

Book Reviews / Critiques

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[See table of contents](#)

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Book Reviews / Critique

Dani Alldrick, *Accretion of Extraterrestrial Matter Throughout Earth's History*
edited by Bernhard Peuker-Ehrenbrink and Birger Schmitz / 77

Peter C. Burns, *Mineral Species Discovered in Canada and Species Named after Canadians*
by Laszlo Horvath / 77

Peter Davenport, *Exploring the Dynamic Earth GIS Investigations for the Earth Sciences*
by M. K. Wallace-Hall, C. S. Walker, L.P. Kendall, C. J. Schaller and R. F. Butler / 78

Herb Helmstaedt, *Mantle Plumes: Their Identification Through Time*
edited by R. E. Ernst and K. L. Buchan / 79

Andrew Hynes, *The Igneous Rocks of Greece: The Anatomy of an Orogen*
by G. Pe-Piper and D. J. W. Piper / 80

Georgia Pe-Piper, *Department of Geology, The Eruption of Soufriere Hills Volcano, Montserrat, from 1995 to 1999*
edited by T. H. Druit and B. P. Kokelaar / 81

Paul F. Williams, *The Life of Frank Coles Phillips (1902-1982) and the Structural Geology of the Moine Petrofabric Controversy*
by R.J. Howarth and B. E. Leake / 82

REVIEWS

Accretion of Extraterrestrial Matter Throughout Earth's History

Edited by Bernhard Peuker-Ehrenbrink and Birger Schmitz

Kluwer Academic / Plenum Publishers
233 Spring Street, New York, New York
10013-1578

November, 2001, 466 pages,
US\$110.00, Hardcover
ISBN 0-306-46689-9

Reviewed by Dani Alldrick
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This book is a compilation of 22 papers presented at the fall 1998 AGU meeting. The reports have been specially prepared, expanded and integrated for this volume. Important topics not covered in the original symposium have been added so that this text reflects the body of knowledge at the start of the millennium within this broad, rapidly evolving, multidisciplinary field.

Taking an earth-centric viewpoint, the book is spatially organized from distal to proximal, starting with studies of cosmic and interplanetary dust, asteroids and comets, and finally coming down-to-earth with reports on marine sediments, recent and fossil meteorites, global-scale impact events and extinctions, formation and features of craters, and cratering records on the earth and moon. Coverage is comprehensive and evenly weighted, addressing the needs and interests of students, instructors and researchers in this field, although as a geologist I would have wished for somewhat less information on cosmic and interplanetary dust (7 papers) and more about meteorites in our midst (6

papers).

Each paper is prepared as a stand-alone article so that an interested reader can begin this book at any point. Some reports are excellent overviews, others are more focused, but take care to refer readers to introductory or overview papers. The article on $^3\text{He}/^4\text{He}$ studies of seafloor sediments usefully reviews the isotope systematics that underlie this technique.

The papers are uniformly well written by their 36 authors and further polished by 43 reviewers and the two editors. The result of this teamwork is a readily readable manuscript with a clear and consistent style that is a credit to everyone's efforts. As expected, text flaws are rare, small and subtle. However, a few omissions made a large impact on this reader. The great Sudbury astrobleme receives scant discussion despite its size and remarkable three-dimensional accessibility via mine workings and innumerable drill holes; the weird and wonderful Sudbury breccias that record this impact in the central Canadian Shield are not mentioned. Abundant spherules exposed in the workings of the Agnes gold mine of the Barberton Mountainland feature prominently, but no reference is made to the postulated fossil meteorite which crops out near by on farm Bon Accord. At a more general level, I feel that geoscience textbooks – especially those prepared for a multidisciplinary audience – should incorporate an index listing all acronyms featured in the manuscript and should also include the particular version of the geological timescale used for the preparation of the volume.

This book will appeal to geologists eager to learn more about Earth in its planetary setting, bring them up to warp-speed on all facets of global impact events, and introduce them to an

imaginative new dimension of terminology such as “meteoriticist” and “impactoclastic”. Geohazard specialists can turn to this text to quantify both the statistical likelihood and the consequences of the next ‘big bang’. Exploration geologists should take particular note of the table on pages 382–385, which lists 160 impact structures, in view of the conclusion that “25% of known terrestrial impact structures have some form of economic deposit associated with them, and about half of these are currently exploited or have been exploited in the recent past”. This book will also help them determine whether impact-generated diamonds deserve to be recognized as a new class of mineral deposit.

Mineral Species Discovered in Canada and Species Named after Canadians

by László Horváth
Mineralogical Association of Canada
P.O. Box 78087, Meriline Postal Outlet
1460 Merivale Road
Ottawa, Ontario K2E 1B1 Canada
2003, 382 pages plus a 16 page colour insert, hard cover, \$45.00

Reviewed by Peter C. Burns
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Mineral Species Discovered in Canada and Species Named after Canadians, authored by László Horváth and edited by Robert Martin, is the sixth in the irregularly published *The Canadian Mineralogist Special Publication* series.

Horváth presents an encyclopedic account of Canadian minerals, with emphasis on information of interest both to the scientific and amateur communities. The book consists of three main parts focusing on the 206 minerals discovered in Canada, the 30 minerals discovered elsewhere but named after Canadians, and a compilation of defunct minerals first described from Canada.

Ten pages of introduction outline the 250-year history of documentation of mineral species occurring in Canada, starting with labradorite and enstatite, the longest surviving Canadian type-minerals. The stage being set, specifics of each of the 206 Canadian type-minerals are presented alphabetically, with each species occupying its own page. Basic information consists of the name, the International Mineralogical Association recognized chemical formula, crystal system, and space group for each species. The geological occurrence of the species is then detailed, together with specifics of the associated minerals. A comprehensive listing of type specimens, including who designated them and where they reside, is provided whenever type specimens exist. The origin of the name is given, and all but three entries for minerals named after people include a photograph of the honored individual. Comments are followed by up to several references pertaining to the species.

Part two of the book covers minerals named after Canadians from localities outside Canada, with content similar to that for entries describing Canadian minerals. Part three tabulates obsolete names of minerals first described from Canadian localities. Some involve duplicate names for single species, in which case historical precedence dictates the accepted designation. Other names are obsolete because they correspond to mixtures of multiple species.

Appendices give a chronology of minerals first described from Canada, specifics of the geographic distributions of type localities (by province and territory), type specimens and their repositories, a chemical classification of Canadian type-minerals, an index of the authors of descriptions for valid species

discovered in Canada, and various statistics concerning the derivation of names and other aspects of Canadian minerals.

Those of you seeking gently flowing prose expounding the beauty and sophistication of Canadian minerals will be disappointed by Horváth's coverage. The book contains 15 pages of color photographs of Canadian minerals that are rather striking, but the encyclopedic layout of the text makes this more of a reference volume than nighttime reading. It is the only current compilation of data limited to Canadian minerals, although some of the data may be found in various reference volumes with a broader geographic scope.

The unique combination of useful data and historical context make this book a must-have for those interested in Canadian minerals. In comparison to, for example, *Dana's New Mineralogy* (Eighth Edition), Horváth provides considerably more detail concerning mineral occurrences. Horváth paints a clearer picture of individuals corresponding to mineral names than does *Encyclopedia of Mineral Names* (1997). Details of type localities and the disposition of type specimens are invaluable.

In addition to the specifics presented for each species, Horváth provides a wealth of interesting information. While on a family vacation last summer in Albert county, New Brunswick, I noted samples of "albertite" on display in local museums. Given the specimens were secured behind glass, no doubt because of their great value, careful inspection was impossible. Horváth advises us "albertite" is nothing more than bitumen, and that more than 200,000 tons of the stuff was mined over 14 years in Albert County. Have you been wondering which Canadian has described the most Canadian minerals? Horváth informs us that the 30-plus club is limited to Joel Grice (34 species), George Chao (31) and John Jambor (30). He also establishes that Mont Saint-Hilaire ranks seventh in the world for number of mineral discoveries. Horváth does not, however, explain why only 206 (5.2%) of all

known minerals were discovered in Canada, while the U.S.A. and Russia lay claim to 652 and 535, respectively.

Horváth presents accurate, informative, interesting and valuable coverage of Canadian minerals. The book is bound in hard cover with a striking photo of weloganite crystals gracing the front cover. The paper is of excellent quality, with sharp print and clear reproduction of photographs. For those interested in Canadian minerals, this book is excellent value at \$45.00.

Exploring the Dynamic Earth GIS Investigations for the Earth Sciences

by M.K. Wallace-Hall, C.S. Walker,
L.P. Kendall, C.J. Schaller and
R.F. Butler

Brooks/Cole – Thompson Learning
511 Forest Lodge Road
Pacific Grove, California
U.S.A. 93950

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2003, 128 p. soft cover with CD-Rom,
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Reviewed by Peter Davenport
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Combining software for a geographic information system (GIS), spatially referenced geological information, and supporting geographic map data with a printed instruction manual and workbook, this intriguing publication should be of great interest to educators at the high school level, and for post-secondary introductory courses in earth science. As its title suggests, the emphasis is on how the motions of the plates that make up the Earth's crust are responsible for the form of the Earth's surface, and for the locations and processes that lead to some of the most devastating of natural hazards: volcanic eruptions, earthquakes and tidal waves.

A CD-ROM contains the data and software for both Macintosh and

Windows operating systems, and minimum hardware requirements are modest. The CD-ROM contains installation instructions for the three software applications required to run the exercises: ArcView 3.0a GIS, QuickTime for displaying animations, and Acrobat Reader for viewing and printing documentation files. Users are expected to have a working knowledge of personal computers, but no specialized knowledge of GIS.

There are two collections of data and images, each divided into several specific subsets that form the basis of an activity in the workbook. The first presents the Earth's plate tectonic framework from a variety of perspectives; the second explores some specific natural disasters in more detail.

In the first collection there are five "views", each a collection of spatially referenced themes. The GIS tools allow users to overlay themes, pan, zoom and query individual spatial features. The geological themes include the distribution of crustal plates, plate boundaries (with information on their type), plate motion, the distribution of volcanoes, ocean ridge volcanism, and earthquakes (with information on magnitude and depth). Geographic themes include countries and cities of the world, US states, the distribution of ocean trenches, and a shaded relief image of the Earth's surface (onshore and offshore). One capability that particularly impressed was a tool to change the projection of the map image from geographic, with its distortion of the world to exaggerate the north and south polar regions, to orthographic, which presents the world more realistically projected on a circle rather than a rectangle. There are custom-designed tools that allow the orthographic map image to be rotated north-south and east-west, providing an excellent perspective on the relationships between plates and other geological and geographic features.

The workbook guides users through an exploration of the relationships between the Earth's tectonic framework and its physiography, and the expressions of the processes that drive the plate motions that are expressed dramatically as

volcanoes, earthquakes and related tidal waves. The spatial relationships are amplified by map-based hot links to additional information such as cross-sections across major topographic features, and animations of geological change through time.

The second collection explores natural hazards and contains general "views" of the global distributions of hazards caused by earthquakes, tsunamis and volcanoes, again in relation to plate tectonic features. There are also three event-specific "views" dealing with tsunamis that occurred in Chile, Alaska and Japan. Both the general and specific views are hot-linked to images and animations of the events. The workbook also contains eye-witness accounts and photographs of natural disasters such as the Lisbon earthquake of 1755, and the destruction of the Caribbean town of St. Pierre by the eruption of Mont Pelée in 1902.

The potential of this type of teaching tool lies in the teachers' (and students') ability to both repackage the included data to address other topical issues, and to add additional data for this purpose. For example the geographic information is slanted towards the USA, but coverage for Canadian Provinces to match the US state theme is freely available from GEOGRATIS (<http://geogratis.cgdi.gc.ca>). Much additional information can be downloaded off the Web from similar government sites. The reason for this extensibility is the design of the product around a real GIS package. Although a proprietary system, it allows the display of many formats of GIS data. One word of caution is the time limit of the version of the software included with the product (120 days from installation). After learning how to use this GIS and becoming familiar with the data sets, the prospect of having to abandon the product after such a short period would be disappointing. Purchasing a copy of ArcView GIS is a solution, but this would be an additional expense that should be recognized when the decision is made to use the product.

In summary, this is an intriguing interactive publication that certainly informed and entertained this reviewer.

Not only does it introduce fundamental geological concepts in a clear and coordinated way, but also introduces the place of a geographic information system (GIS) as an essential tool for the geosciences, with examples that will be of interest to most students.

Mantle Plumes: Their Identification Through Time

Edited by R.E. Ernst and K.L. Buchan
Geological Society of America
 P.O. Box 9140, Boulder, Colorado,
 U.S.A. 80301-9140
Special Paper 352
 2001, 593 pages, US\$ 140.00 (GSA
 members US\$ 112.00)
 ISBN 0-8137-2352-3

Reviewed by Herb Helmstaedt
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As explained by the editors in their introduction, this volume is an outgrowth of a symposium titled "Locating Old Mantle Plumes" held at the Geological Society of America 1998 Annual Meeting in Toronto, Canada, and sponsored by the Geophysics and International Division of the Geological Society of America and the Geophysics Division of the Geological Association of Canada.

Nineteen papers, most of them presented at the symposium, but also some solicited by the editors, were grouped into six sections with the headings: 1) *Overview*, 2) *Lessons from Mesozoic and Cenozoic examples*, 3) *Lessons from Venus and Mars*, 4) *Techniques to Locate Plumes*, 5) *Early Precambrian Plumes*, and 6) *Compilations*. The overview by Ian H. Campbell is to the point and begins by noting that no single criterion exists that can be used to identify ancient mantle plumes. Plumes are "best identified by bringing as many criteria as possible to bear on the problem", keeping in mind that no physical characteristic, trace element plot, or

isotope ratio may be taken in isolation to distinguish plume-related volcanic rocks from other types of mafic magmatism.

Section 2 consists of four papers dealing with Cenozoic and Mesozoic plume-related examples. Menzies et al. examine Oligocene-Miocene flood basalts of western Yemen, thought to be associated with the Afar plume, with the aim of deriving benchmark criteria for recognizing older, more eroded, plume-related flood basalt provinces. Wilson and Paterson look at the Tertiary-Quaternary volcanic province of western and central Europe, in particular the Massif Central, France, attributing these volcanic fields to diapiric upwelling of small-scale, finger-like, convective instabilities from the base of the upper mantle. Coffin and Eldholm present another edition of their large igneous provinces (LIPs) paper series, contrasting oceanic LIPs with "normal" ocean crust, and speculating that "more ophiolite fragments may be obducted sections of volcanic passive margins and oceanic plateaus than we now propose." Storey et al. review some of the main criteria for locating the original position of mantle plumes in large igneous provinces and apply them to the Middle Jurassic Karoo province in southern Africa, the Ferrar Province in Antarctica, and the Chon Aike province in Patagonia, all of which formed prior to, and are implicated in, the break-up of Gondwanaland. While links to a mantle plume center appear to be fairly clear for the Karoo province, they are far less certain for the other two provinces. All three provinces are thought to be related to a large thermal anomaly (superplume) in which several individual hotspots may have existed.

The four papers of Section 3 present details of well-preserved plume structures on Venus and Mars, emphasizing implications for identifying and understanding plume-related features on Earth. The topics covered are 'Large flow fields on Venus' (by Magee and Head), 'Contractional effects of mantle plumes on Earth, Mars and Venus' (by Mege and Ernst), 'Uniformitarian plume tectonics on the post-Archean Earth and Mars (by Mege), and 'Concentric dikes on the

flanks of Pavonis Mons on Mars' (by Montesi). Especially useful to applications on Earth are the descriptions of 'wrinkle ridges' around domal uplifts on Mars and Venus by Mege and Ernst, which can be directly applied to plumes on Earth that are associated with giant radiating-dike swarms. Similarly, the attempt to refine a comprehensive multiplanetary plume tectonics model by Mege should be beneficial to all those who study plumes on Earth.

Five papers in Section 4 deal directly with physical and chemical characteristics to be used in identifying plumes and locating their centers. The section begins with an invited paper by Sengor identifying uplift as the one criterion that may be "uniquely reliable" in recognizing mantle plumes in the geological record. Sengor's discourse is highly entertaining, digressing in all directions, and full of semantic asides. Yet it is well researched and ultimately makes a very strong point by specifying just what type of uplift may be used and how to recognize it. Sengor's paper is followed by an equally informative discussion by Rainbow and Ernst about the sedimentary record resulting from mantle-plume-related uplift.

The Igneous Rocks of Greece: The Anatomy of an Orogen

by G. Pe-Piper and D.J.W. Piper
*Beiträge zur regionalen
Geologie der Erde 29
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Berlin, Germany
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1030-4 US\$98.*

Reviewed by Andrew Hynes
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This book results from many years of work by the authors. It is a comprehensive and exhaustively

referenced survey of the igneous rocks of Greece, and includes an appendix of geochronological and representative geochemical data. The book begins with a brief summary of the tectonic evolution of Greece and its place in the Alpine orogen. Igneous activity is then treated chronologically, from the late Paleozoic to the Quaternary. For each time interval selected, there are detailed descriptions of the setting and geochemistry of the igneous rocks, and discussions of the various hypotheses for the integration of the rocks into the overall tectonic evolution of Greece. The volume ends with a brief overall synthesis and an equally brief discussion of the economic implications of the igneous rocks of Greece.

The systematic and comprehensive nature of the book makes it an invaluable resource for geologists contemplating research work in Greece. While this does mean that the volume would not easily serve as bedtime reading, the book is enlivened by the willingness of the authors to take positions on aspects of the evolution of Greece that are controversial.

In their preface the authors state that they 'hope to perform a valuable service in synthesizing a literature that is relatively inaccessible to many workers'. The breadth and extent of their work in Greece over the past several decades make them ideally placed to perform such a synthesis, and there is little doubt that they have fulfilled their hope. A second hope was that the volume would be of interest to all those who seek to understand the distribution and origins of igneous rocks in orogenic belts. In this they were also certainly successful, although they would have been more so if they had provided a more comprehensive final synthesis.

This book will prove invaluable to anyone contemplating research on the tectonic evolution of Greece, and serves as a timely reminder of the complexity of the products of plate tectonics.

The Timing and Location of Major Ore Deposits in an Evolving Orogen

Edited by D.J. Blundell, F. Neubauer and A. Von Quadt

*The Geological Society Publishing House,
Unit 7, Brassmill Enterprise Centre,
Brassmill Lane, Bath, BA1 3JN, UK
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P.O. Box 979

Tulsa, OK, 74101-0979

Reviewed by Steve McCutcheon

*New Brunswick Geological Surveys
P.O. Box 50, Bathurst, NB, E2A 3Z1*

This book comprises a collection of nineteen papers that arose from a symposium entitled, "The timing and location of major ore deposits in an evolving orogen", which was held in March 2001. The symposium was organized by the SGA (Society for Geology Applied to Mineral Deposits) and highlighted the initial results of the five-year GEODE (GEOdynamics and Ore Deposit Evolution) program that was established in 1998 by the European Science Foundation. The papers range from general overview type to deposit-specific type and cover a large geographic area, although twelve of the nineteen are focused on Europe. They are grouped under **General issues** (two papers), **Modern orogenic systems** (eight papers) and **Older orogenic systems** (nine papers). There is also a **Preface** that contains the editors' synoptic comments about each paper and a key map that shows numbered locations, which reflect the order each paper appears in the book. The book is generally well illustrated although the text in some figures is small and difficult for old eyes to see. All illustrations are in black and white.

The title of the book is a bit misleading because it implies that the subject is "major ore deposits" of a single orogen. However, major ore

deposits are not identified and several orogens are dealt with in this volume. A more appropriate title might have been, "The Timing and Location of Metallic Mineral Deposits in Evolving Orogens". Irrespective of the title, the book does contain useful information.

The introductory paper, by Blundell, sets the geodynamic context by highlighting aspects of modern orogenic systems in the southwest Pacific and in southeastern Europe. He notes that such things as subduction hinge retreat (rollback), slab tear, reversal of subduction polarity, mantle plumes and dynamic changes in plate motions can be related to ore genesis in modern systems. No matter what the tectonic setting, every deposit has three factors in common, namely, a source of metals, a fluid system that transports and concentrates them (migration pathway), and a trap (structural, stratigraphic or chemical), where the metals are precipitated. To a large extent, the tectonic setting controls the nature and style of these three factors. What is missing from this paper is a simplified model showing the typical developmental (geodynamic) stages of an orogen with the types of major deposits that can be expected at each stage.

Paper number two, by Allen et al., is the only one that deals with volcanic-associated massive sulphide (VMS) deposits. Eleven districts with major deposits are compared based upon criteria that are contained in a CODES (Centre for Ore Deposit Studies) database. The districts are Abitibi and Bathurst in Canada, Mount Read in Tasmania, the Iberian Pyrite Belt in Portugal and Spain, Bergslagen and Skellefte in Sweden, the southern Urals in Russia and the Manus and Lau basins in the SW Pacific. The criteria include tectonic setting, volcanic facies, structure, ore deposit characteristics, exhalites, mineralogy, metal zonation and alteration. Ten general conclusions about VMS deposits are drawn as a result of this comparison and a way forward is proposed for a new global research project.

Papers three and four, by Barley et al. and MacPherson and Hall, respectively, are complimentary and

describe the tectonic evolution of southeast Asia and the adjacent Pacific region during the past 25 million years. Barley et al. suggest that gold deposits (epithermal and porphyry Cu-Au) formed in this area during three intervals of tectonic reorganization, noting that most of the known tonnage is in rocks less than 5 Ma old. MacPherson and Hall provide the tectonic context and they also discuss geochemical evidence for some of the tectonic processes involved, including recycling of components (from the mantle wedge and crustal interaction) and slab melting (adakitic magmatism). They conclude by describing the relevance of subduction evolution to mineralization, noting that osmium is now recognized as a potentially powerful tracer of metallogenesis.

The next six papers deal with Late Cretaceous and younger rocks in various parts of the Alpine – Balkan – Carpathian – Dinaride region. The first two, by Lips and Neubauer, provide overviews of the entire region, relating various magmatic belts to different geodynamic settings and different deposit types to late-stage collisional processes, respectively. The next three, by Amann et al., von Quadt et al. and Marchev and Singer, are deposit or district specific and describe the timing of magmatic or mineralizing events in the Siflitz-Guginock area (Austria), Elatsite deposit (Bulgaria) and Madjarovo district (Bulgaria), respectively. The last paper, by Krohe and Mposkos, describes extensional detachments and episodic exhumation of high-pressure rocks in northern Greece, but does not discuss mineral deposits.

The last nine papers, which fall under the heading, "Older orogenic systems", are a spatially and temporally diverse collection. Paper number eleven, by Tornos et al., gives a synopsis of the Variscan metallogeny of southwest Iberia, specifically of the Ossa Morena Zone and the Iberian Pyrite Belt. Boni et al. focus on post-Variscan hydrothermal activity in Sardinia (Italy). Cuney et al. document the radiometric ages of W-Sn-bearing Variscan granites in the Massif Central (France). Jurkovic and Palinkaš discuss criteria

for distinguishing the metallogenic affiliation, i.e. Variscan versus Alpine, of mineral deposits in the Dinarides (former Yugoslavia). Chauvet et al. give a very thorough description of a sediment-hosted, structurally controlled copper deposit of Hercynian age in the High Seksaoua district (Morocco). Paper number sixteen, by Yakubchuk, provides an overview of the tectonic history of eastern Asia and the north Pacific region. The following paper, by Fridovsky and Prokoviev, looks at the tectonic setting of gold mineralization in northeastern Siberia. The final two papers, by Stein and Bingen and Rajavuori and Kriegsman, have a Scandinavian emphasis. The first describes Re – Os dating (circa 1 Ga) of the metamorphism and deformation in South Norway, and the second describes the fluorine contents of orthoamphiboles associated with Zn-Cu-Pb deposits in Finland.

Overall, this book suffers from a lack of focus, reflecting the fact that it arose from diverse papers presented at a symposium with a very broad theme. By analogy, the volume is like a regular issue of *Economic Geology*, rather than the thematic issue that it is supposed to be. It contains some good papers but at a price of £85.00, the book is not a “must have” in my opinion.

The Eruption of Soufrière Hills Volcano, Montserrat, from 1995 to 1999

Edited by T.H. Druit and B.P. Kokelaar
Geological Society Memoir No. 21
Geological Society Publishing House
Unit 7 Brassmill Enterprise Centre
Brassmill Lane, Bath, Somerset
BA1 3JN, UK (Available in Canada
through AAPG web shop www.aapg.org)
2002, 664 p. hardback £140 / US\$234

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This memoir is a detailed record of the 1995-1999 phase of eruption of the

Soufrière Hills Volcano of Montserrat, in the Caribbean oceanic island arc. This was an andesite dome-building eruption that followed six years of increased seismicity. It killed 19 people and rendered half the island of Montserrat barren, burying the former capital under metres of volcanic debris.

The first 115 pages of the book consist of four overview papers, which appear deliberately aimed at the general geological reader. The bulk of the book consists of 20 papers, appropriate for a more specialist audience, that describe, interpret and model volcanic processes, products and hazards. The final six papers are concerned with geophysical and gas studies.

The overview paper on the course of the eruption by Kokelaar describes the initial phase of phreatic explosions, followed by progressive growth of the andesite dome, which eventually overtopped the pre-existing topography. Dome collapses produced block-and-ash flows and pyroclastic surges, two episodes of Vulcanian activity produced fountain-collapse pyroclastic flows and tephra fall, and a flank failure produced a major debris avalanche and a high-velocity pyroclastic density current. Kokelaar also summarizes the lessons to be learned from volcano monitoring and emergency management during the progressive escalation of the disaster. This paper is lavishly illustrated with a series of high quality colour photos that provide a pictorial narrative of the characteristic styles of eruption and their effects through time, including superb pictures of pyroclastic flows.

Sparks and Young provide a summary of “new or surprising scientific observations, results and ideas ... which have either advanced the science or at least have posed new questions”. Unlike most previous well-known eruptions of intermediate to silicic composition at subduction zones, where the most intense activity takes place in the early stages of eruption, at Soufrière Hills eruptive activity escalated very slowly, making confident forecasting difficult. Magma extrusion was pulsatory, with a complex relationship to monitored geophysical and volcanological phenomena, and

pulses are thought to have resulted from degassing, pressurization and rheological stiffening. The detailed geophysical monitoring of the eruption has led to significant advances in the understanding of the dynamics of eruption and the principal geophysical manifestations of the activity. Perhaps of greatest interest to the general geologist is the new information on pyroclastic processes and the resulting deposits: analogous pyroclastic rocks are abundant throughout the geological column in Canada. Petrologists who study ancient rocks may be dismayed by the complexity shown by enclaves, xenoliths, and crystals, which are interpreted as indications that basaltic magma remobilized partly crystalline more silicic magma.

Aspinall et al. summarize the organization and activity of the Montserrat Volcano Observatory, hastily created when the first eruptions began to provide volcano monitoring and hazard advice. This chapter will appeal to those with an interest in risk assessment and management. Harford et al. use $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology to assess the volcanic activity over the past 2.6 Ma and point out the problems created by old xenocrysts in many andesites.

Those interested in pyroclastic flows and related deposits such as debris avalanches will find much information in the more technical papers in the main part of the book. The strong linkage between process and deposits should be of interest to sedimentologists interpreting ancient rocks. For example, Cole et al. provide a synthesis of the deposits arising from dome-collapse and fountain-collapse pyroclastic flows, showing sedimentological sections, grain size data, and photographs of both flows and deposits. Dome-collapse block-and-ash flows were capable of considerable erosion. Some pyroclastic surges became separated from their parent block-and-ash flows. Pyroclastic flows entered the sea building a coastal fan-shaped deposit. Druit et al. describe cyclic Vulcanian explosive activity with fountain collapse that produced fountain-and-ash pyroclastic flows that travelled up to 6 km from the vent. Papers by Voight et al., Sparks et

al. and Ritchie et al. describe a volcano flank collapse that produced a large debris avalanche and depressurized the interior of the lava dome, which exploded to produce a violent pyroclastic density current. Tephra fallout deposits are described by Bonadonna et al.

The abundance and high quality of observational data means that modelling studies from the Soufrière Hills eruption are well constrained by data. Modelling has been applied to volcanic processes ranging from magma ascent to dome collapse. Several papers discuss seismicity associated with the eruption and Oppenheimer et al. provide a record of HCl and SO₂ variations during the eruption.

This book contains a wealth of information on the Soufrière Hills eruption that should appeal to many geologists beyond the tiny audience of research volcanologists in Canada. The overview chapters contain valuable material for those teaching introductory courses in geology or more specialized courses in hazard assessment. The numerous photos and schematic representations (cartoons) would be very useful for teaching volcanology and pyroclastic sedimentology to more advanced students. Numerous papers are of interest to those who study ancient volcanic domes, their pyroclastic deposits, and associated mineralization, although those of us who normally think in tens of millions of years may be overwhelmed by the complexity and variety of volcanic events over a four-year eruption. The papers are of high quality and well integrated with one another. My only complaint about this volume is the use of 9 point font for the text, which makes it more appropriate for quick reference than trying to read an entire paper at one time. This book should be in every geological library.

The Life of Frank Coles Phillips (1902-1982) and the Structural Geology of the Moine Petrofabric Controversy

by R.J. Howarth and B.E. Leake
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From the title of the book, I expected an account of the life of Frank Coles Phillips, and the part that he played in the Moine petrofabric controversy, with some necessary background to the latter. In fact, there is so much on the controversy that the two topics become separate themes. For those of us who are admirers of the work of Phillips, the account of his life and career is interesting. However it is diluted too much by the broad treatment of the Moine controversy, and more or less related topics. The history of the controversy expands into an Anglo-centric view of the development of structural geology, which becomes a sub-theme. The two main themes do not integrate easily, since they only merge naturally when referring to Phillips' substantial pioneering contribution to the acquisition and interpretation of the petrofabric data, and his promotion of the use of stereographic and equal-area projections in structural geology. Consequently, the book meanders back and forth between the different themes in a rather disjointed manner.

The first three chapters are devoted to Phillips' early life, school years and time at Cambridge, and comments on his character. A chapter on the early developments in petrofabric and kinematic studies follows, with a discussion of Sander's work. We are told that Phillips, already skillful with the universal-stage, and fluent in German, was able to keep up to date on major developments that were taking

place in Germany. The next chapter introduces the geology of northern Scotland, with emphasis on the Moine; problems of dating the Moine, and metamorphism, penetrative fabric development and thrusting. Finally the themes merge with a discussion of Phillips' attempt to throw light on the problems, using petrofabrics.

The next chapter is more consistent with the title, covering the Moine petrofabric controversy, and Phillips' part in it during his years at Cambridge (1936-46). However it digresses into other aspects of his life, such as sharing the Sedgwick prize with Sir Edward Bullard, serving as a sergeant in the Home Guard, and working in a munitions factory during the war.

A brief chapter covers Phillips' short time as Professor at Liverpool, where sadly he lost all of his petrofabric data in a fire, and suffered a nervous breakdown. The book returns briefly to the petrofabric controversy and Phillips' involvement. In 1948 he was appointed Lecturer in Petrology at Bristol and continued his petrofabric work in Devon and the Shetlands. Two years later he gave a short course in Structural Petrology, and gave the first course in Structural Petrology to undergraduate students in Britain, in 1953.

Chapter 9 is a fairly detailed account of his lecture tour in Australia in the same year. It stresses his role in the development of structural geology there, and lists the various people that he influenced. There is no doubt that he had an impact on the development of structural geology in Australia, but the impression given by this chapter is perhaps a little exaggerated. Interestingly, it also points out that his book on the use of stereographic projection was influenced by a 1945 version of a 1939 manuscript by Australian workers, Cotton and Garretty (1945), on the same subject.

The next chapter covers the background to the Moine controversy. Phillips features little, because after his initial work he shunned much of the discussion because of his dislike of conflict. Then follows an account of his years in Bristol. It includes more about the history of Highland structural

geology in the 1950s and 1960s, where great advances were made. With respect to Phillips, it is more concerned with other work. For example, fieldwork in Sweden, the Shetlands, Devon and Cornwall, and his revision of a classic book on gemstones by G.F.H. Smith (Smith and Phillips, 1958). The following chapter continues with Phillips' retirement years, during which time, amongst other things, he published his translation of a book by Bruno Sander (1970), and revised his own textbooks (Phillips, 1971, 1972).

There follows a chapter on a more modern interpretation of quartz fabrics in general, and of the Moine in particular. Then finally, comes the conclusion that Phillips was a "superb teacher"; his legacy, we are told, was his students, his text books, and the use of stereographic and equal area projections for representation and manipulation of structural data.

It is not obvious what the envisaged purpose of the book is. As a history of the life of Phillips it strays too much from the subject, however, as a history of the Moine controversy, it might have been developed more logically without the additional theme of the life of Phillips. As it stands, it is an eclectic compendium of information on petrofabrics and structural geology, with an emphasis on the Moine. It is neither a clear, nor an up-to-date coverage of modern petrofabrics or structural geology, but rather covers the history of those aspects that were developed in northern Scotland, whilst treatment of developments that took place elsewhere, are justifiably incomplete. It is a history that will not be easy for the layperson to understand without additional reading.

The book not only meanders back and forth between the life of Phillips and the Moine controversy – it has many minor digressions. Some of these are interesting, though not really germane to the subject, such as a brief account of the Steinmann "Trinity" and a short history of Robert Shackleton, Phillips' successor at Liverpool. Other less interesting digressions, include instructions on how to collect oriented samples and make thin sections,

The meandering nature of the book does not make for easy reading and the problem is exacerbated by long sentences, some almost as long as a normal abstract, and the many, sometimes nested, parentheses. The book reflects considerable research and is a useful source reference for historical papers on petrofabrics and structural geology, but unfortunately it does not reflect the focused approach and clarity of style, that were the hallmarks of Phillips.

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