Copper: Its Geology and Economics

By Robert Bowen
and Ananda Gunatilaka
Halsted Press Division of John Wiley and Sons, New York 366 p., 1977.
$49 50

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Copper mining has been called the second oldest profession and the development of the copper industry closely parallels the development of man's technology Despite the antiquity of the industry, and the proliferation of geological literature, there is a dearth of publications that integrate the geological, technological and economic aspects of the industry to provide an overview The volume attempts this ambitious task, but unfortunately the attempt must be classified as a failure The promise is there, but inadequate preparation and an unbalanced treatment of the subject leave this promise unfulfilled.

The prime emphasis is on the geology of copper deposits, particularly on the theoretical and mechanistic aspects of ore formation with somewhat perfunctory treatment being rendered to the economic aspects of the industry. An introductory chapter covers the geochemistry, consumption, production and geographic distribution of copper and copper deposits. This is followed by a discussion of the relationship between copper deposits and plate tectonics, particularly the relationship between porphyry copper deposits and convergent plate margins. Descriptive chapters constitute 65 per cent of the book with a four-fold division into deposits of plutonic association, hydrothermal vein association, volcanogenic-sedimentary association and stratiform copper deposits Two chapters on the structure of the production and distribution aspects of the industry and on its future conclude the book. Appendices include a list of copper mineral species, geographic copper consumption tables, U S mine production statistics and a somewhat irrelevant discussion of biogeochemical exploration techniques.

The descriptive chapters concentrate on genetic theories and the descriptions of deposits are skimpy and disorganized. Numerous ill founded and even erroneous generalizations and assertions are made, e.g , the twice repeated statement that there are no copper ores in the volcanic rocks of the Canadian Shield. Extensive, but unfortunately not exhaustive check lists of deposits are included with each chapter, but these contain so much erroneous information that they are of dubious value A list of important copper porphyry deposits includes numerous Canadian examples with little or no porphyry affiliations such as Mattagami Lake, Manitouwadge and Consolidated Rambler but omits the Lornex and Gibraltar deposits. Other check lists are similar mines of misinformation, with numerous misspellings of place names, mislocation of deposits (Lake Dufault, Ontario), misclassification of deposits (Thompson, Manitoba a Zn-Cu deposit) and even the classification of the same deposit in two different categories under different names One list of Canadian Cu-Zn volcanogenic deposits contains 14 errors in only 32 entries.

Unfortunately this sloppiness pervades all sections of the book Figures are incorrectly labelled and text references to figures are inaccurate. Many statements are ambiguous or contradictory The tone is set by a figure on page 2 which shows the progressive decrease in copper grades with time, but does not state whether these are average or minimum ore grades

Sections on copper marketing, and pricing mechanisms are brief but adequate The importance of porphyry copper deposits, particularly those in the Western Hemisphere, as the major source of copper on land in the near and mid term future is rightly emphasized. A chapter on the future of the industry provides adequate coverage of the occurrence of copper in manganese nodules and the potential importance of this source.

Overall this volume suffers from apparent hasty preparation, without the checking of facts and editing of text and figures which should be expected in a technical publication particularly one of this price

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Applied Salt-Rock Mechanics: v.1.: The In-Situ Behavior of Salt Rocks

By C. A. Baar
Elsevier Scientific Publishing Company, 294 p. 1977.
U S $38 95

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The first volume of Applied Salt-Rock Mechanics provides a detailed critique of technical and scientific literature devoted to the geology, physical properties and in-situ mechanical behavior of salt rocks. In his introduction the author claims that erroneous and misleading hypotheses, which he considers cannot be reconciled with observations of the actual in-situ behavior of salt rocks, have led in the past to serious problems in the potash mining industries of Europe and North America This volume is intended to draw attention to what the author believes are the misconceptions of a number of research workers and consultants in the field

In the least controversial section of the volume the author provides a rather abbreviated discussion of the geology of evaporate deposits The reviewer considers there would have been considerable merit in enlarging the sections on texture, stratification and structural geology, particularly in view of the dependence of the mechanical properties of salt rocks on their depositional and deformational history

The bulk of the volume is devoted to chapters on the physical properties of salt rocks and their mechanical behavior under conditions met in conventional underground mining. The author provides a sometimes refreshingly intuitive approach, based on detailed observations of underground deformations, to the mechanical behavior of salt rocks He analyzes and criticises the results of research and consequent hypotheses of most workers in the field The reviewer, while admiring the courage required to forward this no-nonsense practical approach, has reservations concerning an inclination of the author to disregard certain fundamental physical laws,

particularly those concerned with the equations of equilibrium and constitutive relations for what are essentially materials exhibiting complex visco-elastic-plastic behavior. This tendency is evident in those sections of the volume in which the stress distribution adjacent to underground openings in salt rocks is related to the corresponding deformations.

Despite the reservations noted above and the inclination of the author to engage in tendentious polemics at the expense of those whose views differ from his, the volume has much to commend it, if only to draw attention to the importance of geological considerations in the mining of salt rocks. The second volume, in which the author intends to discuss the application of stress-relief techniques to the conventional mining of potash, is awaited with interest.

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Seismic Zoning of the U.S.S.R.

Edited by S. V. Medvedev
Izdatelstvo Nauka, Moscow, 1968
Translated by the Israel Programme for Scientific Translations.
Jerusalem, 533p., 1976.
(Available from Halstead Press).
$58.50

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The book is a very comprehensive account of the seismic zoning studies in the USSR from 1960 to 1968. In the nine chapters of part I, well-known experts, such as the editor, Medvedev, Bune, Vvedenskaya, Shebalin, and six others describe the fundamentals of seismic zoning. In frequently overlapping detail they cover the various idealised inputs into, and the production of the final zoning maps, such as the use of geological-tectonic data, seismic activity maps, and engineering seismology data. Part II is a collection of 19 papers by some five dozen authors, most of whom are presumably members of the associated institutes of the Academy of Sciences in the various republics. In these chapters they decribe for each region the actual, often less than ideal data that have gone into the new 1:5,000,000 seismic zoning map of the USSR which has now replaced the earlier one of 1957.

In chapter 1, part I, the editor gives a short overview of the whole seismic zoning process, ending with an interesting attempt to show the relevance of seismic zoning for the national economy by a quantitative statistical approach to the expected financial losses, as a function of mixture of building types, construction norms and ground motion intensity recurrence rates.

Chapter 2 is a discussion of the methodological fundamentals of large scale zoning using the well-explored Soviet Central Asia region as an example. Various conceptual schemes of correlating independently drawn maps of seismic data and geological-tectonic maps are described. Each one is then covered in more detail by other authors in chapters 3 to 5. The seismic zoning procedures start from historic and instrumental epicenters intensities, and magnitudes. The territory is divided in quasi-homogeneous zones of earthquake occurrence. Seismic activity maps are prepared which are characterized by the number of events at or above certain energy (or magnitude) and the "constant" slope of the logarithmic recurrence curves.

The third and perhaps most important parameter of regional seismicity is the "maximum potential intensity". Although this cannot yet be determined from seismic criteria alone, it is maintained that it can be predicted within one intensity unit using tectonic criteria. Much stressed criteria are uplift velocity gradients, and mapping of zones of large faults, both deep and shallow ones. For instance, belts of the "first category" are expected to produce intensity IX or more. To qualify, the uplift gradient must be higher than 10^{-9} rad/year nearly everywhere, and numerous present day faults must cut through the entire crust, many of them tens of kilometres long, some hundreds. Even without historic earthquakes, such a zone will be rated intensity IX on tectonic grounds. Belts down to category 4 are defined, compared and combined with seismicity maps. Finally, this result of seismo-geological and tectonic correlation is modified to allow for ground motions propagating from potential earthquakes in neighbouring zones. Zones are then simply designated by expected maximum intensity IV to VIII and IX and more, with no explicit annual probability of occurrence, even though an average annual occurrence of 0:001 per 1000 km^2 is suggested as a definition for the maximum potential intensity.

Except for a weak attempt to introduce "effective shaking" in chapter 7, intensity is the almost exclusive ground motion parameter used throughout the book; it is clearly defined as the maximum relative displacement of a certain spherical pendulum seismometer (seismoscope!), e.g., intensity V for a displacement of 0.5 to 1mm. The editor devotes a separate chapter (9) to the MSK-64, seismic intensity scale which is named after Medvedev, Sponheuer and Karnik, and is a slightly improved version of the Modified Mercalli scale. Peak ground velocity and acceleration are 1 to 2 cm/sec and 12 to 25 cm/sec^2 for intensity V and exact factors of two for each intensity level. (Richter's acceleration-intensity relation $\log a = I/3$ · · · gives 14.7 cm/sec^2 at intensity V). However, instrumental strong motion data are scarce and intensities in part II of the book are, as usual, estimated from a descriptive characterization and from various regional magnitude-energy-intensity relations. Most of these are within the usual margins of uncertainty of Richter's formula, but definite regional and also directional differences in intensity attenuation are documented.

There is a chapter on long-term seismic forecasting of earthquakes which considers the cyclic occurrence of great earthquakes and filling of gaps along the U.S.S.R. Pacific coast, but earthquake prediction in the current usage of the word is not treated.

Although the zoning procedure is described in rather authoritative, sometimes dogmatic terms, the details of part II of the book give evidence of considerable leeway and arbitrariness, inevitable with insufficient data. In several cases a footnote acknowledges reclassification of regions after the book went to press due to a new earthquake. This comes as a bit of relief to western readers who may feel overwhelmed by the truly massive