American Mineralogist, Volume 65, pages 1071–1073, 1980

BOOK REVIEWS

CHALCOPYRITE—ITS CHEMISTRY AND METALLURGY. By Fathi Habashi. McGraw-Hill, Inc., New York, 1978. 165 pages. $24.50.

This book, as stated by the author, is meant to serve as a literature review restricted to the chemical behavior and treatment of the most abundant copper-bearing mineral, chalcopyrite. It contains twelve chapters of which the first (7 pages) mentions the natural occurrence of this mineral, the present methods of its treatment, the drawbacks inherent in these methods, and the attempts being made to improve copper extraction. It concludes that hydrometallurgical methods must be developed to avoid air pollution. Chapter 2 (5 pages) discusses flotation, chapter 3 (10 pages) deals with structure and physical properties, chapter 4 (17 pages) cites data pertaining to the thermal stability of this mineral. Chapter 5 (17 pages) discusses thermal oxidation and chapters 6 and 7 (48 pages) deal with aqueous oxidation. Chapter 8 (12 pages) is devoted to reduction, chapter 9 (2 pages) to chlorination, chapter 10 (5 pages) to electrolytic reactions and chapter 11 (5 pages) to minor and trace metals in chalcopyrite. The final chapter (1 page) concludes that future chalcopyrite metallurgy will be directed toward acid pressure leaching of flotation concentrates at about 110°C and lists nine advantages of such procedures over other methods such as conventional smelting. The book also contains two appendices; the first (5 pages) lists world primary copper smelters and the second (2 pages) provides references to discussions of the chemistry and metallurgy of copper in the eight-volume (System Number 60) Gmelin's Handbook of Inorganic Chemistry.

The book in addition has a 5-page author index and a 9-page subject index. Although the list of references includes about 400 items, it is by no means complete. Much information in print has not been included, for instance pertaining to the thermal stability and solid solution field of the chalcopyrite phase. There are no data on the effect of pressure on polymorphic inversions and structural stabilities. The reader might understand why the author could not present detailed information on copper and iron sulfides such as covellite, blue-remaining covellites, anilite, digenite, djurleite, chalcocite, pyrrhotite, pyrite, and even bornite, one or more of which frequently coexist with chalcopyrite in ores. It is, however, not easy to understand why cubanite is not described in detail, why practically nothing is said about talnakhite, and why mooihoekite and haycockite are not even mentioned in the text. The latter four minerals are all stable in the temperature range of the hydrometallurgical procedures suggested by the author. Some, or all, of these phases may form as intermediate products during acid pressure leaching or may occur with chalcopyrite in flotation concentrates. The book in at least two places contains statements to the effect that chalcopyrite only during the last 10 to 15 years has been realized to be the most abundant copper-bearing mineral. This has been known to mineralogists at least since the turn of the century. The author also states that "It (chalcopyrite) is mined as cupriferous pyrite and pyrrhotite which contain copper in solid solution, or as disseminated grains of chalcopyrite." Chalcopyrite forms negligible solid solution with pyrite, and although chalcopyrite occurs in solid solution in pyrrhotite at high temperatures, it is rapidly exsolved on cooling and is not found in solid solution in pyrrhotite in ores. Many statements are misleading; for instance the legend to one figure says "Chalcopyrite—a major source of rhenium." Rhenium occurs in solid solution in molybdenite which, particularly in porphyry copper ores, commonly occurs with chalcopyrite. Some of the discussions, for instance that on the thermal stability of chalcopyrite, show that the author did not read the reference material in detail. Some discussions are rather interesting, for instance those pertaining to thermal and aqueous oxidation and to reduction, chlorination, and electrolytic reactions, but depth and detail are lacking.

The book is quite useful as a source of references to the published literature. It was printed with considerable care and is well bound. The illustrations are of good quality.

GUNNAR KULLERUD
Purdue University

PETROLOGY OF THE METAMORPHIC ROCKS. By Roger Mason. George Allen and Unwin, London, 1979. 254 pages. Cloth $29.75, paperback $14.95.

This book, which is the current volume 3 of the classic Hatch and Wells petrology text, is described on the cover as follows: "The style of treatment should make the book useful to a wide readership among geologists and earth scientists. It should be particularly suited to the needs of undergraduates who are not necessarily petrology specialists but need an authoritative introduction to metamorphic rocks at an intermediate level. It may also be of value to teachers and senior school students of geology, and to others needing a comprehensive introduction" [to metamorphic petrology]. In the opinion of this reviewer (note, unrelated to the author), this aim has been admirably and concisely obtained.

The author describes himself as a field petrologist, and throughout much of the book he uses the "case history" approach, describing the different types of metamorphism in the light of specific areas. Most of these are European—the Scottish Highlands, the Swiss Alps, the Scandinavian Caledonides—which may be a minor drawback (or perhaps an advantage) for a teacher in North America. However, the descriptions are fresh and illuminating, and are supported by critical references. Metamorphism is interpreted widely, and includes discussion of shock metamorphism associated with meteorite craters, and shock metamorphism in lunar rocks. Descriptions of metamorphic rocks are illustrated with excellent drawings of these rocks as seen in thin sections. The descriptive petrography is complemented by a final section, "Metamorphic Rocks in the Laboratory," which summarizes the application of laboratory studies of mineral syntheses and metamorphic reactions, and of isotope geology, to metamorphic petrogenesis.

This is a brief but comprehensive book which achieves the goals outlined above.

BRIAN MASON
Smithsonian Institution

SEDIMENTARY ENVIRONMENTS AND FACIES. Edited by H. G. Reading. Elsevier, New York, 1978. 557 pages. $24.00 (soft cover) $45.00 (hard cover).

Within the past decade a number of valuable review volumes, both new publications and revised editions, have treated the evo-

0003–004X/80/0910–1071$00.50

lution and genesis of sediments and sedimentary rocks. It would be a mistake to consider the work under review as merely another text in sedimentology since it is, in this reviewer's opinion, the best available summary of information and theory treating current concepts in the complex relationships which exist between sediments and the environmental conditions under which they accumulate. The treatment of these environments by ten contributors provides an equal balance between terrestrial situations (glacial, alluvial, lake, and desert—25% of the text) and coastal aspects (deltas, clastic shorelines, and arid/evaporite coasts—25%), and the whole spectrum of depositional regimes in the marine environment (50%).

General discussions of an introductory nature, the concept of facies in historical perspective, and present problems and prospects are provided by the editor, and the penultimate chapter on sedimentation and tectonics brings the reader a concise summary of the renewed interest in deep-sea and continental-margin sedimentation as it relates to plate tectonic theory. The volume contains 65 pages of references, some as late as 1978, which are keyed to the chapter sections—a welcome device which facilitates tracing a particular author's contribution to the subject matter. A concise index, featuring boldface type for figure references, rounds out the volume.

The value of this volume to practitioners and students of sedimentology lies in the approach taken by each author in addressing a specific sedimentary environment. Each contribution first addresses the historical development of concepts which have led to current perceptions in sediment controls in space and time, then a statement of environmental agents and processes which yield the various facies within each situation, and finally the application of our present knowledge to the interpretation of paleo-environments as displayed by structures and facies in the rock record.

The organization of the volume reflects a concern for those who wish to use it as a reference tool. Each chapter format includes numerical headings and further subheadings which facilitate location of specific elements within each topic. To those accustomed to consulting references at the end of each chapter, the collection of all citations in one listing near the end of the volume may prove a minor annoyance.

Visual materials complementing the text are of the highest quality, both in the artistic sense and in their reproduction by the printer. Numerous maps, diagrams, and cross-sections have been redrafted in a common format which provides continuity between each chapter. Some reductions have resulted in rather fine print, but all are sharp and in general a delight to the eye.

If one must seek a shortcoming in this excellent volume, it would be in the brief treatment of estuarine environments. Only four pages, two of which are full-page graphics, address this complex and important domain within the coastal zone. However, abundant information on these regions is available elsewhere, and the serious reader can refer to several excellent texts devoted to estuaries.

It is heartening to see the trend of alternative binding on the rise, since most readers find the price of hard-bound volumes well beyond their library budgets. The soft-cover version should find the wide circulation this work deserves, and it should stand for many years as the definitive summary of sedimentary facies and environmental sedimentology.

HAROLD D. PALMER
Dames and Moore
Washington, D. C.

ANCIENT SEDIMENTARY ENVIRONMENTS, 2nd edition. By Richard C. Selley. Cornell University Press, Ithaca, N. Y., 1978. xii + 287 pages, 93 figures, 9 tables. $6.95 (paperback).

Selley's book was not written for the specialist sedimentologist but for the general reader with a basic knowledge of geology. It can be read, however, with profit by anyone—even a mineralogist.

This book begins with a succinct and very perceptive summary of the principles of environmental analysis. The treatment is twofold: analysis based on data collected from outcrops and analysis based on subsurface data obtained from cores and by geophysical logging techniques. This dual treatment reappears throughout the book and is, in fact, the main difference between the first and the second editions. This difference reflects Selley's own experience, first as a geologist in an academic environment and then as one involved in oil and gas exploration and having to make interpretations mainly from subsurface data and having sophisticated tools available to collect such data. Some of the statements made in the introduction are judgemental and may raise the hackles of a few—in particular the statement (p. 6) on the value of grain size analyses.

In the introduction the author also defines the concepts of environment and facies and presents a simplified classification of each. The remainder of the book consists of short chapters dealing with each category: river deposits, wind-blown sediments, lake deposits, deltas, linear clastic shorelines, shelf deposits: carbonates and terrigeneous, reefs, flysch and turbidites, and pelagic deposits. In each chapter there is a short summary of modern or Recent examples followed by one or two well-documented ancient examples.

Two aspects of Selley's treatment of ancient environments are noteworthy and different from much of the older literature, namely his use of the vertical profile and of paleocurrents. The vertical profile or cyclic concept is not new but the understanding of autocyclic (internally generated cycles) patterns is a recent development—a development greatly furthered by the Shell Research group at Houston in the fifties and subsequently promulgated by J. R. L. Allen, DeRaaf, Reading, and Walker, Visher, and others. Selley utilizes this approach with great skill. Paleocurrent analysis is another tool of recent origin, stemming particularly from the work of Potter and Olson in the fifties. Selley himself has made a significant contribution to the subject, especially the environmental significance of paleocurrent patterns.

Selley's book ends with a short essay on sedimentary models—mythical and mathematical. A subject and author index are included.

What is amazing is that Selley has been able to condense and convey so much in such a compact book—the new edition is no more than fifty pages longer than the first. The reviewer knows of no better-written and better-illustrated summary of the state of the art of environmental interpretation. The book is a gem and at the price a great bargain.

F. J. PETTIJOHN
The Johns Hopkins University

THE ANDES—A GEOLOGICAL REVIEW. By W. Zeil. Gebrüder Borntraeger, Berlin, 1979. viii + 260 pages, 143 figures. $75.60.

A geologic synthesis of the longest mountain range on Earth is a monumental undertaking. Prof. Zeil early acknowledges the difficulty of the task and the necessity of being selective in dealing

0003-004X/80/0910-1072$00.50

with sources of uneven geographic distribution and geologic quality. His result is a book, vol. 13 of the series "Beiträge zur regionalen Geologie der Erde," with 207 pages of text, 33 pages of references, three indexes, and 143 figures that include 14 fold-out maps and sections. Owing to dubious organization and poor editing, the book is a disappointment.

Following eight pages of introductory material, six chapters make up the bulk of *The Andes—a geological review*. These are: "Crust and mantle in the Andes" (23 pages), "Igneous rocks" (45), "Sedimentary and metamorphic structural material" (48), "The Andes as a geodynamic body" (60), "The Andes as a plate tectonics model" (11), and "The mineral deposits of the Andes—a brief review" (12). References in the long bibliography, on the other hand, are grouped under "General bibliography", "Crust, mantle, plate tectonics", "Magmatic rocks", "Venezuela", "Colombia", "Ecuador", "Peru", "Bolivia", "Argentina", and "Chile". The reader will lose considerable time hunting the complex bibliography for some of the references cited in the text and, in fact, will find that a few have been left out.

The isolation of igneous rocks in a separate chapter is unfortunate. In so many Andean sedimentary sections, tephra constitute a major component and have important genetic connotations. The metamorphic basement of the Andes (cropping out as "isolated eminences" we are told on p. 77) is dealt with in an independent section 12 pages long. Regionally metamorphosed terrains in the Andes are assembled indiscriminately, yet extensive areas of rocks metamorphosed regionally in Tertiary time on the Guajira Peninsula and in the Sierra Nevada de Santa Marta, Colombia, as well as in the Cordillera Oriental, Ecuador, are supracrustal.

It was disconcerting to find many factual errors on the part of the Andes with which I am familiar firsthand. A few are: contrary to Figure 25, no plutonic igneous rocks are known on the Sta Elena Peninsula, Ecuador, nor are Late Cretaceous or younger plutonites found on the border with Peru on the Pacific; the Antioquian batholith, Colombia, is not Paleozoic (Fig. 65); the Carnegie ridge is referred to as seismically active (p. 26), which it is not, and it is mislocated geographically (Fig. 15); Sumaco, an extinct volcano in Ecuador, is cited as active (p. 58 and Fig. 98); the elevations of the upper Cauca and Magdalena grabens, Colombia, are given as between 1800 and 2500 m (p. 75), whereas they are everywhere below 1000 m; a map of the tectonic elements of the Andes in Ecuador (Fig. 98) omits large areas of basement rocks shown correctly in Figure 69; annual displacement on the Boconó fault, Venezuela, is stated to be 66 cm (p. 150), rather than 6.6 mm; high-*P*/low-*T* metamorphism in the Western Cordillera of Colombia is referred to in several places, but in fact has nowhere been documented; metamorphic basement rocks do not crop out in Ecuador solely in the Eastern Cordillera (p. 80), an extensive terrain is found west of the Andes at the Peruvian border; Pleistocene volcanic deposits near the Río Pisque, Ecuador, are wholly continental and include no marine sediments as stated in Figure 87; the Maracaibo basin is filled with "more than 10,000 m of sediments built up during the Cretaceous and the Quaternary" (p. 111)—what about the petroliferous Tertiary rocks that put Venezuela in OPEC?; Cerro Pantanos, an important Colombian copper prospect, is located in the wrong cordillera (p. 202); and contrary to "until recently only relatively small [petroleum] deposits have been exploited in sedimentation basins on the Pacific coast in Ecuador and Peru" (p. 205), the Talara field in northwestern Peru, in continuous production for a century, is the first-discovered of the world's "giant oil fields."

The usefulness of the book is further sapped by poor editing of the translation from German. A few examples: "impregnation deposits", for disseminated deposits; "sedimentation basins", for sedimentary basins; "material", for rocks, "overtilted", for overturned; "magmatic structural material", for igneous rocks; "mineworthy", for mineable; "horizontal faults", for strike–slip faults; or such unclear expressions as "violent fracture faults"; "positive and negative fracturing"; "latiandesites"; "narrow-bedded alpinotype structures"; "magmatological events"; and many others. Heavy wording and awkward sentence structure assault the reader. Two examples are: " . . . the Cambro-Ordovician series are non-metamorphically developed and contain corresponding fossils" (p. 131); and "The primary and secondary concentration of rich metals in the material constitution of the range was correctly correlated at an early date with the quantitatively high proportion of magmatic processes and rocks" (p. 200). Editing of the maps wasn't much better. The geologic map of Chile, admittedly a tough country to depict on paper, leaves a 400-km-wide gap between the northern (Fig. 79) and central (Fig. 80) portions of the country. Also, the join between the central and southern (Fig. 82) portions does not match. The geology of Ecuador depicted on Figure 69 departs markedly from that shown on Figure 98. Were two maps necessary anyway? Also, five outline maps of the continent are given, each more than a half page, solely to show the geographic locations of Colombia (Fig. 94), Ecuador (Fig. 97), Peru (Fig. 100), Bolivia (Fig. 102), and Chile (Fig. 117). Does not a reader of this book already have a firm idea of South American geography? At worst, he could be referred to a single map, preferably placed in the early pages of the book. The numerous photographs are mostly not well tied to the text. Accent marks and spelling of Spanish names and terms are meticulously correct in places, and seriously in error elsewhere.

Plate tectonic theory and its application to the Andes is treated weakly, at best. The reader is offered statements that are meaningless ("In the countries through which the Andes pass, the violent seismic activity frequently gives rise to severe catastrophes and proves that the mountain range is not yet consolidated with its substructure"—p. 4), or that suggest unfamiliarity with the theory itself ("Since seismic activity and volcanic activity are far from synchronous—frequent severe earthquakes have occurred recently in the region of Peru north of Lima which is free from any recent volcanism—one single explanation cannot easily be found for these different tectonic phenomena"—p. 76; or "The Eastern Pacific ridge has been active for about 20 m.y."—p. 191). Prof. Zeil rightly points out that some zealots have forced or even distorted geological and geophysical data to favor their arguments. Even so, recent papers that deal with the oceanography and geophysics of the Nazca plate and its dynamic boundary with the South American plate strongly support the applicability of plate tectonic theory to the Andes, although simultaneously emphasizing that the story isn't as simple as that envisioned only ten years ago.

The Andes—a geological review stresses the rich heterogeneity of the Andes, and effectively demolishes the concept of a uniform "Andean geosyncline." Nevertheless, the Andinophile will probably learn little new, as the book offers no independent geologic interpretation. The neophyte will be discouraged by the awkward organization and cumbersome prose. He would get a more coherent view of the Andes from Gansser's superb article, only 39 pages long, "Facts and theories on the Andes" (*J. Geol. Soc. London, v. 129,* 1973).

TOMAS FEININGER
Université Laval, Québec

0003–004X/80/0910–1073$00.50