Lick Observatory

Eye on the Sky. Lick Observatory's First Century. DONALD E. OSTERBROCK, JOHN R. GUSTAFSON, and W. J. SHILOH UNRUH. University of California Press, Berkeley, CA, 1988. xii, 295 pp. + plates. $25.

Lick Observatory was the first of the large privately endowed observatories responsible for the rise of American astronomy to worldwide preeminence. Followed by Lowell (1894), Yerkes (1897), Mt. Wilson's 60-inch (1908) and 100-inch (1917) telescopes, and eventually Palomar's great 200-inch in 1948, the completion of Lick in 1888 may be seen in hindsight as a landmark in the history of astronomy in America.

This centennial history is therefore an important and welcome volume. The authors, one of them (Osterbrock) a former director of the observatory, state that this is a popular history, and as such it must be judged.

Fifteen years elapsed from James Lick's decision in 1873 that his monument would be an observatory housing the world's largest telescope to its transfer to the Regents of the University of California upon completion in 1888. The first four chapters of the book deal with this "prehistory," from the courting of the eccentric millionaire to the consultations with Naval Observatory astronomers Simon Newcomb and Edward S. Holden and the difficulties of constructing an observatory on the 4200-foot elevation of Mt. Hamilton in California. The latter subject has recently been discussed in detail in Helen Wright's *James Lick's Monument: The Saga of Captain Richard Floyd and the Building of the Lick Observatory* (1987), to which the authors had access in manuscript. Most of the remaining chapters center on the tenures of the directors, who included Holden, James E. Keeler, William W. Campbell, Robert G. Aitken, C. Donald Shane, and Albert E. Whitford. Two thematic chapters deal with the observatory's solar eclipse expeditions and its important role as a center for graduate education in astronomy.

The authors describe personalities, politics, and science beginning with Holden, the controversial first director, and concluding with the 10-meter Keck telescope now planned in collaboration with Caltech. In between is sandwiched the story of the 36-inch Crossley reflector that became operational in 1898, the successful post-war effort to acquire a large new telescope (the 120-inch reflector was placed in operation in 1959), the controversial association with the Santa Cruz campus of the University of California begun in 1964, and an enormous amount of scientific research. Little attention is given to Lick's early work in positional astronomy, but the observatory quickly delved into the new astronomy: the pioneering work of Keeler with spiral nebulae and Campbell with spectroscopic radial velocities established Lick's reputation as an innovative institution. Subsequent work on solar eclipses, double stars, and proper motions is also described, if not in great detail, as well as the work in astrophysics.

Numerous archives have been used in this study, but most especially the Mary Lea Shane archives of the Lick Observatory. Historians of science and technology will wish for the use of more secondary historical sources, for footnotes, for a more analytic approach, and for placement of Lick's work in the broader context of American science. Among the tasks left for historians of science are an examination of the relation between positional astronomy and astrophysics at Lick, an externalist study of funding policies and institutional interactions, and an internalist history of much of the astronomy at Lick touched on only briefly in this volume.

But as a popular history this volume succeeds very well. It is eminently readable, it lays out the chief personalities involved and lines of research undertaken, and it whets the appetite for more. Reading it, one realizes the need for histories of more of our scientific institutions. A knowledge of where we have have been cannot help but point the way to where we should go.

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An Area of Deformation

Tectonic Evolution of the Himalayas and Tibet. R. M. SHACKLETON, J. F. DEWEY, and B. F. WINDLEY, Eds. The Royal Society, London, 1988. vi, 325 pp., illus., + plates. £69. From a meeting, London, Nov. 1987.

Stretching for more than 1300 kilometers north–south and 2000 kilometers east–west, the Himalaya and the Tibetan plateau form the greatest region of high elevation on earth today and part of the broadest region of intracontinental deformation. Their topographic expression and deformational history are the result of continent-continent collision and continued convergence between India and Eurasia during the past 45 million years. The Himalayan-Tibetan region is one of the most tectonically active areas in the world and serves as a natural laboratory for studying the poorly understood processes of intracontinental deformation. With the exception of a few

pioneer efforts there has been little geological research in most of this region because of its physical inaccessibility and because much of it has been closed to foreigners until rather recently. This is clearly evident on the "carte tectonique de l'Eurasie" that accompanied Argand's famous synthesis of Eurasia in 1924, where about half of the Tibetan region is left blank.

With the growth and development of plate tectonics, increased interest in the Himalayan-Tibetan region has resulted in a large amount of new geological work. This prompted the editors of this volume to organize a discussion meeting under the auspices of the Royal Society to bring together scientists working in the region. The papers contained in this volume are contributions from the meeting and largely reflect the status of current research efforts.

Most of the 12 papers contain reviews of the geology and geophysics of the Himalayan-Tibetan region, although a paper by Alan Smith considers the Late Palaeozoic biogeography of all East Asia. These reviews will be valuable to scientists who did not attend the meeting or who are not working in the region and will bring them up to date on advances in some areas of Himalayan-Tibetan research (the volume was published less than a year after the meeting), but the contributions cover only a few parts of this vast region. The areas from Pakistan to the Kumaun and eastern Nepal are reasonably well covered, but there are no contributions about the eastern part of the Himalaya or about the geology of Tibet. It is unfortunate that there is no general contribution, or even a brief review, from the Chinese-British Tibet Geotraverse, although the results from that study are to be published in a separate volume. Contributions by Molnar and Hirn describe geophysical information from Tibet as well as the Himalaya, and England and Houseman discuss the mechanics of deformation of the Tibetan Plateau. Even though the quantity of new data is not great in most contributions, the papers cannot be considered simply review articles, because all present new ideas and new interpretations from evolving research efforts.

An interesting paper by Hirn on an interpretation of the crust-mantle structure of the Himalaya-Tibet region is based on the Chinese-French seismic surveys in 1981–82, with comparisons with similar data from better-known collisional orogens in western Europe. Hirn shows that Moho reflections beneath one area of the Tibetan plateau are well defined because of the high velocity in the upper mantle, and these data show clear and numerous offsets in the Moho. The interpretation favored by Hirn is that the lower crust and upper mantle have been shortened by thrust wedges bounded by low to moderately dipping faults that are decoupled within the middle crust and have no expression in the upper crust. The main sutures within Tibet are interpreted as being near vertical faults that offset the Moho. Hirn is quick to point out that seismic data from the Himalaya-Tibet region are very limited in quantity and quality relative to the size and complexity of the region and that sweeping conclusions are premature. There is an excellent review of the geophysical constraints on the deep structure of the Tibetan Plateau, the Himalaya, and the Karakoram, the longest paper in the volume (55 pages), by Molnar. From a variety of seismological data, Molnar concludes that the crust is nowhere less than 50 kilometers thick and that it is everywhere less than 80 kilometers thick, with marked lateral variations in thickness or velocity structure. He also concludes that there is a large area in north central Tibet underlain by lower-velocity material and more highly attenuated mantle, implying higher temperatures and thinner crust in that area, although in elevation the area is similar to the rest of the plateau. Isostatic compensation in this area occurs partly because it is underlain by less dense and hotter mantle than is present beneath the rest of Tibet. Molnar speculates that this area in north central Tibet may be the locus of convective upwelling of hot material in the upper mantle and that the corresponding area of downwelling might lie adjacent to the upwelling region, probably beneath southern Tibet and perhaps also beneath northernmost Tibet. Molnar disagrees with Hirn's interpretation that south-dipping lower-crust–upper-mantle thrust wedges exist beneath the Himalaya, arguing that the data are equivocal and that a north-dipping Moho, supported by flexural and gravity studies of the Himalaya, cannot be ruled out.

Hodges *et al.* present new pressure-temperature paths for metamorphic rocks from central Nepal and make the first attempt to relate segments of the pressure-temperature trajectories to specific Himalayan events. These data are used to construct an interpretative model for the tectonothermal evolution of the Greater Himalaya, in which the authors present an interesting series of cross sections that depict the structural evolution of the Greater Himalaya from Middle Eocene to Recent time. In another paper based on studies in the western Himalayan syntaxis, Coward *et al.* conclude that thrusting is thin-skinned and that thrust sheets are detached within the crust. Lower Indian crust has been underthrust about 500 kilometers beneath the region, and deformation within the underthrust crust is characterized by ductile shears and recumbent folds, now uplifted and exposed in the Indus and Nanga Parbat syntaxes. Many of the data presented in this paper have been presented before, but they have been updated and reinterpreted.

Overall this book makes a useful reference work for scientists interested in the Himalaya and in processes of intracontinental deformation. The papers are well referenced and provide useful reviews for the parts of the Himalayan-Tibetan region they cover.

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Combination Effects in Chemical Carcinogenesis. Dietrich Schmähl. VCH, New York, 1988. xii, 279 pp., illus. $89.50.

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