

sticky capture threads to their webs. Shear suggests that selection for cost-effective placement of these threads led to the familiar wagon-wheel-like aerial orb-web.

On the basis of their spiral capture threads, two types of orb-webs can be distinguished. Lubin describes the webs and prey capture behavior of spiders that employ dry, fuzzy capture threads, and seven chapters treat those that use viscous capture threads. Since the 1800's arachnologists have argued the relationships of these two types of webs. Coddington provides the most comprehensive analysis of the issue to date. His cladistic analysis includes both morphological and behavioral characters and shows that the orb-web evolved only once and is not, as some have suggested, convergent.

Such orb-web features as diameter, sticky spiral spacing, and number of radii are often species-typical, but even within a single genus they may vary greatly in ways not explained by spider size. Eberhard uses both modeling and field studies to show that these web parameters are not independent of one another and that orb-webs do not act as passive sieves. The spacing of a given length of capture thread influences the length of framework and anchor threads as well as the behavioral cost of producing the web and its ability to intercept and hold prey. Thus, design constraint, construction cost, and capture efficiency appear to adapt each species' web to a particular type of prey.

Web vibrations produced by a struggling prey alert a spider to a catch. Masters, Markl, and Moffat show that an orb-web transmits effectively only lower-frequency vibrations such as those produced by a buzzing fly. This differential attenuation of vibrations together with the sensitivity of the spider's receptors may determine its response to web vibrations.

Despite its efficiency and intricacy, the orb is not the pinnacle of web evolution. Lubin describes a member of an orb-weaving family that spins only random, sticky threads and uses these much like fishing lines. Stowe describes another spider that simply hangs from a silk scaffold waiting with spread legs for male moths that are attracted to its odor, thinking they are flying to a pheromone-emitting female moth. Even jumping spiders, known for their active prey capture, show evidence of a sedentary, web-using ancestry. Jackson shows that one primitive jumper can still spin and use an elaborate web and can also invade an orb-web, feed on its owner, and then use the web to capture other prey.

Two chapters evaluate the importance of physical features and prey abundance in

determining where a spider will place its web, how long it will remain at the site, and how it will fare. Janetos shows that both random and successional events cause greater variability in the prey caught by an orb-web than by a sheet-web. This and the lower cost of constructing an orb-web suggest that orb-weavers should demonstrate less web-site tenacity than sheet-weavers. Riechert and Gillespie find that as desert funnel-weavers grow, competition for suitable web sites increases radically and females that occupy the small percentage of sites that offer both thermal protection and high insect densities have much higher reproductive success.

In spiders sociality has been observed only in web-builders. Uetz describes an orb-weaver whose colony size and web spacing are determined by prey density. Larger colonies have greater prey-capture efficiencies, although a spider's position in the colony influences the number and size of prey it is likely to catch. Each of these spiders spins and uses its own web, although Tietjen considers another colonial species whose sheet-weaving members share the construction of a large, communal web and the prey this web captures.

Shear introduces this volume by stating that it is "a book of questions." I have focused here on some of the significant new answers that it provides. However, many chapters also make important contributions by more clearly organizing and carefully asking questions that will catch the interest of many readers.

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## Chinese Geology

**The Geology of China.** YANG ZUNYI, CHENG YUQI, and WANG HONGZHEN. Clarendon (Oxford University Press), 1986. x, 303 pp., illus. \$79. Oxford Monographs on Geology and Geophysics, no. 3.

The last book in English with this title (by Li Siguang, also known as J. S. Lee) was published in 1939. Since then not only have tremendous efforts been expended on Chinese geology, it has become recognized that there are many features of the geology of China that are both distinctive and of great global significance. The effects of the active collision of the Indian continent, although spread over much of Asia, are most spectacularly developed in China. China and South-

east Asia have been assembled by microcontinental and island arc collisions over the last 250 million years, so China is one of the best places in the world to study how continents form—a process that was largely complete in North America a billion years ago. Moreover Chinese sedimentary basins are sufficiently distinctive that they were recognized by A. Bally as a separate class, and petroleum geologists in all countries have learned from their Chinese colleagues during the last 15 years that lake beds can be important sources of oil and gas.

*The Geology of China* is basically an advanced general textbook and as such provides a broad background for foreign geologists interested in these and other distinctive features of Chinese geology. Readers should be warned that using the book effectively requires supplementary material, such as the Geological Map of the People's Republic of China published by the Chinese Academy of Geological Sciences (Beijing, 1976) and a good Pinyin gazetteer or first-class atlas, as well as patience and skill because of a condensed style.

The first few pages give a brief account of the development of Chinese geology in both ancient and modern times. We are told of the existence in 700 B.C. of a copper smelter that produced a ton a day (though not of the rumored 1-kilometer-deep gas well drilled in 200 B.C.). This introduction is followed by several pages on China's unusual relief features and drainage systems. About one-third of the drainage is internal; most of China's sea-reaching rivers drain to the Pacific, but some Tibetan and Himalayan rivers flow to the Indian Ocean, and a tiny area in the northwesternmost part of the country drains to the Arctic.

Two-thirds of the book deals with stratigraphy. There is a brief introduction by Wang Hongzhen on stratigraphic principles, including a map identifying distinct stratigraphic regions. This raises an interesting point about Chinese stratigraphy. What is now China was formerly in six to ten separate blocks (some of them parts of Gondwanaland). Thus systems such as the Devonian, which were coherent units elsewhere, were not yet in one piece in China. This fact is ignored here, and the question of how and when China was assembled is deferred to later chapters.

Cheng Yuqi discusses the Chinese Archean, most of which outcrops within the North China block. Gneiss-granulite associations dominate, although high-grade metamorphic equivalents of greenstone belt rocks are present. Numerous isotopic ages, mostly determined in Chinese laboratories, including several in excess of 3 Ga, are reported. Wang Hongzhen writes on the

Proterozoic, which, as is usual in China, is defined to exclude the rocks of the Sinian system (younger than 850 Ma and older than the Cambrian). Older Proterozoic rocks include arc rocks and ophiolitic rock types, but by medial Proterozoic times the North China, Yangzi, and Tarim blocks were established as continental objects. Later Proterozoic and Sinian sediments are widely developed in platform facies, although some thick Proterozoic sequences appear to have been deposited in rifts striking at high angles to the margins of the major continental blocks. The Sinian system (also discussed by Wang Hongzhen) is widely distributed in southern China, but mainly around the edges of the North China block as well as at a number of localities over a large area in western China. Sinian stromatolites and tillites, which have long been famous, are widely distributed.

Yang Zunyi is responsible for 11 highly condensed chapters on the Phanerozoic, each of which includes a brief introduction identifying platform, mobile, and transitional areas and maps of China showing the distribution of outcrops of the age under consideration. There are correlation charts with formation names and faunas for about ten localities, which are linked to a set of columnar sections showing lithologies. I found it necessary to turn back and forth between the map, the correlation chart, and the stratigraphic columns; this information might have been presented in a more convenient way. Altogether the stratigraphic chapters are substantial. They include regional descriptions with faunal lists and brief discussions of paleoenvironments and stratigraphic boundary problems. Referencing is uneven.

The chapters by Cheng Yuqi on magmatic rocks and magmatism and on metamorphism and metamorphic belts contain more discussion of environments than do the preceding stratigraphic chapters. I would have preferred to have this material more closely integrated with the last two chapters, by Wang Hongzhen, on tectonics. Plate tectonic explanations have been used by Chinese geologists for many years to explain the evolution of China. Wang interprets China's geological history in terms of his own related concept of "development stages," which envisages crustal development as a continuous process in which the main changes are accomplished in rapid episodes. Wang's is a thoroughly mobilist approach involving interpretation of the evolution of China in terms of such elements as volcanic arcs and marginal seas. It is disappointing that numerous cross sections in these chapters are rather generalized and difficult to use critically.

In the final chapter Wang distinguishes megastages, stages, and lesser movements in the crustal development of China, very much in the manner of Hans Stille. He addresses specific problems clearly, though in a condensed style. For example, there is currently some international disagreement as to whether North and South China were sutured together along the Qinling range as early as the Devonian or as late as the Triassic. Wang's discussion summarizes the problem, explaining that the absence of marine Triassic rocks in the Qinling east of west Hunan has led some to the idea of closure in the "Late Hercynian" but that others interpret the occurrence of Middle Triassic ammonites along strike in the western Qinling as indicating that a seaway leading to the Pacific existed between the two continents in Triassic times.

The book closes with 19 plates showing many fossils, thin sections of rock, and outcrops along with 11 double-column pages of references indicating those available in English as well as in Chinese. Important sources, such as the provincial stratigraphic correlation tables published by the Geological Publishing House, are fully cited, but the foreign references are incomplete. For example, there is no reference to Molnar and Tapponnier's seminal paper on the collision of India with Asia published in *Science* in 1975. The book ends with a stratigraphic index in Pinyin and Chinese and a seven-page, three-column index.

In summary, this is a book whose authors have attempted to cover a tremendous range of topics. Their success has been uneven, but the effort has been worthwhile because the book has much to offer the determined reader.

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## Some Other Books of Interest

**Defining Biology.** Lectures from the 1890s. JANE MAIENSCHNEIN, Ed. Harvard University Press, Cambridge, MA, 1986. xiv, 337 pp., illus. \$25.

Shortly after the founding of the Marine Biological Laboratory at Woods Hole, Massachusetts, in 1888, Charles Otis Whitman, its first director, inaugurated a series of evening lectures in which biologists who were active at the laboratory were to expound their research interests in a way that,

Whitman hoped, would lead to a unification of biological science as a cooperative endeavor. In the 1890's a total of some 110 lectures were delivered, some but not all of which were published at the time. This volume reprints a selection of ten of the lectures that, according to the editor, "demonstrate the gropings of an important group of scientists at a critical time of change." The lecturers represented are Edmund Beecher Wilson, Henry Fairfield Osborn, Wilhelm Roux, Edwin Grant Conklin, Cornelia Maria Clapp, William Morton Wheeler, Whitman, Herbert Spencer Jennings, Thomas Hunt Morgan, and Jacques Loeb. Each lecture is preceded by a one-page introduction and a photograph of the lecturer. In addition, the editor, a historian and philosopher of science, has provided a 48-page general introduction that recounts the establishment of the Marine Biological Laboratory, outlines the biological issues that were of concern at the time ("a complex of related problems of heredity, individual development, and evolution"), and gives a chronological summary of the content of the lecture series in the decade covered. The volume also includes a foreword by Ernst Mayr, a complete list of the lectures, some early photographs of Woods Hole facilities and workers, and an epilogue by Paul R. Gross.—K.L.

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**Centennial Field Guide.** Vol. 6, Southeastern Section of the Geological Society of America. THORNTON L. NEATHERY, Ed. Geological Society of America, Boulder, CO, 1986. xx, 457 pp., illus. \$40.50.

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To celebrate its centennial the Geological Society of America has undertaken, in its Decade of North American Geology project, to produce a "suite" of some 70 books, maps, and transects. (For a review of the initial, historical volume see *Science* 232, 1279 [1986].) The present volume is the first to appear of the six projected volumes of the Centennial Field Guide. It includes descriptions of 100 localities each of which, according to the editor, "illustrates an important geologic relation of regional significance or an outstanding example of basic geology." The descriptions are arranged under three headings: Interior Low Plateaus and Appalachian Valley and Ridge (43 examples, from "Selected exposures of Pennsylvanian rocks in western Kentucky" to "Birmingham anticlinorium in the Appalachian fold-thrust belt, basement fault system, synsedimentary structure, and thrust ramp"); Blue Ridge and Piedmont (26 examples, from "Harpers Ferry water gap" to "Olistostromal unit of the Silurian-Lower Devonian Lay Dam Formation, Talladega