

advanced undergraduate students of meteorology and for professional meteorologists. He adds that the book may also prove useful to meteorologists studying daily changes of global weather, a timely suggestion indeed. The book assumes knowledge of general meteorology and of many technical terms, but even readers with considerably less technical knowledge will find much handy information when using the book as a reference volume, especially the parts dealing with climate.

Technically, Ramage takes issue with various misconceptions that have plagued tropical meteorology for many years and are hard to eradicate. He makes a strong case against the concept, imposed from outside the tropics, that monsoon weather can be treated as being governed by an "intertropical front" or "intertropical convergence zone." Instead, he proposes a more realistic and complex overall classification scheme of monsoon weather which, it is hoped, will find general acceptance. He also places unusual emphasis on the role of coastal waters, which, under the influence of the broad wind systems, provide a feedback limiting or enhancing monsoon strength in various areas. His example of the situation off the African east coast north of the equator is particularly telling. Among the weather disturbances the treatment of the "subtropical cyclone," especially its role in the vertical mixing of the atmosphere, is novel and impressive. Throughout the book the point is made that heavy monsoon precipitation comes in the form of persistent rains, as contrasted with thunderstorm showers. Indeed, an inverse relation between total precipitation and thunderstorm frequency has been demonstrated by various researchers, for instance in northern Australia. To be sure, one can always find controversial matter in a volume treading so much new ground. For example, according to the author, the summer monsoon "heat" low pressure areas found persistently over West Pakistan and other areas occur under the influence of general subsidence in the upper air, keeping skies clear and permitting maximum radiation from the sun to reach the ground. Undoubtedly correct. But then he suggests that absorption by air of reradiation of this heat from the ground reduces the density of the lower atmosphere to create the heat low. At best, one could investigate the role of a heavy dust layer that may be present (as has been done by R. Bryson, University of Wisconsin).

But it is not demonstrated why heat convection from the ground should not be the principal mechanism here as everywhere else.

Ramage's writing technique consists largely of description backed by qualitative reasoning, a method he defends strongly in the "Concluding remarks." He feels, justly, that useful formulation of models for computers must be preceded by an understanding of the laws and special circumstances creating weather patterns. His book, drawing together the most important observations of the monsoon areas into a general scheme, should be useful in fur-

thering a realistic advance toward objective weather prediction. From the vast literature, he has selected a large and representative sample for references. Illustrative material is plentiful, including many satellite photos. However, the publisher has failed to provide adequate editing of the drawings; many have an excess of lines and are hard to interpret. Also, reduction has been carried too far; much lettering is reduced to 0.04 inch and may require a magnifying glass for reading.

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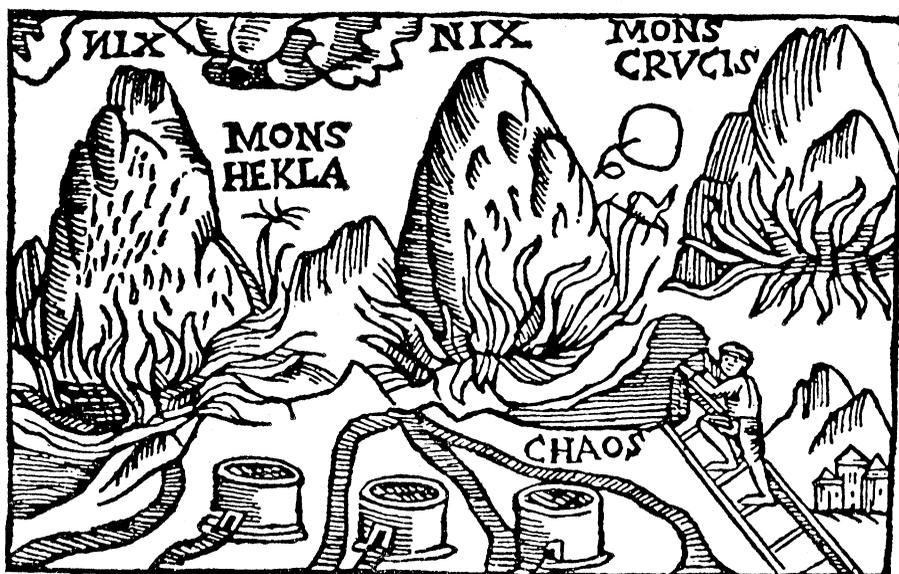
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A Feature of Iceland

Hekla. A Notorious Volcano. SIGURDUR THORARINSSON. Translated by Jóhann Hannesson and Pétur Karlsson. Almenna Bókafélagid, Reykjavik, Iceland, 1970. 62 pp. + plates. \$7.

From the land of fire and ice comes a most useful and interesting volume on Hekla, a notorious volcano. This is from the pen of Sigurdur Thorarinnsson, who is an outstanding volcanologist and is

chairman of the Division of Geosciences of the Science Institute of the University of Iceland. The author's work in the study of tephra layers in Iceland has led to the development of the specialized scientific subject known as tephrochronology and has attained worldwide recognition. (Tephra" is a general term for all solid matter which comes from a volcano as airborne and thus is



The volcano Hekla as depicted in 1555. "After [the volcano] awoke from centuries of slumber in the year 1104 . . . horrific tales about it soon began to circulate throughout the Catholic world: there, said people, was to be found the gateway to Hell, if not Hell itself. . . . In the oldest reference to Hekla, the *Book of Wonders* dating from about 1180 and compiled by Chaplain Herbert of the Clairvaux monastery, the following passage is found: 'The renowned fiery cauldron of Sicily, which men call Hell's chimney . . . is affirmed to be like a small furnace compared to this enormous inferno . . . Who now is there so refractory and unbelieving that he will not credit the existence of an eternal fire?' . . . In a travel book by the Frenchman De la Martinière printed in 1675 readers are informed that the Devil now and again drags the souls of the damned out of Hekla's fires in order to cool them on the pack-ice in the seas off Iceland . . . Icelanders also stood in dread of the volcano, but this had its natural causes, for the damage it did to their property when in ugly mood was severe . . . the belief in Hell inside Hekla never made much headway in Iceland." [From *Hekla: A Notorious Volcano*]

distinguished from lava, which flows.)

The book gives a background from classical literature of some of the myths surrounding Hekla, then proceeds to the placing of Hekla in the two active volcanic belts running southwest-northeast in South Iceland. The next discussion is of the eruption history of Hekla. The changes in types of lava and tephra during an eruption as well as in successive eruptions are described. The list of the 13 known eruptions starting with that in 1104 leads naturally to a detailed discussion of the 1947 eruption, which is then followed by a description of the 15th and last eruption of 1970.

Throughout the detailed accounts of the 1947 and 1970 eruptions the distribution of tephra in time and space is carefully analyzed, as is the flow of lava in both eruptions. A reader can very well become awe-stricken at the disasters which have flowed from the volcano through its tephra fallout. In the 1970 eruption alone tephra containing fluorine contaminated an area of 450 farms, owning 95,000 sheep, and over 6,000 lambs and 1,500 ewes were killed by fluorosis. Fortunately, the fluorine-contaminated tephra is ejected only during the Plinian phase, usually in the first two or three days of the eruption. The wind and weather determine the extent of damage.

Many geophysical problems arising from studies of the tephra and lava are mentioned. For example, the amazing difference in composition of the xenoliths ejected perhaps will give an insight into what is happening in the lower crustal layers which are the source of magma for this volcano. Fifteen figures, two plates, and 54 illustrations are carefully keyed to the text. The book is highly recommended to anyone interested in volcanoes.

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Pre-Tychonic Data Reanalyzed

Ancient Astronomical Observations and the Accelerations of the Earth and Moon. ROBERT R. NEWTON. Johns Hopkins Press, Baltimore, 1970. xx, 310 pp., illus. \$10.

The secular accelerations of the earth's rotation and of the moon in its orbit are strongly interrelated with the definition of time, with the long-term behavior of the earth's interior, and

with the question of variability of the gravitational constant, predicted by the Brans-Dicke scalar-tensor theory. Thus a study of these accelerations that declares that most of the classical work in this area is wrong is likely to attract attention. Newton sets about to destroy the credibility of the methodology of earlier investigators, to establish his own methodology as being without the flaws of his predecessors', and to re-analyze the available astronomical data from pre-Tychonic times. Having established a solution at roughly double the conventional value (due to Spencer Jones) of the lunar acceleration in modern times, Newton concludes with some geophysical speculations, attempting to explain how the accelerations could have changed as drastically since ancient times as his results indicate.

The degree of success attained by Newton will lie in the eye of the beholder. The great difficulty of his subject results from the nature of the observations: poorly documented accounts, frequently by inexperienced observers, of celestial events visible to the naked eye, such as eclipses and occultations. In some cases, the definitions of measurement terms are in doubt. Nearly always, the date and location of the observations are unknown. Perhaps Newton's greatest contribution is his critique of the usual procedure (the "identification game") for assigning dates and localities to such events, a procedure which he claims artificially minimizes the departure of the final result from the initial assumption, and which can lead to the classical result even if a table of random numbers is used. The situation is perhaps overstated, but it seems clear that there is much room to suspect the classical results of serious bias.

Newton is much less convincing in his own treatment of the observations, and many readers will reject the work outright because of its unsatisfactory aspects. This would be a mistake. He has replaced the "identification game" with a statistical guessing match fully as subjective. He criticizes other authors for failing to go to primary sources, and then does not bother to consult easily available references. Sometimes his statistical principles seem at variance with the proper ones as understood by this reviewer. Estimates of achievable observational resolution of eclipse magnitudes are based on laboratory tests with paper cutouts rather than on real eclipse experience. Conventional terminology and usage are widely

flouted. But, it is not obvious that these flaws negate the numerical results. Even if they do, the ground has been broken for a thorough reexamination of this subject.

Newton's unconvincing geophysics need not undermine the view that such a reexamination is in order, for his calculations are based on acceptance of the "modern" value of the lunar acceleration. Van Flandern, however, has indicated a very large correction to the conventional value for the present epoch also, obtaining a value roughly compatible with the values obtained by Newton for 200 B.C. and A.D. 1000. These two studies in fact provide important support for one another's numerical results. Astronomers and geophysicists will be well advised to examine this work carefully.

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The Chandler Wobble

Earthquake Displacement Fields and the Rotation of the Earth. A NATO Advanced Study Institute, London, Ontario, June 1969. L. MANSINHA, D. E. SMYLLIE, and A. E. BECK, Eds. Reidel, Dordrecht, and Springer-Verlag, New York, 1970. xii, 310 pp., illus. \$19.80. Astrophysics and Space Science Library, vol. 20.

In 1891 S. C. Chandler, a businessman in Cambridge, Massachusetts, reported that his analysis of latitude observations showed two periodic components in the motion of the pole—an annual term, and a component with period 14 months. It was not long before the periods of Chandler's wobble were explained. The 14-month term turned out to be the Eulerian free wobble with period lengthened from the theoretical 10 months to 14 months because of elasticity of the earth. The annual component was nicely explained by the seasonal changes in the inertia of the atmosphere and the distribution of snow, groundwater, and ocean mass.

The mechanism of excitation and damping of the 14-month wobble has been debated to this day. Among the hypotheses advanced are nonseasonal changes in the inertia tensor of the atmosphere and in the ocean load, electromagnetic core-mantle coupling, and changes in the solid earth inertia tensor accompanying earthquakes. Some famous men attempted to find what excites the Chandler wobble, including Larmor,