The Canadian Mineralogist
Vol. 40, pp. 991-1000 (2002)

BOOK REVIEWS

Geological Maps, an Introduction (2nd edition). By Alex Maltman. John Wiley & Sons (in Canada: 22 Worcester Road, Etobicoke, Ontario M9W 1L1), 1998, xi + 260 pages, US$59.95. ISBN 0–471–97696–2.

Geological maps, particularly regional geological maps (as opposed to site maps, mine maps, and the like), are the basic tools of the Earth Sciences. In a sense, they constitute the holy writs of geologists and, as such, they can be the cause of much controversy. Conflict resolution is possible, however, because the rocks remain in place, to be viewed (and remapped) by successive geologists armed with new ideas and a progressively more evolved theoretical framework. Unfortunately for the Earth Sciences, regional geological mapping is in decline and may become a "lost art". I'll return to this at the close of the review.

Geological Maps, an Introduction is a large (22 × 28 cm) softcover book, the second edition of one first published in 1990. This new edition differs in having worked solutions to map exercises, a chapter on maps in environmental geology, and an increased focus on surficial deposits. The book is divided into 15 chapters, followed by a section of solutions to the 24 map exercises, five pages of references, and an eight-page index. Eight pages of colored geological maps at scales from 1:50,000 to 1:2,500,000 are inserted between chapters 6 and 7.

The first four chapters are introductory, with chapter 2 "The Nature of Geological Maps..." being, in a sense, a much condensed version of the rest of the book. Although most general principles are covered in these introductory chapters, the reader must await chapter 6 to learn the "law of Vs" and the influence of topography on the exposed widths of beds, and chapter 8 to decipher the outcrop patterns of plunging folds. Specific subjects covered in later chapters are cross sections (chapter 5), unconformities (7), folds (8), and faults (9). Chapter 10 is an odd mix of crystalline rocks, mineral deposits, and superficial deposits. Maps in environmental geology are the subject of the twelfth chapter.

In places, *Geological Maps* is a curious mixture of maps and basic geological principles. Some pages read like an elementary physical geology text. The explanation and classification of unconformities, inliers, outliers, overstep, and offlap (p. 81-85) offer but one of several examples. In short, this book can be grasped by students with little geological background; it can be used in parallel with courses in "Geology 101", or beginning structural geology. At the same time, relatively abstruse notions such as sub-crop and paleogeological maps (p. 87) are treated. These can, of course, be omitted for beginning students. The final two chapters are superb: heritage of geological maps, and production of geological maps. They should be required reading for all Earth scientists, and might well serve as openers in a course using the text here under review.

Although *Geological Maps* covers its ground, so to speak, and is a useful text, it is not without shortcomings. Basic tenets, perhaps with simple numerical examples, ought to have been covered at the outset, rather than being introduced piecemeal. The coverage of crystalline rocks is weak at best. Isograds, for example, are not even mentioned. Many of the maps, heavens forbid, lack scales and north arrows! Figure 7.3c is undecipherable. Some of the map exercises are quite challenging and will be beyond the capacity of beginning students.

A few general words on geological maps and their confection are here in order. The most diverse and demanding work of any physical scientist is regional geological mapping. Beyond the mere identification of rocks (petrography), the field geologist must be versed in the interpretation of the fabric and "lay" of those rocks (structural geology), in the recognition of certain fossils (paleontology), in the sensing of mineralization (economic geology), in the significance of landscape (geomorphology) and vegetation (botany), in the reading of air photos (photogeology), and much more. In addition, the field geologist must be able to keep a legible notebook, to read accurately topographic maps as well as geological maps of adjacent areas, to judge the weather for the next day's traverse, to make and break base and fly camps, to cook, to canoe, to ride horses and to load pack animals, to deal with injuries, to repair equipment, to read analogue compasses and altimeters, to work psychrometers, to start campfires after days of rain, to find water in dry places, to keep tents dry in wet places, to cajole recalcitrant assistants, and on and on. Back in the office, beyond the writing of an organized, grammatically correct and intelligible report, the field geologist must study and interpret thin sections, separate and determine the optical properties of selected minerals, choose suitable samples for chemical analysis, make granulometric analyses, draw cross sections, and draft his final map on a scale-stable base. Over the past 45 years, I've had the privilege and pleasure of carrying out all these tasks. Probably few of the students that I teach today will have such a broad range of challenges in their geological careers.

In North America, regional geological mapping has been turned on its ear and is now much diminished. It is in danger of extinction. As experienced mappers ("surveyors" in *Geological Maps*) die off, they are not being replaced by trained, eager young practitioners. In part, this is because mapping is physically hard, uncomfortable, and at times dirty work. There are far easier ways to earn a living in the Earth Sciences at the dawn of the 21st century. Nevertheless, the decline of regional geological mapping today is being accelerated by two trends: 1) Budgets and privatization. Only governments can justify bankrolling regional surveys. The private sector has no interest in paying for an activity that leads to no immediate financial gain. Pressured by tax-based downsizing, governmental agencies are forced to concentrate their reduced resources on topical studies, commonly related to environmental or economic issues. Compared to the recent past, they are carrying out precious little regional mapping. 2) Technology. The prevailing world-view is that technology can do all. So, we have GPS (obviating the need to know how to read a topographic map), computer-compatible field-data sheets (obviating the need to write or to keep a notebook in which one can express doubts or alternative interpretations), computer-assisted drafting (obviating the need to draw maps and cross-sections), digital instruments, data-handling software, and much else. Injured? Call on your satellite phone. Damaged equipment? Forget it. Beyond changing batteries, it's unrepairable in the field. Yes, things are different. Some changes and innovations are clearly useful, but many are not, and others are used thoughtlessly. The author of *Geological Maps* warns the reader in several places, from p. ix to p. 217, admonishing: "Although the days of using pencils and protractors to work with paper maps may be starting to fade, the principles behind manipulating maps and cross-sections on a computer screen are identical: the need for a clear understanding of the principles is more vital than ever", and "... so rapid is the rise in power [of software] and the sophistication of output, that it is reasonable to ask if the content of the early chapters of this book will soon be redundant". How sad. How much we shall miss!

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Geology of Albania. By Selam Meço and Shyqyri Aliaj (with contributions by Ismail Turku). Gebrüder Borntraeger, Berlin, 2000, x + 246 pages. US$90, ISBN 3–443–11028–2.

Geology of Albania is the 28th volume of Gebrüder Borntraeger's prestigious series "Beiträge zur regionalen Geologie der Erde", begun in 1961. Part of the text was translated from German, and the entire text was edited by Dr. Robert Bowen. In the words of one of the authors (S. Meço, p. v): "This book aims to stimulate interest in Albanian geology, in particular among foreign geologists, and to serve in enlightening all who read it". For the patient reader, the book succeeds.

Until the recent Nth Balkan war, Albania was a nearly unknown corner of Europe. Now, however, following years of media exposure to Kosovo, "Ethnic Albanians", and "humanitarian bombing", we have become aware of yet another European nation. One must keep in mind, nevertheless, that Albania is not a new creation. Its roots go back to the Illyrian Empire in 1225 b.c., although its first mention as a nation in historical records came more than two millenia later, in 1081 a.d. In 1908, the Albanian language was standardized using Latin script, replacing an earlier pot pourri of Latin, Arabic, and Cyrillic scripts. Albanians declared their independence from the Ottoman Empire in 1912. Eight years later, following the ravages of World War I, Albania established its capital at Tirana and joined the League of Nations. Buffeted by Italian imperialism in the 1930s, and shredded by World War II, Albanians founded a provisional Communist government led by Enver Hoxha in October, 1944, a month before the Germans withdrew from Tirana. Hoxha established a fiercely independent Stalinist state and ruled with absolute authority until his death in 1985. Foreign ties under Hoxha were diverse and changeable: Yugoslavia (1946–1948), the USSR (1948–1961), China (1961–1978), determinantly independent isolation thereafter. The country gradually opened to the outside world in the 1990s.

This historical background is necessary to realistically evaluate *Geology of Albania*. For example, the nearly 475 references listed near the end of the book (p. 211–231) show that geological mapping and field studies over the past six decades have been undertaken exclusively by national geologists, with their maps and reports published in Albanian, a relatively obscure language with less than 5 million speakers. Meço, Aliaj, and Turku figure as authors of nearly 20% of the references. Interestingly, most of their post-Hoxha papers are in French or English, though these tend to be "armwavers": regional syntheses and general summaries. Stratigraphic, petrological, and structural details remain buried in the Albanian-language publications. *Geology of Albania* is a timely window through which to view some of these details.

The book is divided into eight chapters: An outline of geography and geological researches in Albania (7 pages); Overview of the structural geology of Albania (14); Geological profiles of tectonic zones (86); Magmatism (25); Tertiary molasse basins (22); Neotectonics and seismicity (24); Geological evolution (14); and Mineral resources (18). The book closes with 21 pages of references (discussed in the preceding paragraph of this review), and two indices: an eight-page geographic index, and a six-page index of geological names.

Albania encompasses the austral Dinarides (the southern branch of the Alpine fold belt), and the northwestern end of the Hellenides. National geologists refer to these orogenic features, separated in northern Albania from one another by the Shkodra–Peja fault, respectively, as the northern and southern Albanides. The Albanides are divided into three internal zones on the northeast, seven external zones on the southwest, and numerous subzones. Stratigraphic columns, sketch maps, and key cross-sections are given for each of the zones. These data and accompanying text constitute the heart of the book: chapters 2 and 3, a hundred pages in all. Details abound!

Igneous rocks are covered in chapter 4. The rocks range from Paleozoic to Cretaceous in age, and from volcanic rocks to granites to ultramafic rocks, petrographically. Volcanic rocks are chiefly Paleozoic and Triassic, with some as young as Jurassic. Scattered occurrences of ash-tuffs of Tertiary and Quaternary age are held to reflect volcanic activity in neighboring Greece and Italy. Two parallel belts of Tethyan ophiolites occupy much of the Mirdita (internal) zone. Owing to their economic importance, the ophiolites have been studied in particular detail. All members of the classical sequence, from mantle rocks to radiolarian cherts, are present. Stocks and sheets of post-Jurassic(?) felsic intrusive rocks occur chiefly in the internal zones. Geochronological control is weak to nonexistent.

Molasse (some coal-bearing) of Tertiary age is covered in chapter 5. More than a dozen individual basins have been identified and generalized stratigraphic sections are depicted.

Most of the sixth chapter treats post-Pliocene neotectonics, relating the subject to Albania's complicated plate-tectonic setting. The country is divided into four zones, each under the influence of distinct extensional, compressional, or neutral forces. The discussion is illustrated by maps, cross-sections, and seismic profiles. The chapter closes with a discussion of seismicity, Albania being possibly the most active country in Europe. Eleven major earthquakes (Ms > 6.0) in the 20th century have caused nearly 400 fatalities. Hypocenters are shallow. A seismic risk map (Fig. 104) divides the country into four zones based upon expected maximum magnitudes (Ms 5.0–7.5).

The geological evolution of Albania in its regional context takes up the 7th chapter. With a certain degree of arm-waving and cartoon cross-sections, the authors attempt a genetic integration of all the minutiae of the preceeding 178 pages into a coherent picture. Given the thin geochronological data-base, and the recency of the introduction of modern tectonic thought to Albania, the authors offer a credible accounting. One is left, however, with a realization of the enormity of effort that remains to complete the task.

The final chapter covers mineral resources. Albania's major resource is chromite from the ophiolites. It is evident that the genesis and distribution of the chromitites await detailed study, and that little geochemical research has been done. Other resources are copper, iron, asbestos, salt, refractory minerals, industrial minerals, oil and gas, groundwater, and mineral springs.

Geology of Albania is heavy reading for two reasons. In the first place, the text is cumbersome, wordy, and grammatically awkward. Order is not everywhere easy to follow. This reviewer had difficulty, for example, to integrate chapters 2 and 3. Then, part of the terminology is outdated, and some is decidedly European rather than North American. Nevertheless, with patience, the reader will be able to stay on track. Some of the small text figures are hard to relate to the country as a whole (Figs. 6 and 27), and a few of the cross-sections are unconvincing. The headings on pages 223, 243, and 245 are wrong, and some citations in the text (notably "Rama's Albanian bibliography" on p. 7, and Sinoimeri on p. 196) are absent in the references. Dozens of minor errors are sprinkled through the text, but none is a major obstruction. Secondly, many parts of the text refer to the 1:200,000-scale geological map of Albania published in 1983. Indeed, it would be enormously helpful if that map were available to the reader. The tiny (11 × 5 cm) colored map printed on the cover of the book serves only to tease.

In sum, *Geology of Albania* is clearly the premier reference for the geology of this remarkable piece of the Alpine chain (Fig. 105). It makes obvious the need for modern petrological – chemical – geochronological studies. With the opening of a nation that until recently was wholly isolated, the research opportunities are legion. The tone conveyed by the authors suggests that the will for scientific cooperation is there. Keep this in mind when concocting a grant application.

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The Dating Game (*One Man's Search for the Age of the Earth*). By Cherry Lewis. Cambridge University Press, 2000, ix + 253 pages. US$25, ISBN 0–521–79051–4.

One October afternoon in 1965, I was playing cards with a group of American Peace Corps Volunteers in Medellin, Colombia. I was back in town for a short break from fieldwork in the central Andes. Skimming a copy of *Time* magazine in the Volunteers' apartment, I learned of the recent death of the eminent British geologist Arthur Holmes at the age of 75, perchance on my 30th birthday. Later that afternoon, on my way to supper, I stopped by the Post Office to find a small but heavy package. It contained the new and fully revised 2nd edition of Holmes's *Principles of Physical Geology* that I had ordered some months earlier. The coincidence strikes me as strongly today as it did then. Now, some 37 years later, we are treated to a short but delightful and sound scientific/personal biography of Holmes. The background of the author, Cherry Lewis, is broad and particularly well suited to the task. She began her professional life in the arts and business, before moving on to obtain a Ph.D. in Geology at University College, London.

The Dating Game is arranged around the historical development of U–Pb dating systematics, with sidetracks into K–Ca and U–He methods. Holmes was, of course, the pioneer of U–Pb geochronology; some geochronologists may be surprised to learn that as early as 1915, he wrote that the way of the future lay with zircon, even though this was decades before the recognition of common (primordial) lead and its significance.

Lewis's presentation of Holmes's life is chronological and follows his persistent effort to construct a geological time-scale. What is not chronological in the text, however, is the telling of the historical scientific development and concurrent events. Most authors would segregate such materials into "boxes", now quite the rage with publishers and firmly out of favor with this reviewer (they shatter continuity). Lewis, on the other hand, skillfully weaves these materials into the text, marking them clearly with scrolled lines. Nowhere is the thread broken nor confusion introduced.

Holmes's life is traced from humble beginnings, through pre-university schooling where the constructive and questioning influence of teachers left indelible marks. On to university, first in physics, then geology, though Holmes never obtained a degree. This was followed by mineral exploration in Mozambique, two disasterous years of oil exploration in Burmah, and a nadir as shopkeeper in London. Holmes's luck turned in 1924 when he received an appointment at Durham University to found a geology department. He also found Doris Reynolds (on a field trip) and in 1933 brought her to Durham as a lecturer in geology. Even though the two were married in 1939, the year after the death of Holmes's first wife, his romantic involvement with Miss Reynolds placed in jeopardy his position, and in 1942 he accepted the prestigious Regius Professor in Geology at Edinburgh University, taking his new wife with him. Ill health prompted his retirement in 1956. Eight years later he was awarded the Vetlesen Prize. By now too frail to travel to the ceremony in North America, he received the gold medal in his London apartment. In his acceptance, he said: "Looking back it is a slight consolation for the disabilities of growing old to notice that the Earth has grown older much more rapidly than I have – from about six thousand years [the then oft-cited date of creation at 4004 b.c.] when I was ten, to four or five billion years by the time I reached sixty" (p. 234).

The book concludes with an interesting section ("Thanks and Acknowledgements", p. 239-242), which tells of the author's mode of research and her sources. This is followed by two chronologically ordered lists of references, 84 in all. Unfortunately, no index is offered.

A few errors have crept into *The Dating Game*. Perhaps the most serious are: 1) Lavoisier could not have identified the 92 elements (p. 42); fully 62 (including helium, aluminum, potassium, sodium, and silicon) were discovered only after his tragic death by the guillotine in 1794. 2) Atomic number is not of necessity equal to the number of orbiting electrons (p. 113). Lesser errors include "draw" (for drawer) on p. 41, "Russell Wallace" (for Russel Wallace) on p. 93, and "Massachusetts Institute for Technology" (instead of Massachusetts Institute of Technology) on p. 166. Two words drove me to the dictionary: "meme" (p. 18), and "treacle" (p. 157). The former is apparently a misprint.

In summary, this is a lovely, well-written and informative book that all Earth scientists would enjoy. It balances nicely the scientific and human qualities of a remarkable geologist. It must be admitted that an already favorable view was enhanced because Holmes, like the present reviewer, held a distaste for administrative meetings (p. 215 and 232), was a pipe smoker (p. 62), and a letter writer (p. 67).

It is worth emphasizing, in conclusion, the importance that letters have in the compilation of this fascinating biography. Letters between Holmes and the major figures of the day in geology: T.C. Chamberlin, R.A. Daly, Alfred Nier, and many others, all added a remarkable scientific and personal richness to the narrative that goes far beyond that which can be gleaned solely from scientific papers. How many scientists today take the time to express their thoughts to colleagues on paper, perhaps enriched by sketches or diagrams, then reread their words before signing and folding them into an envelope to be mailed? Tomorrow's biographers may have far leaner materials to mine.

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Introduction to Optical Mineralogy (2nd edition). By William D. Nesse. Oxford University Press. Available from Oxford University Press, 70 Wynford Drive, Don Mills, Ontario M3C 1J9. 1991. xii + 335 pages. CDN $131.50 (20% off on school orders). ISBN 0–9506–245.

It is perhaps embarrassing to review a decade-old book; your reviewer was familiar with the first edition of Prof. Nesse's text, published in 1986, but somehow missed the second edition, published five years later. The reasons for his oversight can be read between the lines of this review. No matter, it is worthwhile to offer a short evaluation of this fine book, which is in print and much promoted by its publisher.

Optical texts fall into three categories: 1) Texts that treat theory alone, such as “Mineral Optics” by Phillips (1971), “Crystal Identification” by Stoiber and Morse (1994), and “Optical Crystallography” by Bloss (1999). In general, these works fulfill their mission. 2) Texts that offer theory and mineral descriptions, including “Optical Mineralogy” by Kerr (1959) or by Shelley (1985), and “Rock-Forming Minerals in Thin Section” by Pichler and Schmitt-Riegraf (1997). The quality and usefulness of books in this category range widely. Commonly, they are used chiefly as guides to mineral identification. (It is assumed that the reader is familiar with these books, at least peripherally; full references seem unnecessary. There are of course several additional books in each of the three categories.) 3) Texts designed for courses where optical is a caboose to mineralogy, as “Minerals in Thin Section” by Perkins and Henke (2000), and “Earth’s Materials” by Sen (2001). Such books serve little purpose in the advancement of mineralogy.

The first edition of Prof. Nesse’s book was well received (see review by Horace Winchell, *American Journal of Science*, v. 287, p. 399). It was clearly written, logically ordered, and free of errors. What struck the present reviewer upon reading the second edition is how little it departs from the first; the two are within Ångströms of being identical! Rather than to flog a second edition, the publisher would have been more candid to have called the volume an updated second printing.

Following a preface (two in the second edition), each edition carries 15 chapters with parallel headings and virtually duplicate contents, three identical appendices, and two indexes. So, where does the second depart from its predecessor? Polarization by reflection and Brewster’s angle (p. 14), and accessory stage devices (mechanical, spindle, and universal; p. 20-22) have been added, as have a few words and two illustrations of nonminerals (textile fibers, bubbles...; p. 116-117). A dozen or so additional black-and-white photomicrographs of selected minerals now bring the total to 62. Anthophyllite and gedrite have been divorced (p. 218-221), and a few references have been tacked on (as in the first edition, they are given at the ends of chapters). A chart that depicts average index of refraction *versus* birefringence has been printed on the back of the tip-in interference color chart (of excellent quality, by the way).

The layout of *Introduction to Optical Mineralogy* is conventional. The first seven chapters cover theoretical optical principles; three are introductory, and the four that follow deal with topics progressively murkier for the student: isotropic materials, anisotropic minerals (a lucid discussion of things to come), uniaxial optics, and biaxial optics. The final eight chapters are practical, opening with a chapter that explains what should be looked for, and points the student toward identification tables in Appendix C. The succeeding two chapters describe 45 non-silicates that occur in rocks. The final five chapters deal with the rock-forming silicates, arranged structurally from ortho- (or neso-) silicates to tectosilicates. Individual mineral descriptions follow a uniform and logical format, accompanied by crystal drawings that show form, cleavage, and crystallographic and optical elements. Where appropriate, diagrams that relate composition to optical properties are offered. Several of the methods to determine plagioclase compositions optically are covered in detail (p. 271-276).

The first of the three appendices treats sample preparation: grain mounts, thin sections, and a few words on the spindle stage. The second deals with ray-velocity surfaces. The final appendix is composed chiefly of 13 tables that list minerals following useful parameters such as color, indices of refraction, *etc.* The tables are well chosen and decidedly student-friendly. The book concludes with a mineral index (5 pages), and a subject index (6 pages).

Although *Introduction to Optical Mineralogy* is nigh impeccable, there are a few errors and shortcomings. The most serious, in this reviewer’s judgment, is the relegation of ray-velocity surfaces to an appendix. These are powerful tools and offer the student a firm launching pad toward the mysteries of the indicatrix. The ray-velocity surfaces for isotropic, uniaxial, and biaxial substances should be taken from their distant exile and in a third edition be incorporated, respectively, in chapters 4, 6, and 7. Then, the mere passing mention of the spindle stage is pitifully inadequate. At the least, a basic introduction to this marvelous (and inexpensive) device should be offered. It is unfortunate that the Ångström is nowhere mentioned. Many students have long been exposed to this (non-SI) unit. Other, minor points: The reference to Wahlstrom on p. 111 lacks a date. The olivine in figure 11.1 looks like fayalite and perhaps should be identified as such. The absence of any reference to DHZ under “more complete compilations of optical data” at the close of chapter 8 is surprising (DHZ are cited at several other places in the volume). Figure C.1 precedes the tables in Appendix C, rather than to follow them as hinted on p. 115. Andradite commonly displays anomalous birefringence and should be added to Table C.9.

The first IMA report on the nomenclature of amphiboles was taken into account, but not the second, nor (thank goodness, in this reviewer’s firm opinion) was the IMA report on the nomenclature of pyroxenes. Accordingly, the serious petrographer will find his friends bronzite, crossite, hypersthene, and salite in the mineral index.

The review of textbooks is particularly demanding, because the thorough reviewer should answer the question: “Would I use this text if I were to teach the complete subject?” For *Introduction to Optical Mineralogy* the response is a qualified “yes”. It fills the bill nicely as a single complete and accurate text combining theory and practice. However, the cost is high (CDN $131.50; or $105 for bulk orders to schools). On the other hand, the combination of Bloss's MSA Monograph 5 "*Optical Crystallography*" (for theory), and DHZ's "*Introduction to the Rock-Forming Minerals*" (for practice) is more exhaustive and comes in at CDN $110.74 (or $98.04 for MSA members). Perhaps best is to root out a used copy of the 1st edition of *Introduction to Optical Mineralogy*. This reviewer paid CDN$19 for a pristine copy in an Ottawa second-hand bookstore in 1990. Perhaps now it would go for even less.

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Strunz Mineralogical Tables, ninth edition. By Hugo Strunz and Ernest H. Nickel. E. Schweizerbart'sche Verlagsbuchhandlung, Johannesstrasse 3A, D–70176 Stuttgart, Germany. 2001, 870 pages, US$142 (hardcover). ISBN 3–510–65188–X.

The first edition appeared in 1941 and now, 60 years later, a ninth edition appears, which is truly a magnificent marathon effort by Hugo Strunz. This is the first edition in English and is co-authored by the eminent Canadian-born mineralogist Ernie Nickel. The contents may be divided into three parts: an introduction (33 pages), chemical composition – structure mineral-classification system (704 pages), and alphabetical index of mineral names (133 pages). The introduction contains information on chemical bonding, crystal systems, crystal classes, Bravais lattices, space groups, symmetry operations, coordination polyhedra, and definitions of class, division, subdivision, group, and family, for a classification based on chemical composition and structure. The main portion of the book contains (where available) a simple description of the structure with the diagrams and coordination numbers, a chemical formula, unit cell, crystal system, space group, value for *Z*, and references. This section is up-to-date, with an appendix of new minerals published in 2000. The information in this section is exceedingly valuable. The chemical–structural classification is distinct from the pure chemical classification of Hey and Dana. In my opinion, this is a better classification than a purely chemical classification; however, there are drawbacks with it, such as the separation of the isostructural mineral subgroups such as galena (page 90), halite (page 149), and periclase (page 184). The use of bold font for valid names, and plain font for other names, overcomes the problem of the approval by the Commission of New Minerals and Mineral Names of the International Mineralogical Association to name mineral species, mineral varieties, mineral series and hypothetical minerals. Questionable names are given in quotation marks. There are significant differences in valid names compared to other recent publications, which shows that the status of some 200 minerals is not settled. The alphabetical list contains about 9,000 obsolete mineral names without references, in contrast to the 32,000 obsolete mineral names with references in Bayliss (2000). There are a number of errors in this list. The list is computer-sorted, so that a space (ASCII 32) occurs before a hyphen (ASCII 45), which occurs before the letter "a" (ASCII 97). The text is printed on high-quality paper in a clear clean manner. Because the ninth edition is the first English edition and the main author is German, it should be noted that the English is excellent. This book represents a significant compilation of data. I highly recommend it for all museums, crystallographers, mineral collectors, and mineralogists.

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Alkaline Rocks and Carbonatites of the World. Part 3: Africa. By Alan R. Woolley. The Geological Society. Available from The Geological Society Publishing House, Unit 7, Brassmill Enterprise Centre, Brassmill Lane, Bath BA1 3JN, U.K. 2001, 372 p., £85.00 (US$142.00), £39.00 (US$65.00) for Geological Society members, hardbound, ISBN 1–86239–083–5.

With the third volume of his four-volume encyclopedic coverage of the alkaline rocks and carbonatites, Dr. Woolley has made available another great work of scholarship and reference. The effort involved in producing these volumes is enormous and is a testament both to his determination, and to the incredible library resources of the Natural History Museum, the Geological Society, and the various university libraries of the London area. This huge undertaking began more than twenty years ago. Part 1, dealing with North and South America, appeared in 1987, Part 2 (The former USSR) came out in 1995, and now we have Part 3 dealing with Africa where, to a large extent, the study and recognition of the true magmatic nature of carbonatites really began.

In an undertaking of such magnitude, the question of what exactly is an alkaline rock is the first that has to be decided, for it has attracted a variety of definitions and, hence, breadth of usage. Woolley has adopted, essentially, the usage of Shand, wherein alkaline rocks are defined chemically as those in which there is a deficiency of SiO_2 or Al_2O_3 (or both) relative to the "molecular" ratio of $Na_2O + K_2O : Al_2O_3 : SiO_2 = 1:1:6$ in alkali feldspar. Thus, an alkaline rock may be undersaturated or oversaturated with SiO_2 (*i.e.*, feldspathoids or quartz in the mode), saturated or oversaturated with Al_2O_3 (hence feldspar or feldspathoids or both, with or without corundum in the mode), and saturated or oversaturated with alkalis (hence feldspars, feldspathoids, and sodic pyroxene or alkali amphibole or both in the mode). The alkaline rocks, therefore, encompass the full range from silica-deficient feldspathoidal rocks to the silica-oversaturated but peralkaline or peraluminous granitic and comenditic rocks. This usage specifically excludes granites and syenites that do not contain an alkaline pyroxene or amphibole, as well as the alkali olivine basalts. Although basically a chemical classification, the restrictions in chemical composition imply a mineralogy that serves to define the alkaline rocks mineralogically and petrographically in convenient manner. However, Woolley has also chosen (wisely) to include fenites which, although demonstrably not magmatic, are commonly associated spatially with occurrences of alkaline rocks, and some gneissic feldspathoidal rocks for which a magmatic origin also may be in doubt. He similarly includes some ultramafic rocks and melilite-bearing rocks, again because of their frequent occurrence with true alkaline rocks. The result is a catalogue of all the obvious magmatic alkaline rocks and carbonatites, and some that might or might not be truly igneous alkaline rocks.

The format of the book renders it convenient to use, with its double columns that make scanning both quick and easy, something that many users will need to do when looking for some particular feature of these rocks and their field associates. Each country has a separate section, beginning with a simple map showing, with numbered dots, the distribution of all occurrences described. A table then gives the name and number of each. A new introduction in part 3, and one that is much appreciated, is that carbonatites are indicated with a [c] after the name. There is then a succinct description of the form of each occurrence and its constituent rock-types, with a note on its age where known (and the geochronological methods employed), and a note on any economic significance where applicable. The Lat. and Long. coordinates of each occurrence are given on the title line, both appearing in bold type. The terminology of the rocks types is kept very simple, so we are spared the topsailite of the Los Islands in Guinea, the aiounites of Morocco or the ampasimenites of Madagascar, and hope that they have finally been consigned to oblivion.

There is no attempt to discuss the petrogenesis of the occurrences, for this is not the author's purpose. It is also a pleasure to see that Woolley distinguishes the term peralkaline from agpaitic rather than using them synonymously, which is still irritatingly common among some of our European colleagues. There is considerable value in using the term agpaitic for those peralkaline rocks that have unusual concentrations of elements that generate the less common minerals, such as eudialyte and ramsayite, to name but two.

The question of cost always arises in reviewing books of this type. At eighty-five pounds sterling, it is hugely expensive for those who are incurably infected with a fascination for these rocks. In reviewing Part 2, I questioned whether modern methods of desk-top publishing could not produce the book in a cheaper yet durable format that would stand up to extensive library usage (even allowing for several copies to be bought). Publication has moved from the British Museum (Natural History) for Part 1, to Chapman & Hall for Part 2, and to the Geological Society for Part 3. Unfortunately, it is still largely out of reach for individuals, and such an expensive format virtually ensures that these volumes will never be revised.

Part 3, together with its preceding volumes, is a splendidly useful creation and one for which all alkaline rock and carbonatite petrologists owe an immense debt of gratitude to Alan Woolley. There are today few workers with the initiative, determination, endurance and library resources to stick at the task for so many years while still finding time to produce contributions to the mineralogy and petrology of these rocks in scholarly journals. As with the previous volumes, Part 3 has been carefully proof-read. Some users of Part 3 may find that they are aware of more recent information than appears in particular descriptions, but it must be remembered that a work of this magnitude can only ever be a progress report. These are books in which to browse; you can open them at almost any page, start reading, and be assured that thoughts and ideas for future lines of investigation will soon emerge. The simple compilations represent far more than brief descriptions. They provide a means of checking the validity of some generalizations found in the more expansive literature of carbonatites and alkaline rocks. One example is the number of carbonatites without any accompanying alkaline silicate rocks, lending support to the view that this has been a commonly overlooked principle in schemes of carbonatite genesis.

Part 4 (Europe, Oceanic Islands, Asia, Antarctica and Australasia) is keenly anticipated, and we all join in wishing Alan Woolley the continued tenacity that he has displayed so far, and hope that the Italian delights of his alternate home in retirement will be no deterrent to completing the work.

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Madagascar: A Mineral and Gemstone Paradise. By Frederico Pezzotta. Lapis International LLC, P.O. Box 263, East Hampton, Connecticut 06424, U.S.A., 2001, 97 p. US$26.00 + $3.00 shipping to non-U.S. addresses, soft cover (ISBN 0–971–53710–0).

In this eye-opening monograph, Frederico Pezzotta, curator of the Natural History Museum, Milan, reviews the geology of the minerals and gemstones of the fourth largest island in the world. It is an elegant guide to Madagascar's mineral localities, the source of some of the world's most exceptional specimens of numerous mineral species.

A wealth of information is packed into this modest volume. An introductory index gives the selected mineral localities described, and there is a complete list of minerals (using IMA-approved nomenclature) known to occur in Madagascar. Then come succinct overviews of literature, traditions, collections, the history of the search for minerals, and the 3.5-Ga-worth of geology of the island. No small assignment to be sure, but one that is executed in fine flowing style. The bulk of the volume consists of lavishly illustrated sections on: skarn deposits, pegmatites, alpine veins, and lastly, amethyst and various treasures (celestite, sapphire and fossils) from Paleozoic and Mesozoic sediments.

By far, the focus (over 40 pages) is on " Madagascar's Rich Pegmatite Districts". Pegmatite deposits occur in exceptional variety, with hundreds of producing localities and many unproven ones. Pezzotta presents a new classification of Malagasy pegmatites, including ten types in addition to Černý's (1991) classification, together with an insightful review of the characteristics of the most important types. All this is interspersed with high-quality photographs, mostly of mineral specimens, a few landscapes, and some strategically positioned black and white oldies from the early cozy times enjoyed by colonial administrators. Among the privileged apparently were three thoroughly spoiled prospectors shown being carried about in "palanquins" by the natives to various mineral localities! Here in pegmatite country occur numerous fabulous gemstones, among them beryl, (yellow) scapolite, thortveitite, Japan-law twinned quartz, chrysoberyl, extraordinary tourmaline (elbaite–liddicoatite), emerald of superior quality, and the world's best londonite (Cs-rich end-member of the rhodizite group, accepted as a new mineral in 2000).

Reference to the "extraordinary" reminds me of Madagascar orthoclase, chips and thin sections of which this reviewer first encountered as a grad student years ago in the University of Otago's teaching collections. For some reason, this mineral is iron-rich (2.93% Fe_2O_3), possibly a world record. However, there is apparently little relationship to the mineral's optic axial angle, the chief effect of the iron being to promote the stability of the sanidine modification, according to the authoritative work of Coombs (1954). Such details, however, are totally incidental when viewing the golden, shimmering, facetable, gemmy, $10 \times 7 \times 7$ cm single crystal figured on page 31! The best such material, we are told, comes from the old village of Itrongay in the south-central part of the island where, in 1922, Alfred Lacroix first reported the occurrence of these remarkable crystals. For about 40 km to the southwest, mining continues today to exploit sporadic patches of gem-quality orthoclase (plus spinel, diopside, titanite, apatite, phlogopite and zircon) present in fracture-filling veins associated with granitic pegmatites intruded into marble. Most of the work is confined to primitive surficial mining methods. Pezzotta advises us that, unfortunately, minerals come to market commonly heavily damaged. This is because the miners, digging by hand and on the lookout for gemmy sections, usually break crystals apart. Specimen production ceases when hard weathered rock is encountered. Consequently, the potential left in the ground is said to be enormous.

Madagascar's skarns, like its pegmatites, are also treasure chests. The astonishing array of minerals includes (in addition to micas) diopside, scapolite, titanite, apatite, spinel, corundum, hibonite, sapphirine, kornerupine and grandidierite, the size of which is normally only seen in pegmatites. Their origin is attributed to the geological reworkings of the crystalline basement during the Pan-African (upper Proterozoic to early Paleozoic) construction of the Gondwana supercontinent. Pure speculation? Perhaps, but during exploration in northeastern Zambia in the early 1960s, we encountered swarms of basic dykes of different ages as well as swarms of granitic pegmatites. Poorly exposed yes, but all grown along the western front of the Mozambide Belt – the same high-grade metamorphic terrane that comprises the very backbone of Madagascar, a mere 200 km or so east of continental Africa. My mineral collection still sports a stubby 10-cm-long rutilated quartz crystal picked up on traverse east of the Luangwa. Talk about potential treasure chests!

According to Pezzotta, the two best localities for "alpine veins" are in north-central Madagascar and the northeast coast. The mineralogy is simple and includes quartz (typically in elongate habit), rutile, anatase, tourmaline, dolomite, titanite and hematite, the last two constituting the most remarkable finds in these deposits. Hematite occurs either as "iron roses" or as large flat crystals partly included in smoky quartz. The titanate is world-famous, present as both isolated yellow-green gemmy crystals to 6 cm, or in groups on matrix associated with apatite. Madagascar amethyst exhibits a wide range of habits, and ranks with the world's best.

Last but not least are the treasures revealed in Paleozoic and Mesozoic sediments. These include collector specimens of magnificent sky-blue celestine for which only a single deposit exists. Production is highly restricted, owing mainly to local traditions, which see to it that a single small ethnic minority is allowed official access. However, it is a tale from the recently discovered sapphire fields that takes first prize. Pezzotta tells of one site where the porters (whose job it is to carry sacks of gravel to be washed) get to keep one sack a day as payment for services rendered. Recently, one porter (who we understand, has since taken early retirement), discovered in his load an outstanding crystal of alexandrite that he subsequently sold for US$100,000! In addition to these fabulously rich modern placers, it seems that extensive paleoplacer gemstone deposits exist within strata of Permian and Mesozoic graywackes. This comes about courtesy of the weathering process. From which, it seems probable, Madagascar's nickname, the "Red Island" is derived.

The reference to the soil seems clear enough. What I have difficulty getting my mind around is that Homo sapiens reportedly arrived here from the far shores of Indonesia and Malaysia only 2000 years ago. Since that time, the species certainly seems to have done its utmost to expose the underlying red color of the island. A few arresting photographs, which happen to reveal the results of large-scale deforestation and erosion, readily attest to the environmental and ecological crisis in Madagascar. This important problem, which will undoubtedly have implications for future mining propositions on the island, is not addressed. One has to wonder, for mention is made (p. 40) of natives in the Andapa pegmatite field along the northeastern coast "...burning the vegetation in a deforestation effort." I was also puzzled to encounter (p. 24) the statement that "... Madagascar's location..... has allowed an unusually thick layer of humus-rich soil to form" . Surely, what is intended to be stated here is "... a thick layer of lateritic soil...".

Quibbles? One misspelling – celcius for Celsius – on p. 26, and a truncated sentence on p. 13, line 32. Inclusion of at least a short bibliography would have been very useful; likewise, a subject index. However, all things considered, this is a collector's volume. Congratulations to extraLapis for English No. 1 edition. This should be a super series!

References

ČERNÝ, P. (1991): Rare-element granitic pegmatites. 1. Anatomy and internal evolution of granitic deposits. *Geosci. Canada* **18**, 49-67.

COOMBS, D.S. (1954): Ferriferous orthoclase from Madagascar. *Mineral. Mag.* **30**, 409-427.

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Tektites in the Geological Record: Showers of Glass from the Sky. By Joe McCall. Published by the Geological Society Publishing House, available from the AAPG Bookstore, PO Box 979, Tulsa, Oklahoma 74101-0979, U.S.A. (www.aapg.org), 256 p., US $108. Soft cover (ISBN 1–86239–085–1).

Tektites are impact-generated glass bodies that show varying degrees of aerodynamic sculpting due to passage through Earth's atmosphere. They have been prized for thousands of years, first as attractive shiny stones and desirable carving media, and much later, as interesting geological oddities. The ancient Chinese attributed tektites to thunderstorms, because of the ease with which there were recovered following heavy rainfall. Charles Darwin described them as probably arising from volcanic activity. In the 20th Century, there was a famous (infamous, really) and prolonged argument over a possible lunar origin. However, it has been clear for thirty years now that tektites form from large asteroid and/or comet impacts onto the Earth. Charley Schnetzler delivered a famous epitaph for the lunar origin of tektites in 1970: "The lunar origin of tektites, a controversial and stimulating theory on the scientific scene for almost 75 years, died on July 20, 1969. The cause of death has been diagnosed as a massive overdose of lunar data."

Between the 1940s and 1990s, many books dedicated to tektites appeared, most of which are now long out of print. The first 21st century book dedicated to tektites has appeared, written by the Australian planetary scientist Joe McCall. What a pleasure to read a modern, timely, well-composed, thorough book on the subject of tektites, one that has not been written solely to regenerate the long-discredited idea that these fascinating glass objects somehow emanated from the Moon. My authority for writing this review is a longstanding interest in terrestrial and extraterrestrial glasses, which extends to many trips to collect bediasites (tektites from the North American Strewn Field) a short distance north of my home in Houston. One notable feature of tektites is that they are available to so many people. All of the continents save South America and Antarctica have strewn fields.

The author of the book resides in Perth, Western Australia, home of the beautifully aerodynamically sculpted australites (which appear to have been melted twice). This book is timely because it has been quite some time since a scientifically sound volume has been devoted to tektites. Also, with the recent passing of John O'Keefe, the last professional scientist to strongly (stridently, in fact) advocate a lunar origin for tektites, a scientific blind alley has been closed. Finally, the impact crater for the North American tektites has, apparently, recently been found buried far below, beneath Chesapeake Bay, providing a solution to a great tektite mystery.

This well-illustrated book does a capable job of describing the occurrence, physical and compositional properties, and scientific importance of tektites. It is written for geologists, mineralogists, petrologists, planetary scientists, *i.e.*, the readers of this review. It is not a popular book written for the general public. Here, I briefly touch on a very few of the book's discussions, to give you a taste for the contents.

There is a very nice discussion of the continuing search for the source of the indochinites. For planetary scientists, this is a little like the search for Fermat's last theorem. The indochinites (and related australites, *etc.*)

are the youngest of the tektites, at 700 kyr, and have an immense strewn field, stretching a third of the way around our planet. Despite the relatively "young" age, the source crater for the indochinites has never been identified, although this is not for lack of looking. People have been searching through Southeast Asia for decades (wars permitting), and there are probably no two tektite workers who agree on the likely location for the impact site. McCall presents a strong case for an impact in southern China. Perhaps one of the readers of this book will be inspired to complete this search.

Fairly complete descriptions are given of other types of impact glasses, which are not considered tektites, such as glasses found near Zhamanshin (Kazakhstan) and Wabar (Saudi Arabia) craters, Libyan Desert Glass (Egypt), Darwin Glass (Tasmania), *etc.* For some reason, the Lonar Crater glasses (India) have been neglected. An impact origin for the latter has been disputed, but it would have been useful to present this controversy.

McCall spends considerable ink describing old controversies, such as the apparent age paradox. Many tektites were reworked after initial deposition at the surface, and so ended up in younger sediments. Further aggravating this problem, humans frequently carry tektites over great distances, and leave them in creative places. A possible example of this is the rather large North American tektite found at Martha's Vineyard (currently an island), Massachusetts, hundreds of kilometers from the present outcropping strewn field in the southeastern United States. For years, tektite workers agonized about these apparently young ages, before detailed field work settled the issue.

Today, a principal importance of tektites (where they have not been reworked into younger sediments) is as chronostratigraphic markers. In this regard, the distal microtektites are the most useful. Scientists logging deep-sea core samples frequently use microtektites to locate their sediments in time. All of this is well described in the book.

I do have a few minor quibbles with this volume. The author missed the opportunity to present the evidence that has definitively proven a terrestrial volcanic origin for the macusanites (Peru) and americanites (Columbia). I am tired of seeing these presented at mineral shows as genuine tektites (or as genuine lunar rocks for that matter!). Also, there are a few minor typographical errors scattered throughout the book, but nothing that will mislead a reader to a significant degree.

In summary, I recommend this book to anyone wishing to learn about the study, properties and history of tektites. There is an impressive quantity of data packed into 256 pages. The book is very well written, and even entertaining to read. It should find its way to the offices of many planetary scientists. In particular, it belongs on the shelf of anyone interested in the scarring our planet regularly receives from asteroids and comets.

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