

the butt-end of the rod, and the female ferrule; or, rather, we have made a variety of butt-ends, some elegant and some crazy botched affairs, but all alike incomplete, and all awaiting the test of whether they will receive the male ferrule of fact. Some will no doubt prove too narrow to be united at all; others will be so broad that they would accommodate any conceivable partner, and the actually realized possibilities of the world will slop around inside them like a stick in a bucket. One—we can hope—will be just right [p. 160].

In summary, it is difficult to recommend this book except to patient specialists.

MICHAEL J. WADE

Department of Biology, University of Chicago, Chicago, Illinois 60637

Southern African Geology

Crustal Evolution of Southern Africa. 3.8 Billion Years of Earth History. A. J. TANKARD, K. A. ERIKSSON, D. R. HUNTER, M. P. A. JACKSON, D. K. HOBDAI, and W. E. L. MINTER, with a contribution by S. C. Eriksson. Springer-Verlag, New York, 1982. xviii, 524 pp., illus. \$45.80.

Komatiite, Fig Tree Group, Bushveld Complex, Damara Province, Dwyka tillite, Karoo volcanics—these and numerous other names from southern Africa not only help to fill the geologic glossary, they represent major concepts in the understanding of planet Earth. Komatiite immediately makes one think of early crustal evolution, the Fig Tree Group of the development of life on Earth, the Bushveld Complex of metallogenesis par excellence, and the Damara Province of possible intracratonic orogenesis; the Dwyka tillite is virtually synonymous with climatic change; and the Karoo volcanics are on anyone's list of igneous rocks related to continental fragmentation. A. L. Du Toit's 1954 volume *Geology of South Africa* and L. C. King's 1962 volume *The Morphology of the Earth*, which is also based upon a southern African perspective, are classic contributions to the geologic literature. The new book by Tankard and his colleagues is the first complete geologic history of the southern part of the African continent to be published since the broad acceptance of the plate tectonics paradigm for at least the late Mesozoic and Cenozoic. With many earth scientists currently exploring the nature of earlier tectonic activity, as well as the history of life on Earth, the book is a timely contribution that will be of widespread interest. Unquestionably it should be on the shelves of every geologic library, and indeed probably on those

of every serious historian of the earth.

The authors divide the geologic history of southern Africa into five stages: Archean Crustal Development, Early Proterozoic Supracrustal Development, Proterozoic Orogenic Activity, The Gondwana Era, and After Gondwana. Spatially they consider the African continent south of approximately 18°S latitude to be composed of ten distinct tectonic provinces defined on the basis of such parameters as lithology, structure, metamorphism, and predominant radiometric age. Some of these provinces will be familiar to readers outside of southern Africa (Kaapvaal Province, Namaqua Province), others less so (Saldanian Province). Inevitably there are a large number of unfamiliar names for the outsider to absorb, but numerous clearly drafted maps and tables help to overcome this obstacle.

The six principal authors must have put a lot of effort into coordinating their contributions, because the discussions of such subjects as structural geology, petrology-geochemistry, and sedimentology-stratigraphy blend well into the account of the various temporal and spatial subdivisions, and the geologic problems, discussed. As is pointed out in the foreword by Brian F. Windley, an impressive attempt is made to separate a review of factual data from consideration of various interpretations of those data, and space is not wasted on unwarranted speculation.

It is no criticism of the volume to point out that scientists seeking detailed information on the state of knowledge of, say, the Pan-African belts or the Cape fold belt will want to follow up the references in the bibliography, which covers material into the earliest 1980's. The space devoted to the five stages of southern African crustal development is approximately proportional to the time intervals involved. Thus the late Precambrian Pan-African orogenic activity is described in just over 50 pages and the early Mesozoic Cape orogeny in one page. One can quibble with the weight of the treatment given to one topic or another, but any suggested alternative arrangement will probably merely reflect one's own special interests. This reviewer, for example, would like to have found more Gondwana-wide comparisons even though the book does by no means treat southern African geology in vacuo.

The strength of the volume lies in lucid description of a panoply of important and evolving geologic processes that occurred in one unique and important location through virtually the entire span of geologic time. It takes little foresight to

predict that this work on one part of a large continent will be carefully scanned for years to come in the formulation of hypotheses concerning the tectonic history of the earth as a whole.

IAN W. D. DALZIEL

Lamont-Doherty Geological Observatory,
Palisades, New York 10964

Porphyry Copper Deposits

Advances in Geology of the Porphyry Copper Deposits. Southwestern North America. SPENCER R. TITLEY, Ed. University of Arizona Press, Tucson, 1982. xiv, 560 pp., illus. \$35.

Southwestern North America is one of the great copper provinces of the world and accounts for most of the copper production and reserves of the United States, the world's leading copper-producing country. The region attracted the attention of several generations of geologists, and much has been written about it, including the predecessor to this volume, *Geology of the Porphyry Copper Deposits, Southwestern North America*, published in 1966 and edited by Titley and C. L. Hicks. Nevertheless, discoveries of more deposits, accumulation of geological information, and advances in concepts of porphyry deposit geology make this volume a welcome, timely addition to the literature on this classic porphyry copper region.

The book is divided into two parts: Topics in Porphyry Copper Geology and Deposit Descriptions. There are chapters on grades and tonnages of deposits, geological settings, fluid and heat transport, fracture and dike patterns, style and timing of mineralization and alteration, hydrothermal alteration in silicate rocks, skarns, a rock geochemical study at Kalamazoo, the sulfur and copper in magmas and rocks and the petrology and chemistry of igneous rocks at Ray, leached cappings, geochemical prospecting, and 12 selected porphyry copper deposits and one district. Deposits have been included for which no previous reports have been published and for which substantial additions have been made to the information contained in earlier studies. Because the volume lacks descriptions of some of the most important porphyry copper deposits of the region, it should be used in conjunction with the 1966 volume and other papers.

The quality of papers and editing is generally high. Some papers, especially those by Titley, reflect many years of