces they left behind. The record of such eruptions is far from complete, and we have much to learn before we can assess confidently their real frequency and their hazards.

Even so, it is disconcerting to learn of an eruption several times larger than the one of Mount St. Helens—and similar to the Krakatau eruption of 1883—that occurred only 300 years ago and yet went completely unrecorded at that time by the Western world. This book deals with such an eruption, one that occurred on Long Island in the Bismarck Sea and distributed ash over a large area of Papua New Guinea. Although it was not described in written literature, the eruption was abundantly recorded in the oral traditions of the region, which refer to its ash fall as "the time of darkness." A truly remarkable feature of the event is its preservation among more than 30 different language groups. It thus provides a splendid opportunity to investigate not only the event but the precision with which it was recorded.

The Time of Darkness is an admirable and far-ranging account of interdisciplinary sleuthing that should be of equal interest to geologists, anthropologists, and oral historians. It should interest many general readers as well, despite some technical jargon and diagrams and cryptic descriptions of some analytical methods. An appended glossary of volcanic terms should be helpful for the nongeologist.

Blong is a geomorphologist and devotes almost half of the book to a description of the eruption and its deposits. He shows how a widespread ash layer of mainland New Guinea, the Tibito Tephra, can be identified and correlated with the Matapun beds on Long Island by various physical and chemical criteria. Comparing these deposits with those of well-recorded eruptions, he then reconstructs the probable history of the eruption, including its magnitude and duration, and the spreading of its ash cloud.

Blong turns next to the legends about the time of darkness, as recorded by a large number of field observers who questioned local informants. He compares these descriptions with geologic evidence in an attempt to evaluate the accuracy of the traditions. The comparison shows that in most respects the legends seem to give a realistic portrayal of the expected physical characteristics and consequences of such an ash fall. Blong argues that although these accounts were not written down they appear to be as accurate as most European accounts of ash falls (some "scientific" descriptions have been grossly inaccurate) and should therefore be regarded as history and not as myth.

In one important respect, however, the legends do differ significantly from the geologic reconstruction. They appear to err in recording time. Temporal inaccuracy is expressed in two ways. First, the duration of the tephra fall appears to have been exaggerated in almost all versions of the legend, in some cases by more than an order of magnitude. This circumstance could have arisen from stress and from an absence of clocks when the diurnal movement of the sun was not available to mark the passage of time. Second, and of much greater importance to oral historians, the legends severely underestimate the interval since the eruption occurred. Whereas most geologic and historical evidence indicates that the eruption occurred about 300 years ago, the evidence from genealogies points to its having occurred only about 100 to 150 years ago. If the genealogies really do err by this amount, we must question once again the reliability of such evidence. For this reason alone, Blong's work deserves close attention.

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A Weather Anomaly

Volcano Weather. The Story of 1816, the Year Without a Summer. HENRY STOMMEL and ELIZABETH STOMMEL. Seven Seas Press, Newport, R.I., 1983. xii, 178 pp., illus. $15.

This is a pleasant small book. An impressive amount of study and scholarship is evident from the very first chapter, which starts off with a brief account of the political situation in the Sunda Islands (modern Indonesia) after the end of the Napoleonic wars, with reports requested by the temporary British administration about a major eruption of Mount Tambora on the island of Sumbawa in 1815, and with the history of subsequent ascents of that volcano. The story is nicely illustrated with pictures of Thomas Stanford Raffles, naturalist and founder of Singapore, who was then lieutenant governor of Java, and with drawings of the volcano. Of particular interest is a diagram that compares the volume reduction of Tambora with that produced by the recent eruption of Mount St. Helens.

The following eight chapters describe the weather during the exceptionally cold summer of 1816 in New England and in western Europe and relate the social consequences of the resulting food shortage. The reader gains a strong impression of the resilience of New England's scrabble farm economy, but also of the impetus that the disaster gave to westward migration into the Great Plains and beyond. The whole development is profusely and interestingly documented with quotations from contemporary journals, diaries, accounts of academic and legislative meetings, lists of wheat prices, and so on. The narrative is enlivened by many illustrations of historical interest.

The last third of the book seems less informative. Chapter 10 considers a possible connection between the climate anomalies of 1816 and a subsequent widespread cholera epidemic, which reached New York in 1832. This connection is at best tenuous. The beginning of the scourge is associated with a famine in Bengal in 1816, which in turn is attributed to the peculiar weather conditions of that year. This contradicts an earlier statement that "it would appear . . . that the truly exceptional character of 1816 weather was limited to a small portion of northeastern America, Canada and the extreme western parts of Europe." It is a pity that the Indian lead was not followed up, because I believe that there were some British records available from Bengal at that time and the connection