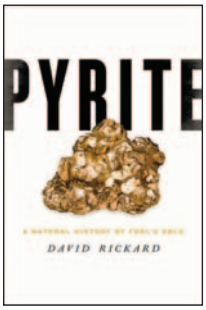
PYRITE: A NATURAL HISTORY OF FOOLS GOLD[2]

David Rickard has pulled off a remarkable trick by writing a book on mineralogy and geochemistry that will entertain and interest an unusually wide range of readers. The Preface indicates that the target audience is a popular readership. Indeed, the book is accessible to beginners of science and to amateur mineral enthusiasts. Yet it also provides a wealth of new knowledge for most professionals. Even though I thought I was fairly well informed about sulfides, I found the book full of surprises and very enlightening.



The title is simply *Pyrite*, the word stretching across the front cover in large capital letters, presumably stressing the importance of the mineral even before the book is opened. When reading the Prologue, I felt slightly skeptical by the phrase, repeated several times, that "pyrite is the mineral that made the modern world." Is pyrite so very special? Does this mineral deserve a book to itself? The answer is an emphatic "Yes!" The first few chapters remove any doubts that a reader may have about the great importance and special role that pyrite has played in the history of our civilization.

Pyrite is one of the few minerals with which the general public is familiar, probably because of its fame as "fool's gold." It is appropriate, then, that the first chapter takes us on a dizzying journey through time and cultures, from ancient Greece via the medieval realms of England, Germany, and China, to modern Europe and North America, in search of the origins and uses of the concept of "fool's gold," and the association of this term with pyrite. It will probably astonish many readers to learn that pyrite played a major role in the colonization of both Canada and the United States by Europeans. The motivation was finding real gold, which usually turned out to be either inadvertently or fraudulently misidentified pyrite. An analysis of what "pyrite" meant during Classical, Arab, and Medieval times reveals that it was often called "marcasite", whereas at other times the term "pyrite" referred to several different sulfide minerals. I was delighted to receive an explanation for how and why the widespread, and to me annoying, term "iron pyrites" got into the literature.

We also learn that the origins of our civilization are closely connected to pyrite. The use of fire was vital to the evolution of humans, and pyrite was key to making fire portable: the mineral was used in fire-lighting kits up to the Iron Age. In addition, because it was a source of sulfur and sulfuric acid, pyrite was the foundation for the development of the earliest chemical industry, pharmaceutical industry, the modern arms industry, and the production of fertilizers. I, like many mineralogists, had been vaguely familiar with the technological uses of pyrite. Yet, the text is rich in historical details and facts that I had never come across before. The insights of Rickard ensure a compelling read for all.

The first half of the book provides a fascinating account of the cultural history and practical importance of pyrite; the second half emphasizes more contemporary science. A chapter on the structure of pyrite introduces the reader to the history of crystallography and explains how pyrite played a pivotal role in science by being one of the first structures to be determined by W. H. Bragg and W. L. Bragg. The eye-catching pyrite cubes, dodecahedra, and framboids are a delight, and the formation pathways of distinct crystal morphologies are described in detail, again providing many surprising new facts. We are then drawn into the depth of the ocean: hydrothermal vents and the origins of massive sulfide deposits, then on to bacterial sulfate reduction and the formation of sedimentary pyrite, which is described in an engaging style and with great insight. We are then introduced to inorganic and bacterial oxidation of pyrite and their resulting acid environments, as well as the roles of sulfur compounds in atmospheric pollution. In places, the author uses pyrite as an excuse to wade into his favorite topics and educate his readership about important environmental issues.

All pieces of the pyrite geochemical puzzle fall into place in the chapter entitled "Pyrite and the Global Environment," in which we receive the big picture of the role of pyrite in the global cycles of sulfur, oxygen, and carbon dioxide, and how sulfur isotopes in pyrite hold the key to understanding the history of our planet. Pyrite has been implicated in several origin-of-life hypotheses, which are summarized and made digestible for the nonexpert reader. The book concludes with a chapter that discusses current industrial uses of pyrite as a source of various metals (including gold), and we even get a glimpse into the possible future in which pyrite could be used as a material for solar cells.

This book convinces the reader that pyrite deserves its special distinction among minerals, both because of its historical and cultural importance and because of the major roles it has played in important areas of science and technology. In fact, halfway through the book I started wondering what other minerals could belong to the same exclusive club. It is hard to find more than a handful: quartz, calcite, magnetite, apatite, and halite are the ones that are on my list.

A strength of the book is its historical perspective in which every facet of science that is related to pyrite is viewed and narrated. The depth and breadth of the author's knowledge, as well as his humor, makes the book a delightful read. My only critical comment concerns the figures: there are a number that are in greyscale that really should have been printed in color.

David Rickard's several decades' worth of original research experience and the associated knowledge he has accumulated are condensed in this highly entertaining and very informative book. I recommend it to anyone interested in geochemistry, in mineralogy, and in science generally.

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2 David Rickard (2015) *Pyrite: A Natural History of Fool's Gold*. Oxford University Press, Oxford, UK, 320 pp, ISBN 978-0-19-020367-2, £20.49

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The last three chapters are essentially case studies of particular deposits: Chapter 12 on the Giant Mine (Yellowknife, Canada; by Jamieson), Chapter 13 on the Empire Mine (California, USA; by Alpers, Myers, Millsap and Regnier) and Chapter 14 on the Tsumeb Deposit (Namibia; by Bowell). These three chapters emphasise the importance of hydrogeochemistry and its influence on arsenate mineral stability. Unusually, the chapter on the Empire Mine also served as a field-trip guide for a visit by the short course participants. Another unusual feature coming at the end of this volume is a mineral-name index that lists the pages where particular minerals are mentioned. This index complements the appendices of Chapter 2, which list most of the arsenate, arsenite and common arsenic sulphide and arsenide minerals. Such editorial touches further enhance the usefulness of these tabulations.

Overall, this is a very welcome addition to the prestigious RiMG series and maintains the high standards that have been set in terms of authoritative content and excellent presentation. It is almost certain to become a 'best seller'.

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