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John Ridley
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Ore Deposit Geology

Mapping closely to how ore deposit geology is now taught, this textbook systematically describes and illustrates the major ore deposit types, and links them to their settings in the crust and the geological factors behind their formation.

- Written for advanced undergraduate and graduate students with a basic background in the geosciences, it provides a balance of practical information and coverage of the relevant geological sciences, including petrological, geochemical, hydrological and tectonic processes.
- Important theory is summarised without unnecessary detail and integrated with students' learning in other topics, including magmatic processes and sedimentary geology, enabling students to make links across the geosciences.
- Students are supported by pointers to further reading, a comprehensive glossary, and problems and review questions that test the application of theoretical approaches and encourage students to use what they have learnt.
- A website includes visual resources and combines with the book to provide students and instructors with a complete learning package.

John Ridley is the Malcolm McCallum Chair of Economic Geology at Colorado State University where he has taught ore deposit geology and field geology for the past seven years. His earlier academic positions spanned three other continents, with positions at universities in Australia, Switzerland and Zimbabwe, and over his career he has taught courses in geochemistry, petrology and structural geology. Professor Ridley has published over seventy articles in refereed journals and books, in addition to geological maps and reports for companies and groups within the mining and minerals industries.

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"This is ore deposit geology the way most professional economic geologists think, using deposit descriptions as a basis for understanding genetic processes. It is clearly structured, simply illustrated and lucidly explained. This book will be appreciated by students, teachers and professional geologists for its clarity of expression and scholarship of content."
Dr Noel C. White – *Consulting Economic Geologist and Honorary Research Professor, CODES, University of Tasmania*

"If you've been searching for a modern textbook on metallic ore deposits, this is a good choice. Incorporating recent observational and theoretical advances, excellent graphics, an accessible treatment of chemical processes, and end of chapter questions, this book appears ideal for undergraduate geology majors."
Professor Donald M. Burt – *School of Earth and Space Exploration, Arizona State University*

"In this textbook, the author combines up-to-date scientific literature with well-structured discussions on ore-forming processes. This results in stimulating and insightful chapters, which provide students and teachers with an extremely useful tool. The end-of-chapter boxes and questions provide great pedagogic support for courses."
Dr. Paolo S. Garofalo – *Geological & Environmental Sciences Department, Università di Bologna*

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PREFACE

Ore deposit geology may be taught late in a student's undergraduate programme, or even at the beginning of a graduate programme. At this stage the student is able to link many of the concepts involved in ore genesis into his or her knowledge of the building blocks of the geosciences. Or it may be taught early, to show students potential applications of their emerging knowledge. This book is designed for the former case and also to be a reference if a student chooses to work professionally in the field. Knowledge typical of standard undergraduate courses in mineralogy, igneous, metamorphic and sedimentary geology, structural geology and tectonics, and geomorphology are assumed, together with some basic chemistry. It is not assumed that students have had courses in isotope geochemistry or in geochemical thermodynamics.

The subject is scientifically expansive. There are few areas of the Earth sciences which are not touched upon in a thorough study of the subject. A balance needs however to be reached in teaching between detail and breadth. Some geologists work on one deposit type all their lives; others need to have enough knowledge of all types to make suitable judgements when they are called to evaluate them. A balance also needs to be reached between the local and the global. A practising ore deposit geologist may remain in one area or work over the world. The subject thus needs to be taught with case studies from globally, but also tailored to local geology.

It was a truism while I wrote this book, over the years before, and hopefully for at least a few years after, that the professional community of ore deposit geologists needs to become scientifically more sophisticated to be successful in our search for resources to replace those that are being mined. The easy to find, outcropping ores are almost all found. We need to be able to predict the likely positions of ores, and find them and evaluated them with a reasonable success rate through drilling to depths of a few hundred metres. Accurate prediction will require good knowledge of the nature of ore, of empirical markers of ore systems, and accurate conceptual models of how ores form.

It is with the aim of training with all the ends and needs listed above this book was written. Description, genetic analysis and discussions of advances in understanding of other sub-disciplines of the geosciences are combined. About 30 deposit types are described and discussed in varying depths.

I made two specific choices in format that warrant some explanation: First, for the benefit of simplicity, I felt the need to take stands on some of the conflicting interpretations and debates in the community of ore deposit geologists and to write some of the deposit descriptions and analyses from the viewpoint of one 'side'. Debate is an integral part of science. Descriptions run the risk of being supplanted as new discoveries are made. Genetic analysis runs an even greater risk. We need to keep aware that at least some of our interpretations, especially of the unknowable of ore genesis in the geological past, are at all times 'castles in the air'. We need further to be aware that our interpretations can be intensely personal.

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My intention throughout is to present deposit descriptions and data as we know them, and leave a teacher enough room to discuss with students where and why other interpretations may be held. The book would have been much longer and the text less transparent had multiple interpretations been weighed up against each other in every instance at which they could be weighed. I have probably offended people by taking sides. However, at least one of two conflicting models must be wrong.

A second choice was to minimise citation in the text. This choice was also made for conciseness and flow. I have in general cited articles which I judge to be the best recent descriptions of classic deposits of each type, rather than work that supports genetic models. Ore deposit geology is a warren of detailed observations and data. It is easy, however, to search (in for instance Web of Science or Google) for original papers that report specific data and their interpretation at deposits. It is much more difficult to find syntheses of ore forming processes and discussions of commonalities of deposits.

Some notes on the components of the text:

A word or phrase in bold in the text is a signal that the word is defined in the glossary.

Boxes serve various purposes:

- Samplers of research techniques which are commonly referred to in ore deposit geology literature. The intention is to tell students that these research techniques exist and to give sufficient background that research results can be understood in broad terms.
- Discussions of results of recent research in the Earth sciences which is relevant to ore deposit geology.
- Discussions of debates on the genesis of ore deposit types, specifically those debates which inform on how debates develop and are resolved.

Questions and exercises are in a range of forms:

- Sample arithmetic calculations given with the intention to put sizes, rates of processes, etc., into context. My experience in teaching is that some students learn through such quantification, whereas for others the questions would leave no lasting understanding.
- Review questions. Many of these are designed to link themes from different sections of a chapter or from different chapters. Students cannot answer these questions by simply reading through a single subsection of the book.
- Discussion question. These include both questions that have an answer and others that specialists could debate and not resolve.

Further readings are an introduction into selected themes from the literature. They are chosen for accessibility. Some give an introduction to lines of research on background topics.

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