Book reviews

Stable Isotope Geochemistry by Jochen Hoefs, fifth revised and updated edition, Springer, Berlin, 2004, 244 pp. US$ 79.95. ISBN 3-540-40227-6

Few geochemistry texts achieve a fifth edition, which is a tribute to the value of this book to a wide audience. It is a slim volume, but with over one thousand references, the pages are packed with information. The book provides both an overview of the topic and a starting point for more detailed study of individual isotopic systems. The writing is concise and is supported by an abundance of first-class illustrations.

The opening chapter reviews the general principles of stable isotope geochemistry and the analytical methods used to measure isotope ratios. This includes useful discussion on mass-independent isotope fractionation, a topic which has produced important findings in recent years. It is not an overstatement to say that recent innovations in analytical techniques have been spectacular. This has resulted in great improvements in sensitivity, in spatial selectivity within samples (laser microprobe, continuous flow, SIMS) and in the measurement of isotope ratios for heavy elements, such as Zn, Cu, Fe, Cr, Mo, TI (TIMS and multiple collector ICP-MS).

Chapter 2 deals with isotope fractionation mechanisms for selected elements. In addition to C, O, H and S, for which there is a long history of study, elements that have only recently been investigated because of analytical developments, are described.

Chapter 3, 'Variations of Stable Isotope Ratios in Nature', is the main (117 pages) and last part of the book. In individual sections, the chapter describes variation for all elements for which data are available and isotope data for all the main sampling media, including: the different occurrences of water; igneous, sedimentary and metamorphic rock types; and the principal types of mineral deposits. Illustrations are clear, simple and consistent in style.

Applications of stable isotope geochemistry to exploration for mineral deposits have been limited. The primary reason for this is that historical analytical methods have provided data on a limited range of elements, and have been expensive and thus not well suited to the analysis of large batches of samples. With new analytical approaches, this is changing. There is a particular opportunity to use isotope ratios to discriminate between 'false' anomalies and those that are indicative of mineralization.

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Geochemistry of Sediments and Sedimentary Rocks: Evolutionary Considerations to Mineral Deposit-Forming Environments by David Lentz (ed.), Geological Association of Canada, GeoText 4, 2004, 184 pp. US$80. ISBN 0-919216-76-5

How can geochemistry be applied to our understanding of the formation and evolution of sedimentary rocks and sedimentary basins? Collectively, the ten papers included in this book address this question and suggest that geochemistry is important for (a) understanding changes that take place in the diagenetic environment, (b) interpreting provenance and developing crustal evolutionary models, (c) dating sedimentary rocks, and (d) understanding the genetic relationships between sedimentary ore deposits and their associated sedimentary sequences.

The introduction by David Lentz is a good historical perspective and review of the use of geochemistry in sedimentary rock research that provides perspective for the more data-specific papers that follow. However, a clearer picture of the primary goals of the book and how the papers were chosen would have been useful to help a reader understand the common theme that threads the papers together. The paper by S. McLennan et al. shows the significance that geochemistry can play in the study of modern and ancient sedimentary systems and the possible role that it plays in interpreting crustal composition and secular changes through time. H. W. Nesbitt highlights changes that take place within the diagenetic environment, although the mechanisms for forming sedimentary rocks, including weathering and erosion of parent materials, is also included. Using Sr, S, C and O isotopic systems in carbonate-rich sedimentary sequences, J. Veizer presents the vast amount of palaeoenvironmental information relating to solid earth, ocean, and even climatic secular changes through time. The papers by P. J. Patchett and McLennan et al. provide reviews on the radiogenic Nd and Sr signatures of elastic sedimentary rocks, which have implications to tracing source regions. P. Fralick unravels the various geochemical contributions to the formation of sedimentary rocks and he discusses hydrodynamic effects that relate to placer development. Detailed compositional data and dating of specific minerals (e.g. zircon), especially as applied to provenance determination, are presented in a paper by R. Cox. The Re–Os systematics in organic-rich sedimentary rocks, as it relates to metal accumulation processes in that environment, is reviewed by R. Creaser. The last three papers are pertinent for understanding the genetic relationships between sedimentary ore deposits and their associated sedimentary sequences. A. Brown reviews the current genetic understanding of sedimentary rock-hosted copper, lead and uranium–vanadium deposits and their metal sources, which has been a longstanding problem. R. Coveney reviews the role that organic-rich shales play in the genesis of a variety of redox-controlled sedimentary ore deposits. Finally, J. Peter reviews the association between exhalative ores and associated iron formations, and uniquely applies statistics to help distill the enormous database that he has collected. Implications for exploration of associated base metal sulphide deposits are highlighted.

In terms of presentation, I think it is worth noting that the font size of the text is remarkably small and will be difficult for anyone over 45 years old to read! Along these same lines, many of the figures are barely legible. All figures are black and white but some colour would have served to make the book more attractive and help clarify details, particularly photographs of rocks and minerals (e.g. in papers by Cox and Peter).

Although some of the data presented in individual papers has been presented previously and is redundant, each paper serves to capture, summarize, and bring up to date various aspects of sediment and sedimentary rock geochemistry, and therefore the book is an excellent comprehensive resource. What is lacking is a summary paper about the application of geochemistry to hydrocarbon and mineral exploration in sedimentary environments. There are bits and pieces of discussions in some papers.
that might peak an explorationist’s interest, but a separate paper would have been a valuable addition. This is a particularly obvious omission since the discussion at the end of the Introduction brings up this point. Specifically, it is stated that one main interest in sedimentary geochemistry is its application to exploration. For example, sedimentary chemostratigraphy, which has been used in both the hydrocarbon and mineral exploration industries, can help resolve complex structure in fold-and-thrust belts; and the geochemical study of hydrothermal alteration related to mineral deposits has proved to be a powerful exploration method for some sediment-hosted deposits in recent years. Neither of these topics is thoroughly covered in the book.

Overall, the editor and authors produced a modestly priced, worthy book and anyone interested in sedimentary rock geochemistry, mainly researchers and students, will find this a useful addition for their library. It provides a comprehensive, up-to-date summary of the field of sedimentary geochemistry and how that is applied to a wide variety of problems.

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Introduction to Ore-forming Processes by Laurence Robb, Blackwell Publishing, Oxford, 2004. 373 pp. £32.50 (paperback). ISBN 0-632-06378.

The book emphasizes processes that give rise to mineral deposits and how these processes fit into the Earth system. It is primarily intended for students at senior undergraduate or graduate level. It assumes that readers have basic knowledge in a wide range of core Earth science disciplines, as well as in chemistry and physics.

Each chapter in the book starts with a list of topics and case studies (in separate boxes) to be discussed. Case studies, which are boxed separately from the main text, describe briefly examples of classic deposits to give context and relevance to the processes being discussed. Each chapter ends with a useful summary and directs the reader to selected references that delve further into certain ore-forming processes.

An introductory chapter explains a classification scheme for ore deposits. It avers that, although many ores are metamorphosed, metamorphism itself is not a fundamental process whereby deposits are formed. It argues, however, that ‘hydrothermalism’ is a viable analogue for metamorphism as it also involves modification of pre-existing rocks or deposits, as well as heat/mass transfer and pressure fluctuation. Thus, deposits are classified based on igneous, hydrothermal and sedimentary/surficial processes. It warns the reader, however, of drawbacks of this classification and punctuates that ore-forming processes span more than one of the three classes. The adapted classification forms the basis for structure and layout of the book.

Part 1 – Igneous Processes – comprises Chapter 1, which deals with processes related to magma formation and its subsequent cooling and crystallization, and Chapter 2, which discusses processes related to exsolution of fluids during the later stages of magma crystallization. Chapter 1 explains metallogeny of oceanic and continental crust, relative fertility of various types of magmas, ore-forming processes such as partial melting, crystal fractionation and liquid immiscibility. Mineralization processes related to felsic magmas and to mafic magmas are distinguished clearly. Topics in Chapter 2 include formation of magmatic aqueous phase, properties of magmatic–hydrothermal solutions, significance of pegmatites to ore-forming processes, fluid–melt trace metal partitioning, fluid flow in and around plutons that form fluid sources, and models for formation of porphyry-type, skarn and epithermal deposits. High- and low-sulphidation epithermal deposits are discussed in this chapter, but cognizant that the latter are formed from dominantly meteoric fluids.

Part 2 – Hydrothermal Processes – contains only one chapter, which covers the wide and diverse range of hydrothermal processes not covered in Part 1. Chapter 3, the largest chapter in the book, is thus concerned with hydrothermal mineralization related to fluids derived from sources other than magmatic solutions, such as those formed from metamorphic dehydration reactions, from expulsion of pore fluids during diagenesis of sediments, and from meteoric waters. It then explains processes that induce hydrothermal fluid flow, precipitation mechanisms for metals in solutions, and fluid–rock interaction (leading to hydrothermal alteration). Treatment on deformation vis-à-vis hydrothermal fluid flow demonstrates that structural discontinuities are active rather than passive ‘plumbing systems’ for mineralization. The chapter also illustrates modern analogues of hydrothermal mineralization – ‘black smokers’ for VMS deposits and Salton Sea and Red Sea geothermal systems for SEDEX mineralization. The Red Sea system provides the best evidence for the still-contentious notion of a VMS–SEDEX continuum. The chapter further explains mineralization associated with aqueo-carbonic meta-morphic fluids (orogenic, Carline-type and conglomerate-hosted gold), connate fluids (stratiform sediment-hosted Cu and MVT Pb–Zn), and near-surface meteoric fluids (sediment-hosted U).

Part 3 – Sedimentary/Surficial Processes – includes Chapter 4, which is concerned with surficial and supergene ore-forming processes, and Chapter 5, which deals with sedimentary ore-forming processes. Topics in Chapter 4, the smallest chapter in the book, involve principles of chemical weathering, lateritization (including enrichment of precious metals and nickel), formation of clay deposits and calcrete-hosted deposits, and supergene enrichment of copper and other metals. Formation of clay minerals by hydrothermal processes is noted however. Chapter 5 explains clastic sedimentation and heavy mineral concentration, chemical sedimentation, and formation of fossil fuels. The discussion on placer deposits lacks treatment on eluvial types. Synopses of oil/gas formation and coalification are definitely a plus not found in most books about mineral deposits.

Part 4 – Global Tectonics and Metallogeny – consists of Chapter 6, which is concerned with patterns in the distribution of mineral deposits, both spatially in the context of global tectonics and temporally in terms of crustal evolution and metallogeny through Earth history. Chapter 6 ends with a summary of plate-related tectonic settings and mineral deposit types associated with them.

The book is a thoroughly good read, has adequately diverse case studies and abundantly good illustrations. The author succeeds (at least for this reviewer) in providing a better understanding of nature and origin of mineral occurrences in the context of Earth systems. Aside from geoscience students, geoscientists practising in the minerals and related industries should find this book valuable. For example, knowledge of ore-forming processes is important in defining deposit recognition criteria, which are applied in GIS-based modelling of mineral prospectivity. The book would be an inexpensive addition to libraries of institutions catering to geoscience education or practice.

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