

REVIEWS

Giant Metallic Deposits—Future Sources of Industrial Metals. PETER LAZNICKA. 2006. Pp. 732. Berlin, Springer. ISBN-10 3-540-33091-7. Price US\$199.

This book, the latest in a series of compilations by Peter Laznicka, is focused on giant mineral deposits that are responsible for the bulk of the world's metallic ores. The title itself is somewhat unclear, as many geologists tend to use the term industrial minerals for describing various non-metals. Thus, although the title clearly states this is a book about metallic ore deposits, the use of the term "industrial metals" might initially confuse some potential users; this book, however, is solely focused on metallic mineral deposits. The book is divided into three sections, which include 70 pages of introduction, 11 chapters on the ore deposits that make up the bulk of the text, and 70 pages of summary material. All 300 figures, mainly cross sections of ore deposits, are in black and white, which the author states helped keep the book cost down. Many of the figures are, however, reproduced in color on an accompanying CD-ROM that also contains useful summary tables with grades, tonnages, ages, and deposit types compiled for the world's giant deposits.

The first part of the book describes, sometimes in too much detail, the meaning of various tonnage classifications that are used to group deposits. The overwhelming number of groups include low to high giants, near-giants, low to high super-giants, world-class deposits, etc. Laznicka also provides readers with an introduction to the characteristics of global metal production, demand, price trends, metal price inventory and statistics, and future metal suppliers. The material includes a useful list of the largest deposits for each metal.

The author states that classifications of mineral deposits in textbooks and most databases are not accurate and thus our existing classifications often hinder attempts to analyze prospectivity. Thus an aim of this book is to provide a more useful and comprehensive classification of the world's giant deposits, which is the material comprising chapters 4 through 14. Laznicka claims that the classification used here combines plate tectonics, depositional environments, geological age groups, deformation and metamorphism, supergene modification, genetic groupings, and ore types, so that it therefore more fully emphasizes what is seen in the field and on geologic maps. I found this approach very complex and expect many readers will also find it quite difficult to follow the reasoning behind much of the organization of the ore deposits.

Giant deposits are grouped into the following 11 chapters: (1) Mantles to oceans; (2) Young island arcs; (3) Andean-type margins; (4) Cordilleran granitoids; (5) Volcano-sedimentary orogens; (6) Precambrian greenstone-granite terrains; (7) Intracratonic orogens, granites, hydrothermal deposits; (8) Proterozoic intracratonic orogens and basins: Extension, sedimentation, magmatism; (9) Rifts, paleo-rifts, rifted margins, mantle plumes, anorogenic and alkaline magmatism; (10) Sedimentary associations and regolith; and (11) Higher grade metamorphic associations. All chapters contain a great deal of

material on processes of ore formation and details on the geology of various giant deposits. However, organization of material is confusing. In the chapter concerning late Cenozoic island arcs, the author inexplicably discusses processes of terrane accretion, the Cretaceous Chugach terrane of Kodiak Island, the Sierra Foothills gold province, and Triassic VMS deposits in Alaska and British Columbia. Much of the chapter on Andean-type margins is actually focused on the mineral deposits of western North America, and there are many errors, such as Table 6.1, that indicates a 38 Ma for the Pebble Cu deposit and porphyry deposits in the Fairbanks gold district. A chapter on intracratonic orogens seems like a strange place for a description of many orogenic gold deposits, which are themselves strangely explained in a section on Mesothermal gold, with subsections titled "Intrusion-related Au" and "Gold skarns," subsequently followed by a section on "Dominantly orogenic Au deposits." The chapter describing giant deposits in Proterozoic orogens and basins has a strong focus on gold paleoplacers, but the described type example is the Witwatersrand goldfields of Archean age. There is far too much repetition of many deposits between different chapters. For example, the same mercury deposits are named in the chapters on Andean margins, Cordilleran granitoids, volcano-sedimentary orogens, and intracratonic orogens, which suggests that the selected classification system may have significant problems in discriminating geologic environments for giant deposits in a manner useful for explorationists.

The final part of the book summarizes the primary characteristics of giant mineral deposits. The author describes factors that lead to their formation, the numbers of giants of various deposit types, tectonic settings, and distribution of giant deposits through geological time, expanding on many aspects of his 1999 article in *Economic Geology*. The impact of giant deposits on human history and modern politics, as well as company ownership, dollar values, and exploration costs are all discussed relative to giant ore systems. An interesting list of discovery dates is included for the various deposits, and a final discussion evaluates global areas of mining risk and prospective areas for discovery of new giants.

The hardbound volume is well put together by the publisher, although with some peculiar features in presentation. In a number of places, and for no obvious reason, the font becomes slightly smaller for entire sections of text. There are a few unnecessary advertisements for Data Metallogenica and the need to visit such on the internet for a "virtual field visit" to many of the described deposits. Too often, Laznicka reverts to outdated eugeoclinal and miogeoclinal terminology. Also, the editing could have been improved in many places. For example, (1) rather informal terminology is used throughout the volume (e.g., geo-nirvana, geo-multiculturalism, empirical pigeonholes, ever popular, mine finding, vintage geotectonics, genetic postmodernism); (2) referring to "Stanton, 1972" in one line and then "Dick" in the next is too personal; and (3) inappropriate editorial comments remain in the text (arguing poor classification of ore deposits may be a problem

for the explorationist is indeed valid, but continuing by stating such might not be a problem for a professor with secure tenure or with funded grants seems a bit over the line).

In summary, and despite the above concerns, there is a lot of valuable compilation material hidden in the volume such that it does belong in the ore deposits section of any good research library. Whereas the organization of the book may hinder readers in easily locating some of the desired material, if one uses it by the locality index in the back, rather than the chapter listings, it could serve as a valuable resource for geologic information of giant ore deposits.

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Evolution of an Andean Margin: A Tectonic and Magmatic View from the Andes to the Neuquén Basin (35°–39°S lat). SUZANNE M. KAY AND VICTOR A. RAMOS, Editors. Pp. 359. Geological Society of America Special Paper 407. 2006. ISBN 978-0-8137-2407-2. Price member US\$67.00, non-member US\$95.00.

This volume, dedicated to the memory of Pablo Groeber, a German geologist who laid the geologic foundations for the region under consideration, is a welcome addition to Andean geologic literature. The 15 closely integrated and complementary papers provide a comprehensive overview of the magmatic, structural, sedimentological, and tectonic evolution of the Andean arc and back-arc regions between latitudes 35° and 39°S, which is the northern part of the southern Andes in Chile and Argentina. The back-arc region coincides with the Neuquén basin, which contains one of the most prolific hydrocarbon accumulations in the Andes. The Late Cretaceous through Quaternary interval is the focus of the volume, although the influence of preexisting basement lithology and structures is certainly not ignored. The abundant new information on Late Cretaceous and Cenozoic volcanic rocks, particularly their distributions, ages, and petrochemistry, coupled with structural data from surface mapping and subsurface seismic interpretations, helps to clarify for the first time the complex tectonomagmatic development of the transect. The linkage between the angle of the subducted slab, the stress condition in the shallow crust (extension vs. contraction), and magma chemistry is emphasized in several chapters, as is the role played by transverse structural features of different origins.

In common with much of the southern Andes, the arc and back arc between latitudes 35° and 39°S lack important metallic mineral deposits, although minor subeconomic porphyry copper, sediment-hosted strata-bound copper, and vein gold

occurrences have been known for several decades. More important in the back-arc region, in addition to the hydrocarbon resources, are potassium-rich evaporite and sandstone-hosted uranium deposits. The volume offers new insights to one of the perennial questions of Andean metallogeny: why metal endowment is so many orders of magnitude less in the southern Andes than in the central Andes. A first reading suggests that the principal episodes of crustal contraction, thickening, and uplift—accompaniments to intrusion and giant porphyry copper deposit formation in the central Andes and elsewhere—were more subdued between latitudes 35° and 39°S, and probably throughout the southern Andes, and perhaps did not attain the minima required to optimize copper concentration. Interestingly, Late Cretaceous contractional events were mainly nonproductive in both the central and southern Andes, whereas the late Miocene pulse was spectacularly fertile in the southernmost central Andes, as little as 100 km north of the transect.

The volume not only offers a possible explanation for the apparent absence of giant porphyry copper deposits in the southern Andes, but could well also hold the clues to identifying specific tectonomagmatic niches that merit prospecting for gold, silver, and perhaps other metals, in some cases perhaps for the first time. For example, both the arc and back arc in the region under consideration contain Cenozoic volcanic complexes in which felsic rocks constitute subordinate parts of either andesite-dominated or bimodal suites. Could one of these occurrences offer unidentified epithermal precious metal potential? In this regard, it is salutary to recall that a well-defined epithermal precious metal province in the Late Jurassic extensional back arc of the southern Andes between, approximately, latitudes 42° and 48°S, was entirely unsuspected prior to the first gold discovery there only 15 years ago.

Special Paper 407 will be of particular value to geologists interested in the tectonic controls of Andean metal deposits, and needs to be consulted in conjunction with texts that refer to central Andean tectonics and metallogeny, including those by the volume editors. The volume is excellently prepared, as we have come to expect from the Geological Society of America, and contains numerous easy-to-read diagrams, maps, sections, and photographs, including quite a number using one or more colors in addition to black and white. A comprehensive index follows the text. The volume represents good value for money, especially for Geological Society of America members, but will likely be consulted rather than purchased by most economic geologists, be they academics or explorationists.

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Sulfide Mineralogy and Geochemistry. DAVID J. VAUGHAN, Editor. Pp. 714. 2006. *Reviews in Mineralogy and Geochemistry*, Volume 61. Mineralogical Society of America, Washington, DC. ISBN 093995073-1. Price US\$40.

Volume 61 of the MSA's influential *Reviews in Mineralogy and Geochemistry* series seems, at first glance, to be a reprise of Volume 1, published in 1974 under the title *Sulfide Mineralogy*. However, a closer look quickly reveals just how far sulfide mineral studies have come in the succeeding 32 years. A few chapters have similar titles; for example, chapters on crystal structures, chemical bonding, and phase equilibria, but the chapter contents of Volume 61 are both up-to-date and major advances on their predecessors.

The biggest difference between Volumes 1 and 61 is not the updating of older topics, but the new areas of research that have emerged and that are treated in depth in Volume 61. Surface chemistry of sulfides, for example, which is discussed in two chapters by Rosso and Vaughan, has emerged as a vibrant area of research for practical reasons such as sulfide mineral oxidation and acid mine drainage, and for scientific reasons because new, high-resolution tools have been developed that are ideal for studying surfaces on an atomic scale. Sulfur isotope geochemistry was in its infancy when Volume 1 was written. Today, sulfur isotopes have become key research tools for studies ranging from the chemistry of ore deposits to the evolution of Earth's atmosphere. In Volume 61, sulfur isotopes are reviewed in a concisely elegant chapter by Seal. Another new topic in Volume 61 concerns sulfide minerals in

biosystems. The knowledge that some sulfide minerals form as a consequence of biological activities is certainly not new, but discoveries of deep-sea sulfide chimneys, and the realization that life might have first arisen on a sulfide mineral surface in such an environment, has heightened studies of biologically mediated sulfide reactions.

A generation ago, students of mineral deposits turned to Volume 1 of *Reviews in Mineralogy and Geochemistry*, and to the relevant chapters in the three editions of *Geochemistry of Hydrothermal Ore Deposits*, each edited by Barnes. Today's students should start with Volume 61, not just for information on ore deposits, but for introductions to the ever widening fields of activities in solid state properties of sulfides, surface chemistry, spectroscopic properties, and metal sulfide complexes in solution. Volume 61 is a tour-de-force and Editor David Vaughan and the volume authors are to be both thanked and congratulated for an exciting and valuable volume. The Mineralogical Society of America is to be congratulated too; under the initial editorship of Paul Ribbe, and subsequently of Jodi Rosso, the society started and has continued to produce an outstanding series of volumes, a series that has no peer.

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