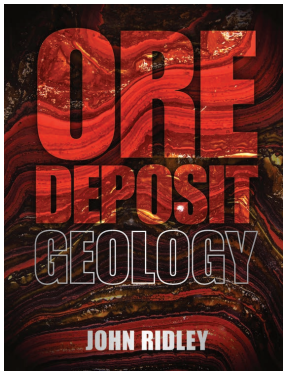
American Mineralogist, Volume 99, pages 2159–2160, 2014

Book Review

ORE DEPOSIT GEOLOGY by John Ridley (2013) Cambridge University Press, New York, p. 409. $85 ISBN 978-1-107-02222-5 (Hardback). www.cambridge.org/oredeposit



The book *Ore Deposit Geology* has a beautiful cover of banded iron formations and the hardback format is very practical and robust for reading during travels, which makes this book not a dusty addition to your shelf collection. The book is subdivided into six chapters, with glossary, index, and references. Figures, cross sections, ore and mine photographs, and geological maps are available in color online with additional resources for teachers, which is an excellent source for lecture material. The target audience is advanced undergraduate to graduate students, and the major goal of the book is to link the building blocks of geosciences to ore deposit geology. The book is also intended as reference for professionals who wish to refresh their knowledge or learn about other types of deposits. The author, John Ridley, sought balance between detail and global perspective and between scientific research and applied field ore geology. The book demonstrates progress in ore geology that has been made by collaboration among the academic research and professional communities. Instances of this collaboration are among the topics covered "text boxes," which provide additional explanation and call attention to topics that are worthy of more detail than can be covered in the chapters. Examples of the "text box" themes are research techniques, novel research findings, and discussions of the genesis of ore deposit types. For the students and teachers, there are exercises and further reading suggestions at the end of each chapter, to permit linking different chapter themes, build discussions, and make quantitative calculations. Common expressions in economic geology that may not be part of the normal geological lexicon such as cut-off grade and prospects are marked in bold and summarized in a handy glossary at the end of the book permitting the reader unfamiliar with those terms to look up swiftly their definitions.

The book is organized following the conventional classification scheme of ore deposits based on their genetic models including magmatic, hydrothermal, and sedimentary ore forming processes. For each ore deposit type, the author gives an overview of the distribution of ores on a global tectonic scale, then shows geological maps and cross sections of ore distribution and deposit sizes, followed by a description of a detailed petrography and mineralogy of ores and host rocks. These descriptive ore characteristics are accompanied by more details on genetic models including magma/fluid sources, temperatures, the role of alteration zones, structural features and analogues in current geologically active systems (e.g., active volcanoes and subduction-related continental- and island-arc settings). Chapter 1 gives an overview of basic concepts in ore deposit geology by introducing common terms and illustrating the factors affecting the value and costs of extracting metals from an ore deposit, giving the reader a sense of what constitutes ore deposits and their worldwide occurrences. Chapter 2 describes the formation of magmatic ore deposits by starting with basic principles of element partitioning between melt-mineral and immiscible melts followed by the description of different ore types. These include LREE ores in the carbonatite at Mountain Pass, California, the chromite cumulates in the Great Dyke, Zimbabwe, and in the Bushveld Complex, South Africa, and the formation of base-metal (Ni-Cu) and precious metal (PGE) magmatic sulfide ore deposits through silicate-sulfide melt immiscibility. The latter include the classical examples from the impact crater at Sudbury, Canada, and the komatiites at Noril'sk-Talnakh, Russian Federation, and Kambalda, Western Australia. The formation of PGE sulfide deposits is illustrated with rhythmic chromite cumulate layering in the Merensky Reef in the Bushveld complex, the Great Dyke of Zimbabwe and the Stillwater Complex in Montana. To conclude Chapter 2, rare-metal pegmatites (focused on LCT-type) resulting from extreme melt fraction processes are described and diamond deposits in kimberlites and lamproites. Chapter 3 describes the formation of hydrothermal ore deposits in magmatic and orogenic environments and starts with the description of the H_2O phase diagram; concepts like supercritical, liquid-like, and vapor-like are shortly discussed and descriptions are given for different types of fluids (i.e., meteoric, metamorphic, and magmatic). Metal sources, ore deposition as function of depth, temperature, and compositional changes together with the mechanisms of formation for different alteration zones around magma bodies are also presented. Magmatic-hydrothermal ore deposits presented include porphyry Cu-Au-Mo deposits such as Bingham Canyon, Utah, the Cu-Au deposit in Cadia, New South Wales, Australia, and the Ann-Mason Cu-Mo deposit, Nevada. Cross sections of magmatic bodies are presented with distribution of dikes, stockwork veins and upper section together with different alteration types (propylitic, potassic, phyllic, and argillic) making it possible to reconstruct the hydrothermal setting of a porphyry deposit as a plutonic-volcanic stratovolcano system. Other types of deposits included are Sn greisen, Cu-Au and W-Sn skarns, and Zn-Pb-Ag and Sn carbonate-replacement deposits. Then epithermal deposits are presented with examples of high-sulfidation Au-Cu-(Ag) deposits from Summitville, Colorado, and Kyushu, Japan, and low-sulfidation epithermal Au-Ag deposits in Hishikari, Japan.

0003-004X/14/0010–2159$05.00/DOI: http://dx.doi.org/10.2138/am-2014-651

The formation of these deposits is linked to processes occurring in analogue active geothermal systems such as White Island and the Taupo Volcanic Zone, New Zealand. Critical observations for epithermal systems are discussed including rock porosity, temperature gradients, salinity and pH, vein formation and alteration, pressure changes, and vapor-liquid phase separation among others. The topic of hydrothermal alteration is then shifted to the submarine environment, exploring volcanic-hosted massive sulfide (VHMS) deposits such as the Kosaka deposits in the Kuroko Belt, Japan, and the Pilbara Craton, Western Australia. Concluding the magmatic-hydrothermal chapter, the author presents syn-orogenic hydrothermal ore deposits including orogenic Au deposits, Carlin-type gold deposits and iron-oxide-copper-gold (IOCG) deposits in former tectonically active zones. Chapter 4 describes non-magmatic hydrothermal ore deposits in sedimentary basins including epigenetic Pb-Zn Mississippi Valley Type (MVT) deposits such as the Bonneterre Formation, Missouri, and the sedimentary exhalative (SEDEX) Pb-Zn deposits in the Northern Territories, Australia, and the Carboniferous Red Dog deposit in the Brooks Range, Alaska. The chemical characteristics of basinal fluids are presented with salinity and solubility of base metals (Pb, Zn, and Cu) as a function of chloride complex formation and the redox state of fluids. Large-scale fluid flow in basins are described using MVT deposits with source of sulfides for ore deposition, fluid flow paths along basins and driving forces for fluid flow. The Kupferschiefer-red-bed-type Cu deposits are presented with an example from the Zechstein Basin, northern Europe. The chapter concludes with the description of uranium deposits in sedimentary basins such as the giant unconformity-related uranium deposits in the Proterozoic Athabasca Basin, Saskatchewan. Chapter 5 describes ore formation in sedimentary environments due to chemical precipitation from surface waters including banded iron formations (BIF), such as the Hamersley Province, Western Australia, and ore resulting from physical separation processes in clastic sedimentary environments such as the Witwatersrand palaeoplacer Au-U deposit, South Africa. The role of ocean chemistry in the genesis of these ore deposit types is shown for BIFs in relation to the chemical evolution of the atmosphere and ocean from the early Archean times and changes recorded in sulfur isotopes are given to illustrate how the ore genesis models are constrained. Finally, chapter 6 presents supergene ore deposits formed in situ in regoliths including bauxite Al ores, laterite Ni-Co ores, and Fe-Mn ores with examples of weathered soil profiles and typical mineral-water reactions.

In my opinion, the book achieves the author's goal of reaching both academics and the professional community of ore deposit geologists. However, I personally would have preferred the author to have opened the book with descriptions of characteristic mineralogy, textures and processes, and conditions of formation of each deposit type followed by the geology and regional distribution of different ore deposits with some specific examples. Nevertheless, I was able to adapt to the presentation style of the book, which gives the geological setting of the ore, then the nature of the ore followed by a description of processes for the formation of the deposit. I strongly recommend making use of the online supplementary materials, because the black and white figures in book, especially the maps and cross sections, are not always easily read.

The book contains numerous petrographic descriptions, which are very useful for learning about ore deposits. I would have liked to have seen more pictures of textural relationships and drill cores showing magmatic textures, veins and different alteration assemblages; such an atlas may be a good future addition to the online material. I personally enjoyed reading the text boxes which gave summaries of methods or discussions of controversial issues, e.g., Boxes 2.3, 3.1, 3.4, 3.5, 3.6, 4.1. In text Box 5.2, the author gives sage advice to economic geologists, "We can never be absolutely certain that our interpretations of geological events and past processes are correct and complete, and exploration strategies should take the uncertainty of our geological interpretations into account." Overall, I can recommend this as useful reference for students and professionals involved in ore geology.

ALEXANDER P. GYSI
Department of Earth and Planetary Sciences
McGill University
Montreal, H3A 0E8 Quebec, Canada