

COAL AND PEAT FIRES

A Global Perspective

VOLUME 3

CASE STUDIES – COAL FIRES

Edited by

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Coal and Peat Fires: A Global Perspective

Volume 3: Case Studies – Coal Fires

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Amsterdam – Boston – Heidelberg – London – New York – Oxford – Paris
San Diego – San Francisco – Singapore – Sydney – Tokyo

Elsevier
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The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK
225 Wyman Street, Waltham, MA 02451, USA

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ISBN: 978-0-444-59509-6

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

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Printed in the United States of America



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Captions for Front Cover Photos

Top Photo: The Centralia mine fire in eastern Pennsylvania, where anthracite in abandoned coal-mine tunnels has burned since 1962. Most buildings in Centralia were demolished because of the fire. These row homes are at the base of a hill from which gas is exhaled because of burning anthracite in the subsurface. The Centralia fire is discussed in Chapter 25. Photo by Janet L. Stracher, 2013.

Bottom-Left Photo: Kremersite from the burning Anna I coal-mine dump, Alsdorf, Germany. The horizontal field of view is 1.5 mm. This and other beautiful minerals nucleated in association with coal-fire gas at the Anna dump are discussed in Chapter 7. Photo by Vincent Bourgoïn, 2010.

Bottom-Middle Photo: Fragments of vitreous clinker welded into a monolith in the vicinity of Oktyabrinka Village, Kuznetsk coal basin, west Siberia, Russia. Such clinker is common where there are deep underground coal fires that burn at extremely high temperatures for a long time. Russian coal fires are discussed in Chapters 19–21. Photo by Victor V. Sharygin, 2005.

Bottom-Right Photo: A drag line and other mining equipment ignited by a coal fire at the Blair Athol Coal Mine, New South Wales, Australia. Australian coal fires are discussed in Chapter 1. Photo courtesy of the Law Offices of Countryman and McDaniel (<http://CargoLaw.com>), Los Angeles, California, 2009.

Dedication

We dedicate this four-volume book to Janet L. Stracher whom we love and admire for her kindness to strangers, devotion to family and friends, and her love of nature. Her inspiration and guidance throughout our undertaking of this monumental project assured its completion.

Preface to Volume 1

COAL AND PEAT FIRES: A GLOBAL PERSPECTIVE, Volumes 1–4, is a comprehensive collection of diverse and pioneering work in coal and peat-fires research conducted by scientists and engineers around the world. It contains hundreds of magnificent color photographs, tables, charts, and multimedia presentations. Explanatory text is balanced by visually impressive graphics.

This work is devoted to all aspects of coal and peat fires. It contains a wealth of data for the research scientist, while remaining comprehensible to the general public interested in these catastrophic fires. Amateur and professional mineralogists, petrologists, coal geologists, geophysicists, engineers, environmental and remote sensing scientists, and anyone interested or involved in the technical aspects of coal and peat mining, coal and peat fires, and the effects of burning; from human health to combustion metamorphism, will find all these four volumes useful. Although the technical level varies, the science-attentive audience will be able to understand and enjoy major portions of this work.

The four volumes are also a valuable source of information about the socioeconomic and geo-environmental impacts of coal and peat fires. As an example, the mineral and select-gas analyses presented will be of great interest to environmental scientists, academicians, people employed in industry, and anyone interested in minerals and pollution.

The contents of this work can be used to design and teach courses in environmental science and engineering, coal geology, mineralogy, metamorphic processes, remote sensing, mining engineering, fire science and engineering, etc. A variety of case studies on a country by country basis, including prehistoric and historic fires, encompass a wide range of geoscience disciplines. These include mineralogy, petrology, geophysics, engineering, geochemical thermodynamics, medical geology, numerical modeling, and remote sensing—all making this work a cutting edge publication in “global coal and peat-fires science.”

Volume 1 before you contains 19 chapters illustrated in full color. Chapter 1 discusses the origin of coal and coal fires. Chapter 2 discusses the techniques used for mining coal in addition to coal fires that occur in association with such mining. In Chapter 3, the connection between spontaneous combustion and coal petrology is discussed. Chapter 4 is about the utilization of coal by ancient man. Geotechnical and environmental problems associated with burning coal are discussed in Chapter 5. The general effects of coal fires that are burning around the world are discussed in Chapter 6. Chapter 7 examines the environmental and human-health impacts of coal fires. Chapter 8 is devoted to explaining the laboratory procedure of gas chromatography, used to analyze samples of coal-fire gas collected in the field. Numerous complex processes associated with the nucleation of minerals from coal-fire gas and sampling techniques are presented in Chapter 9, and in Chapter 10 some analytical methods used to identify such minerals are discussed. Chapter 11 presents a synopsis of the analytical procedures used to identify the semi-volatile hydrocarbons that nucleate from coal-fire gas. In Chapter 12, the magnetic signatures recorded by rocks and soils affected by the heat energy from burning coal are examined. Chapter 13 presents a synopsis of the historical utilization of airborne thermal infrared imaging for examining coal fires, and in Chapter 14, a more in-depth synopsis of the use of remote sensing technology for studying coal fires is presented. In Chapter 15, the historical and political implications for US government policy regarding coal fires are presented. The former U.S. Bureau of Mines role in controlling coal fires in abandoned mines and spoils piles is presented in Chapter 16. Chapters 17 and 18, respectively, present engineering fire-science studies of smoldering-coal combustion and the suppression of smoldering-coal fires. Volume 1 concludes with Chapter 19 in which the use of compressed-air-foam injection, for extinguishing coal fires, is discussed.

Volume 2 presents hundreds of color photos of coal and peat fires burning around the world as well as multimedia presentations that include movies, radio talk shows, and presentations given at professional meetings and elsewhere. Volume 3 presents case studies about fires on a country by country basis. Volume 4 is devoted to all aspects of peat and peat fires.

The editors of this four-volume book believe that scientists and engineers as well as the general public will find that the information presented herein reveals the complexity of coal and peat-fires science, the effects of these fires, and useful methods for investigating them. We hope that the information presented will create global awareness about these fires and trigger new research ideas and methods for studying them, accelerate efforts to mitigate and extinguish them, and build a better-living environment in mining areas around the world.

Glenn B. Stracher
Anupma Prakash
Ellina V. Sokol

Preface to Volume 2

COAL AND PEAT FIRES: A GLOBAL PERSPECTIVE, Volumes 1–4, is a comprehensive collection, both in hard cover and online editions, of diverse and pioneering work in coal and peat-fires research conducted by scientists and engineers around the world. The four-volume set, illustrated in full color, contains the largest collection of coal and peat-fires research available in any book ever published. Although the technical level varies, the science-attentive audience interested in these catastrophic fires will be able to comprehend and enjoy major portions of this work.

Each volume or the entire set can be used as a supplement for teaching courses in earth science, environmental engineering, mining engineering, fire science and engineering, etc. In addition, the socioeconomic and geo-environmental impacts of coal and peat fires are discussed and illustrated in color.

Volume 2 (Photographs and Multimedia Tours) contains 24 chapters. Additional chapters, coal-fire gas and field data, and a wealth of multimedia materials are available on the companion Elsevier website for this book (<http://booksite.elsevier.com/9780444594129>). The multimedia materials include short movies, radio talk shows, entire conference proceedings, and presentations given at scientific meetings and elsewhere. Each chapter in Volume 2 presents a synopsis of selected fire localities for the country discussed, a photo tour of those fires, a list of journal and book references, and a list of World Wide Web addresses for additional reading. Chapters 1–24 discuss fires in the following respective countries: Australia, Azerbaijan, Canada, China, Colombia, the Czech Republic, England, France, Germany, India, Indonesia, Israel, Italy, Kazakhstan, Poland, Portugal, Romania, Russia (coal fires), Russia (peat fires), Scotland, South Africa, Spain, the United States, and Venezuela. Although combustion in Azerbaijan, England, and Israel are potentially related to hydrocarbon reservoirs other than coal or peat, the effects of combustion are analogous as illustrated in the remaining chapters, and so these three colorful and intriguing chapters were included for the greater reading audience.

Volume 1 discusses coal, coal combustion, and analytical techniques for studying coal fires and the by-products of combustion. Volume 3 presents case studies about fires on a country by country basis. Volume 4 is devoted to all aspects of peat and peat fires. In addition, an online interactive world map of coal and peat fires by Rudiger Gens, University of Alaska Fairbanks, is available on the Elsevier companion website mentioned above.

The editors of this four-volume book believe that scientists and engineers as well as the general public will find that the information presented herein reveals the complexity of coal and peat-fires science, the effects of these fires, and useful methods for investigating them. We hope that the information presented will create global awareness about these fires and trigger new research ideas and methods for studying them, accelerate efforts to mitigate and extinguish them, and build a better-living environment in mining areas around the world.

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Preface to Volume 3

COAL AND PEAT FIRES: A GLOBAL PERSPECTIVE, Volumes 1–4, is a comprehensive collection of diverse and pioneering work in coal and peat-fires research conducted by scientists and engineers around the world. It contains hundreds of magnificent color photographs, tables, charts, and multimedia presentations. Explanatory text is balanced by visually impressive graphics.

This work is devoted to all aspects of coal and peat fires. It contains a wealth of data for the research scientist, while remaining comprehensible to the general public interested in these catastrophic fires. Amateur and professional mineralogists, petrologists, coal geologists, geophysicists, engineers, environmental and remote sensing scientists, and anyone interested or involved in the technical aspects of coal and peat mining, coal and peat fires, and the effects of burning, from human health to combustion metamorphism, will find all these four volumes useful. Although the technical level varies, the science-attentive audience will be able to understand and enjoy major portions of this work.

The four volumes are also a valuable source of information about the socioeconomic and geo-environmental impacts of coal and peat fires. As an example, the mineral and select-gas analyses presented will be of great interest to environmental scientists, academicians, people employed in industry, and anyone interested in minerals and pollution.

The contents of this work can be used to design and teach courses in environmental science and engineering, coal geology, mineralogy, metamorphic processes, remote sensing, mining engineering, fire science and engineering, etc. A variety of case studies on a country by country basis, including prehistoric and historic fires, encompass a wide range of geoscience disciplines. These include mineralogy, petrology, geophysics, engineering, geochemical thermodynamics, medical geology, numerical modeling, and remote sensing—all making this work a cutting edge publication in “global coal and peat-fires science.”

Volume 3 contains 29 chapters illustrated in full color. Additional chapters, photos, and data will be available on the companion website for this book at <http://booksite.elsevier.com/9780444594129>. Chapter 1 discusses spontaneous combustion in association with open-pit coal mining in Australia. Chapter 2 examines nanominerals and particulate matter from Brazilian coal fires. In Chapter 3, case studies utilizing remote sensing and in situ mapping for examining coal fires in China and India are presented. Chapter 4 discusses coal combustion and associated mineralization in the Helan Shan Mountains of northern China. Chapters 5 and 6 about the Czech Republic discuss, respectively, mineralization associated with burning coal in colliery-waste piles and combustion metamorphism in the Most Basin. The burning Anna I coal-mine dump in Alsdorf, Germany, and mineral nucleation mechanisms are discussed in Chapter 7. Chapter 8 explores the geothermal uses of smoldering coal-waste dumps. Mining impacts in the Jharia coalfield of India, the world's most complex coal-fires system, are discussed in Chapter 9. The physical properties of stone-tools affected by hydrocarbon combustion and their use by ancient people in Israel are the subject of Chapter 10. Chapter 11 is devoted to a geophysical study of pyrometamorphic and hydrothermal rocks in Israel, along the Dead Sea Transform fault. For the first time in any publication; in Chapter 12, the coal fires in the eastern African country of Malawi are assessed. Chapters 13 through 17 are devoted to case studies about coal fires in the upper Silesian coal basin of Poland, including fire prevention associated with the Rymer Cones (Chapter 13); thermal transformations in the Starzykowice coal dump (Chapter 14); a thermal history of waste dumps (Chapter 15); a general overview of coal mining and combustion in coal-waste dumps (Chapter 16); and a study of mineral transformations, actinide mobility, and combustion metamorphism in the Wojkowice coal-waste dump (Chapter 17). Chapter 18 presents a study about the mineralogical and magnetic effects due to coal mining and the use of coal from the Douro Coalfield in northwest Portugal. Case studies about Russia are presented in Chapters 19–21, and these examine ancient coal fires along the southwestern border of the Kuznetsk basin in Siberia (Chapter 19); combustion metamorphism and the ellestadite-group minerals (Chapter 20); and fayalite paralavas and combustion metamorphic complexes in the Kuznetsk coal basin (Chapter 21). The Ravat coal fire in central Tajikistan and fayalite-sekaninaite paralava are the subject of Chapter 22. Venezuela's coal-fire volcanoes are explored in Chapter 23. The hazards posed by coal fires in the interior of Alaska appear in Chapter 24. Anthracite-mine fires in north-eastern Pennsylvania are covered in Chapter 25. In Chapter 26, a historical account of coal fires in the Richmond

basin of Virginia is provided. The infrequently heard of coal fires in Oregon and Washington State are discussed in Chapter 27. Chapter 28 presents a study about the combustion, mineralogy, and petrology of oil-shale slags in Lapanouse-de-Severac, France, along with coal-fire analogies. The final chapter in Volume 3, Chapter 29, provides readers with a review of sampling techniques used to study coal fires.

Although combustion at Lapanouse-de-Severac and along the Dead Sea Transform is associated with hydrocarbon reservoirs other than coal or peat, the effects of combustion are analogous; so these chapters were included for the reading audience.

Volume one discusses coal, coal combustion, and analytical techniques for studying coal fires and the by-products of combustion. Volume 2 presents hundreds of color photos of coal and peat fires burning around the world as well as multimedia presentations that include movies, radio talk shows, and presentations given at professional meetings and elsewhere. Volume 4 is devoted to all aspects of peat and peat fires. In addition, an online interactive world map of coal and peat fires by Rudiger Gens, University of Alaska Fairbanks, is available on the Elsevier companion website mentioned above.

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Acknowledgments

We thank all contributors to **COAL AND PEAT FIRES: A GLOBAL PERSPECTIVE**, Volumes 1–4, for the submission of their research for publication. We are also grateful for the permission granted by numerous publishers to use data and reproduce figures from their journals and books. In addition, for Volume 3, we thank Elsevier's Associate Acquisitions Editor, Louisa Hutchins; Publisher, John Fedor; Project Manager, Sharmila Vadivelan; Designer, Greg Harris; Contracts Associate, Melanie Prince; and Marketing Manager, Caitlin Beddows for their assistance with this unique project. We also thank all the other people at Elsevier who assisted in the publication of this work and the development of the companion website for it, located at <http://booksite.elsevier.com/9780444594129>.

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Volume 3

Case Studies – Coal Fires



East Kalimantan, Indonesia



Shakhty, Russia

Thousands of coal fires are burning around the world; on every continent except Antarctica. Their environmental impact on a global scale is unknown and is worthy of intense investigation.



Witbank Coalfield, South Africa



Southern Ute Indian Reservation, Colorado

Photos: Alfred E. Whitehouse (East Kalimantan, Indonesia, 1998, a coal fire of unknown origin started in 1997, excavated and extinguished in 1999), Sergey Sayamov (Mayskaya coal-mine fire, west of Shakhty, Rostov oblast (province), Russia, 2006, a highly altered and oxidized protolith of unidentified composition), Lisa Lafoose (Witbank Coalfield, South Africa, 2009, massive coal-waste pile ignited by spontaneous combustion), Glenn B. Stracher (Southern Ute Indian Reservation near Ignacio, Colorado, 2003, sulfur (yellow-green) encrusting the throat of a coal-fire gas vent in sandstone in the Fruitland Formation).