Book Reviews

Bikini and Nearby Atolls. *U.S. Geological Survey Professional Paper No. 260* (a–w). U.S. Geological Survey, Washington, D.C., 1954–1959 (order from Superintendent of Documents, Government Printing Office, Washington 25, D.C.). xv + 798 pp. Illus. $24.15.

When the sea-worn H.M.S. *Beagle* returned to England in 1836 bearing the young naturalist Darwin and the collections he had accumulated, no one then living could have imagined the profound effect that such a modestly financed voyage would have upon the intellectual life of the modern world. Because in later years the *Origin of Species* received the lion's share of attention, and because it impinged upon such a diversity of interests, a second outgrowth of this unique voyage is often overlooked by the scientific world at large. This was Darwin's account of coral reefs and his theory that atolls had grown upward from subsiding foundations whose rate of sinking had been slower than the rate of upgrowth.

Strong support for Darwin's conclusions came from a contemporary explorer-naturalist, James Dwight Dana, who accompanied the United States Exploring Expedition on its voyage around the world under the command of Charles Wilkes. Two vessels of this expedition, the U.S.S. *Peacock* and the *Flying-fish*, visited Bikini, which was then uninhabited, in 1841.

In the following century, the subsidence theory was attacked repeatedly, and for a period, around World War II, there appeared to be almost as many theories proposed as there were investigators in the field. A leading thesis advanced in opposition to the idea of subsidence argued that, if the reef-bearing foundation remained stable, a platform upon which the reef might flourish could have been carved during a time when sea level was lower than it is today, perhaps during the glacial stages of the Pleistocene. This concept, with a variety of amendments added to it through years, was the chief contender with the theory of subsidence. In addition to these two extremes, a number of intermediate hypotheses were advanced, embodying features of both.

Largely because the more imposing atolls are far from scientific centers and because they are such inscrutable structures, rising as they do from the abyssal depths of the open ocean, little more has been known of them than can be seen in the uppermost few fathoms; all else is shrouded in darkness. The obvious first step toward arriving at a solution to the problem of atoll formation would be to drill a hole through the coralline part of a reef and see how far down it actually extends. In part because of the distance and expense, only two holes had been drilled on reefs in the open Pacific before World War II—one to 1114 feet by the Royal Society, in 1896–98, at Funafuti atoll, the other by the Japanese to a depth of 1416 feet at Kaita-daito-jima, near Okinawa, in 1934–36. Although both holes revealed reef material all the way, the advocates of either theory were able to claim, by skillfully marshaling their arguments, that the imperfect evidence of these early bore holes supported their case.

Fortunately, the need for making a complete environmental study of the Marshall Islands atolls in connection with the earlier phases of the atom-bomb testing program in 1946 had as a scientific outgrowth the papers that have been gathered together to form this publication. The scientific community can be grateful indeed that such an opportunity was provided by the United States Navy in an enlightened approach to the values of pure science, very much in the tradition of the support given the pioneer investigations, in the last century, of Matthew Fontaine Maury in oceanography or of the Charles Wilkes expedition in marine geology, biology, geography, and ethnology. The comparison between the first naval scientific investigations of this distant part of the world and the investigation reviewed here is indeed an interesting one. The intervening 105 years have seen an incredible advance in what might be described as the technology of science, yet one cannot fail to be impressed by the intellectual acuity of our predecessors.

The results of the many aspects of this detailed, postwar investigation of Bikini and the neighboring atolls in the Marshall Islands appear in a series of separate, paper-bound 9- by 11½-inch booklets, lettered consecutively from A to W, and together making up a single publication, *U.S. Geological Survey Professional Paper No. 260*. The 23 papers are attributed to 38 authors or groups of authors, but because some authors participated in the writing of more than one article, 29 people are actually involved. If all this sounds complicated, it is. It also makes it virtually impossible to review the work within the space available. The following list indicates the far-ranging nature of this inquiry:

Part 1, *Geology*. (a) "Geology of Bikini and nearby atolls," by K. O. Emery, J. I. Tracey, and H. S. Ladd, with foreword by Roger Revelle (1954).

Part 2, *Oceanography*. (b) "Circulation systems of Bikini and Rongelap lagoons," by W. S. von Arx (1954); (c) "Adjustment of Bikini atoll to ocean waves," by W. H. Munk and M. C. Sargent (1954); (d) "Sea temperature in the Marshall Islands area," by M. K. Robinson (1954); (e) "Biologic economy of coral reefs," by M. C. Sargent and T. S. Austin (1954); (f) "Plankton of northern Marshall Islands," by M. W. Johnson (1954); (g) "Recent brachiopods," by G. A. Cooper (1954); (h) "Recent foraminifera of the Marshall Islands," by J. A. Cushing, Ruth Todd, and R. J. Post (1954); (i) "Recent corals of the Marshall Islands," by J. W. Wells (1954).

Part 3, *Geophysics*. (j) "Seismic studies of Bikini atoll," by M. B. Dobrin and Beauregard Perkins, Jr. (1954); (k) "Seismic-refraction studies of Bikini and Kwajelein atolls and Sylvania guyot," by R. W. Raitt and Beauregard Perkins, Jr. (1954), (l) "Magnetic structure of Bikini atoll," by L. R. Alldredge, Fred Keller, Jr., and W. D. Dichtel (1954).

Part 4, *Paleontology*. (m) "Fossil calcareous algae from Bikini atoll," by H. W. Johnson (1954); (n) "Smaller foraminifera from Bikini drill holes," by Ruth Todd and Rita Post (1954); (o) "Larger foraminifera and smaller diagnostic foraminifera from Bikini

drill holes," by W. Storrs Cole (1954); (p) "Fossil corals from Bikini drill holes," by J. W. Wells (1954).

Part 5, *Miscellany*. (q) "Marine annelids from the northern Marshall Islands," by Olga Hartman (1954); (r) "Physical oceanography in the Marshall Islands area," by Han-Lee Mao and Kozo Yoshida (1955); (s) "Seismic reflection studies of Eniwetok atoll," by R. W. Raitt (1957); (t) "Chemical erosion of beach rock and exposed reef rock," by Roger Revelle and K. O. Emery (1957); (u) "Geothermal measurements on Eniwetok and Bikini atolls," by J. H. Swartz (1958); (v) "Larger foraminifera from Eniwetok atoll drill holes," by W. Storrs Cole (1957); (w) "Lower Eocene phosphatized globigerina ooze from Sylvania guyot," by E. L. Hamilton and R. W. Rex (1959).

The contributors have a wide variety of affiliations, other than the Geological Survey. This in itself is quite an innovation for publications by that organization. Among the institutions represented are the Naval Ordnance Laboratory, Pacific Ocean Fisheries Investigations, Scripps Institution of Oceanography, U.S. Navy Electronics Laboratory, U.S. National Museum, University of Southern California, and Woods Hole Oceanographic Institution. This departure from customary procedure introduces a variety of individualistic approaches into what is rather often a stylized format and is a welcome change indeed.

It is most difficult, from such a mass of observations and interpretations, to make a wise choice of the significant contributions without reflecting the prejudices or interests of the reviewer. To me, the principal value of this complex study is the detailed information it provides on the foundations of Bikini, presumably a representative coral atoll, and the ecology of the reef-building organisms and their associated marine flora and fauna.

Five drill holes were bored on Bikini in 1947, three shallow and two deep, the latter to depths of 1346 and 2556 feet, respectively. All the Bikini drill holes revealed calcareous, mostly unconsolidated or poorly cemented reef material all the way. Much of this material appears to have had a lagoonal origin and it seems to have been deposited at no great depth. This interpretation is corroborated by the contained fossils, which are shallow-water organisms whose ecologic requirements call for depths far less than those from which the fossils were recovered. The oldest rocks of the reef, to the depth penetrated by the drill, appear to be of Miocene age.

Both the lithologic and paleontologic evidence strongly suggests that Bikini atoll had an origin virtually identical with that proposed in Darwin's theory more than 100 years ago. That is, the reef grew continuously upward on a subsiding foundation whose rate of sinking was less than the rate of coral growth.

Three deep holes were drilled on nearby Eniwetok atoll in 1951 and 1952. The two deepest (4222 and 4630 feet) are exceptionally significant because they were drilled completely through the 4000-foot cap of shallow-water reef limestones and into the foundation rock, which proved to be an olivine basalt, much like that of other typical volcanic islands of the Pacific Ocean.

Although the holes drilled on Bikini are logged in great detail, no mention is made in the chapter on geology of the very significant Eniwetok borings, although the larger foraminifera recovered from their cores are described in part 5 (chapter v). One must look elsewhere for the description of the Eniwetok well logs. This appears to me to be a singular oversight (explainable, perhaps, by the long delay in publication). However, in view of the title of the professional paper, it would be most desirable to have all the data collected during the Marshall Islands investigations brought together in a single series—a procedure that was followed successfully by the great exploring expeditions of the 19th century, as in the *Challenger* reports.

The individual chapters (by several authors in most cases) are the heart of this publication and are essentially of specialist interest. The authors have done an admirable job of describing the physical environment and the marine inhabitants of Bikini and its neighboring atolls. This is probably the first time that such islands have had such intensive and quantitative investigation. The physical characteristics of the reefs, lagoons, and submarine slopes, ridges, and mountains are thoroughly mapped and described, together with the physical oceanography of the surrounding sea and the magnetic and seismic properties of the sea floor and the reef foundations. The biological sections of the report are equally impressive and contain a fund of information on the distribution and ecology of both planktonic and reef-dwelling organisms. Algae are the dominant dwellers of the reef today, but corals are by no means out of the running. More coral species are known from Bikini atoll than from any other comparable area in the world, very likely as a result of intensive collecting during this expedition.

To one who knows little of this specialty, the fossil record appears to be unusually complete and exceptionally interesting. These deceased organisms not only provide us with an excellent insight into the environments of the past, but they also give us a means of dating the events in the geologic history of this remote archipelago. The coralline material at the bottom of the deep holes on Eniwetok, to judge from the foraminiferal content, was deposited in the Eocene. If this is the case, then the rates of subsidence called for are not excessive and are well within the limits of coral upgrowth. According to Cole (chapter v), the subsidence rate required for the 615 feet of Recent, Pleistocene, and Pliocene sediments would average 50 feet per million years; for the 2165 feet of Miocene deposits the rate would be 130 feet per million years; and for the 1773 feet of Eocene rocks the rate would be 170 feet per million years.

Phosphatized globigerina of Eocene age were recovered from deep-sea oozes that have sifted down into fractures in a volcanic tuff on the summit of Sylvania guyot, a flat-topped, plateau-like feature at a depth of 790 fathoms and a part of the same ridge on which Bikini atoll stands. This find, as described by Hamilton and Rex (chapter w), is of crucial importance in arriving at an understanding of these planed-off submarine mountains. The upper slopes of Sylvania guyot consist of basaltic rocks which are largely pyroclastic and which are believed to have been erupted when the water covering them was much shallower.

Many explanations have been offered for the mysterious, table-topped submarine mountains in the mid-Pacific, to which the name *guyot* has been applied in honor of Arnold Guyot, the Swiss geographer and associate of Louis Agassiz, and these are thought by some to be of very great geologic antiquity indeed. The evidence at Bikini of a mountain with an internal composition of largely unaltered basalt, capped with

globigerina ooze containing Eocene foraminifera, indicates a comparatively recent volcanic origin. Some time before the beginning of the Tertiary the volcanic mountain was truncated, and in the submergence that followed, the rate of sinking was too rapid for coral growth to keep pace. Therefore, no reef material accumulated as it did to a thickness of several thousand feet on the more slowly subsiding foundations of nearby Eniwetok and Bikini atolls.

There are a score of other contributions in this collection that are equally deserving of mention, but space is limited. Fortunately, the individual chapters can be obtained separately, and the title of each is sufficiently distinctive for a specialist to identify the ones most likely to be of interest to him. The range in price is wide, however, with a high of $9.00 (for chapter a) and a low of 20 cents (for chapter s). The total cost ($24.15) is likely to be too high for the average academician's already overextended book budget, or even for that of all but the most affluent institutional libraries.

The one element lacking in this stimulating collection of papers, I believe, is a section synthesizing the findings of the various contributors. This deficiency is remedied to some degree by Roger Revelle's foreword, but this is quite brief and was written largely before all the papers were published; it appeared in 1954, and chapters in this series continued to appear through 1959. The volume of material in this publication is too diverse and too highly specialized to be of general concern, yet the problem of coral reefs is of compelling interest, and a broad, comprehensive review of the findings of this 20th century expedition in terms of their relationship to past discoveries, to our present state of knowledge, and to the nature of problems still to be solved would have been most welcome.

The Geological Survey is to be congratulated on its excellent presentation of the results of this endeavor. The illustrations are of uniformly high quality, and the colored maps and charts of Bikini and other Marshall Islands atolls are superb examples of cartography; in fact, they are works of art in their own right.

The collating and publishing of this imposing accumulation of information of purely scientific interest is an achievement in the great tradition of the Survey's founders, notably such men as Powell, Gilbert, Dutton, and Walcott. We can surely hope that an approach as successful as this one proved to be may establish a pattern to be employed more frequently in the future in a vigorous, wide-ranging series of investigations which may help us with the solution of the many riddles still confronting us about the nature of the earth and its past history.

WILLIAM C. PUTNAM
Department of Geology,
University of California, Los Angeles

From Field to Factory. New industrial employees. James Sydney Slotkin. Free Press, Glencoe, Ill., 1960. 156 pp. $4.

The central purpose of this study is to place the problem of labor in economic development (or, better, the problem of recruiting labor for industrialization) within a context of cultural anthropology. While the author is concerned with the problem of developing an anthropological theory about recruiting and committing labor in the underdeveloped areas now undergoing or about to undergo industrialization or modernization, he has not developed a series of interrelated propositions about this process.

What is of particular value in the study is the spelling out of a number of cultural factors that affect the industrialization process, but the propositions about the process are at such a high level of abstraction that they add little to the theoretical literature on industrialization or culture change written from other perspectives. In fact, the theory of culture change has advanced considerably beyond the framework of acculturation which is heavily used by Slotkin, and it is somewhat more sophisticated than is apparent from such conclusions as, "When a culture becomes inadequate in providing desired goods and services industrialism is adopted voluntarily" (page 143). It has long been known that cultures are particularly prone to change under stress, but just what combination of conditions are most favorable for initiating the industrialization process in underdeveloped areas is not apparent from this study. As a first step to a general theory, however, the work is of value.

ALLAN R. HOLMBERG
Department of Sociology and
Anthropology, Cornell University

Science and State Government. A study of the scientific activities of state government agencies in six states. Frederic N. Cleaveland. University of North Carolina Press, Chapel Hill, 1959. xvii + 161 pp. Illus. $3.50.

As an "interpretive summary" of the findings of reports on scientific activities in state government, this small volume tells the determined reader more than he wants to know and, possibly, more than he needs to know. It is long on fact, short on analysis and opinion; this is not always a virtue.

In 1954 the National Science Foundation contracted with the Institute for Research in Social Science at the University of North Carolina for a systematic study of science as a function of state government. Six states—California, Connecticut, New Mexico, New York, North Carolina, and Wisconsin—were selected as representative in their diversity. Using a common research design, teams of researchers converged on each of the states. The final reports afforded the basis for a statistical summary of the essential data by the National Science Foundation [*Scientific Activities in State Governments, Summary Report on a Survey Fiscal Year 1954* (Government Printing Office, Washington, D.C., 1958)].

Presumably this is the final effort to extract the last ounce of benefit from the reports, which must have been costly both in dollars and research travail.

If there is a "profile" of science in the six states, it is extremely fuzzy and indistinct. Indeed, the recitation of statistical differences tends to obscure the common features of scientific activity as a function of state government. There *are* common features—and significant ones—in the relationship of science to state government. But these are, perhaps, the ones least susceptible to analysis and appraisal by objective data.

Several observations are in order. First, the notion of shared responsibility between the federal government and the states in scientific activity is extravagant nonsense. The big money comes from Washington; the pattern and pace of government research effort is determined in Washington, whether in research on agriculture or on mental illness. Second, it is doubtful whether support for science in state government is "big business," as the author suggests. Less than 2 percent