The Canadian Mineralogist
Vol. 41, pp. 541-552 (2003)

BOOK REVIEWS

Tourmaline: extraLapis English No. 3: a Gemstone Spectrum. A.U. Falster, M.D. Jarnot, G.A. Neumeier, W.B. Simmons and G.A. Staebler, editors. Lapis International LLC, P.O. Box 263, East Hampton, Connecticut 06424, U.S.A., 2002, 106 p. US$24 (plus $2 for shipping to non-US addresses), soft cover (ISBN 0–971 5371–2–7).

Dedicated to a remarkable mineralogist, the late Eugene Edward Foord, the *Tourmaline* volume provides a clear perspective across the spectrum of species in this important and complex group of minerals. Whereas in 1962 there were only three accepted tourmaline species, schorl, elbaite and dravite, there are now 14 recognized (and counting!). Thanks to the work of Hawthorne & Henry (1999), tourmaline-group minerals are now elegantly defined at the species level by their *X*, *Y* and *W* site occupancy, the essential ingredient here being their initial assignment according to *X*-site chemistry to either an alkali, calcic, or vacancy group. Color, the origin of which may have diverse causes, is evidently not a characteristic of any one species: rather, diffraction patterns, physical properties and analytical information are required for identification at species level. All this and more, by way of systematics, are set out in erudite fashion by William B. Simmons in an important introductory trilogy in this volume, effectively setting the stage for another masterly volume in this series.

In addition to an invaluable broad overview of worldwide localities of tourmaline provided in the 30-page concluding chapter "From Paris in America to Amerika in Saxony – a Survey of the World's Tourmaline Deposits" (by M. Glas and friends), the editors also managed to integrate short chapters (4 to 7 pages) on key aspects of the mineral. The following are the titles taken from the text rather than from the somewhat abbreviated Table of Contents: "Tourmaline – History in Brief" (V.T. King); "New from Sludyanka" (G.A. Staebler and G.A. Neumeier); "The Tourmaline Group", "The Crystal Structure of Tourmaline", and "Species by Species – the Tourmaline Group Minerals" (W.B. Simmons); "The Crystals of Mr. Vorobiev and His Search for the Positive End" (F. Damaschun); "Are There Really Black Tourmaline?" (J.W. Zang and W. da Fonseca-Zang); "Cut Longitudinally with Drafting Pen and Paintbrush" (B. Wöhrmann); "News about the Star" (J.W. Zang, A.U. Falster and W.B. Simmons); "Dravite from Qârusulik, Ameralik Fjord in Southwestern Greenland" (O.V. Petersen, C.A. Francis, M.D. Dyar and M.T. Rosing); "The Tourmaline of Paraíba, Brazil" (B.C. Cook); "Tourmaline from Bolivia's Tropical Rainforest" (A. Petrov); "Burmese Tourmaline – An Historical Perspective" (R.E. Kane); "The Kremlin's Carbuncle" (M. Glas); "Inclusions in Elbaite Crystals" (J.I. Koivula); "If Icarus Had a Tourmaline" (M. Glas); "Pegmatites – an Overview" (W.B. Simmons).

Immensely informative, *Tourmaline* boasts five editors (two of whom, A.U. Falster and G.A. Neumeier, also served as translators), and contains written contributions by 16 authors, photos and drawings by 34 contributors, and judging from "acknowledgements", the encouragement and advice of numerous other individuals and groups. The stamp of a "contributed volume" having been thus conferred, the editors nevertheless have achieved a surprisingly high degree of harmony in the overall presentation. It must not have been an easy assignment.

There is something for everyone in this state-of-the-art report. A sampling: admire the intricacies (59 forms developed on a single crystal!) of the most complex tourmaline ever observed (Mr. Vorobiev's crystal); theorize to your heart's content on the cause(s) of the pink star-shaped zoning in liddicoatite–elbaite crystals from Madagascar; gaze awestruck at the magnificence of classic untreated (unique ?) Paraíba elbaite, and salute "Heitor the Fool" for his perseverance and fantastic good fortune; hunt for mushroom-shaped "rubellite" in Myanmar; dream of the incredible pegmatite fields of Minas Gerais, Brazil, probably the most tourmaline-rich region on the planet; revel in stories like "The Kremlin's Carbuncle"; learn about the latest finds and developments. (Question: could the new Nigerian find of Paraíba-like tourmaline be part of same pre-Continental Drift gemological province as Paraíba, Brazil?). There's much more to minerals than meets the eye, and tourmaline is a case in point.

So, if the spirit moves you after reading *Tourmaline*, feel free to pass the word along. You might, incidentally, impress your friends with an account of the pyroelectric and piezoelectric properties of tourmaline. To wit, the mineral's use as a prototype pipe cleaner (ash-attractor) should spark some interest. But follow through (as does Max Glas) by explaining that tourmaline is exceptional in providing piezoelectric service to temperatures above 700°C (well beyond the 320°C limit of oscillating quartz), and further, that it is this property of tourmaline that since 1964 has been used, among other things, to monitor vibration in jet engines and to thus help facilitate safe flight.

There are of course numerous other ways to attract public interest and appreciation of our favorite science or hobby. A splendid example is, quite incidentally, right there tucked away in a small corner of the *Tourmaline* volume. On page 91, it is reported that the Maine Geological Survey is seeking to establish a permanent mineral collecting park in Newry. What better way to win friends and to influence young people? The dedication of this volume to Eugene Edward Foord provides us with a ready-made example of the dividends this sort of investment might yield. Simmons & Webber (1999) recall that Gene Foord's early interest in minerals began as a young boy with his family in Maine collecting (tourmaline, what else?!) from pegmatites in Maine.

The eye- and mind-popping possibilities and perspectives on display in *Tourmaline* are simply too numerous to enumerate. But I found disconcerting the common mismatches between chapter titles listed in the Table of Contents and those set out in large bold type in the body of the text. "Is there really black tourmaline?" in the Table of Contents becomes in the text "Are there really black tourmalines?" Perhaps a casualty of translation, "News from the Star" in the Table of Contents reads (more appropriately) in the text, "News about the Star". Referencing is neither standardized nor complete. Some sources are given in full, others are reduced to initials. The first couple of references I checked (on p. 74, Boehm, 2001; on p. 96, Gesner, 1565) do not appear in the bibliography; nor does the source (on p. 94) to the drawings of either Tschermak (1897) or Maskelyne (1895). Schmetzer and Bank (1983) in the text becomes Schmetzer and Band (1984) in the bibliography; and so on. Illustrations are first-class except for the ghastly map (p. 47) accompanying the otherwise first-class contribution on Paraíba tourmaline. I noticed only two typos (p. 73) "sheer" not "shear", and misspelling of "copper" (p. 77). The volume ends with an incomplete sentence on p. 98: "While little is being said about the deposit, a photo circulating of an 8 cm long, water clear crystal whose colour gradates from green to blue" That's it, no period to signal completion, even if it were appropriate, which it is not. There must have been more! But now that I think of it, we were warned by Vandall T. King in the introductory chapter (p. 8) that "...there is still clearly much to learn about tourmaline". Case closed. Gene would doubtless agree.

Reference

HAWTHORNE, F.C. & HENRY, D.J. (1999): Classification of the minerals of the tourmaline group. *Eur. J. Mineral.* **11**, 201-215.

SIMMONS, W.B. & WEBBER, K.L. (1999): Memorial of Eugene Edward Foord, 1946–1998. *Am. Mineral.* **84**, 790-793.

David J. Mossman
Department of Geography
Mount Allison University
144 Main Street
Sackville, New Brunswick E4L 4P1

The Manual of Mineral Science. By Cornelis Klein, John Wiley and Sons, 605 Third Avenue, New York, N.Y. 10158–0012, U.S.A. (available in Canada: 22 Worcester Road, Etobicoke, Ontario M9W 1L1), 2002, xii + 647 pages. US$83.95. ISBN 0–471–25177–1.

The Manual of Mineral Science is the 22nd edition of a distinguished text that first appeared 155 years ago: the familiar workhorse, Dana's *Manual of Mineralogy*. The new edition differs from its immediate predecessors not only by bearing a new title, but also in its order of presentation of topics, and in its authorship, with Prof. Cornelius S. Hurlbut, Jr. (b. 1909), my teacher at Harvard more than 40 years ago, having passed the baton, once shared, to Prof. Klein exclusively.

Much of this revision is the natural outcome of the changing needs for mineralogy by modern professionals, as outlined in the Preface (p. v). Thus, rather than opening with crystallography, this new edition launches directly into crystal chemistry and mineral (read here "chemical") reactions, *etc.*, right through to page 169, or nearly one quarter of the book. Right off, however, the student will run into difficulty dealing with crystal form and habit (p. 17) and the awkward (surreptitious) introduction of the Miller index. Further on, the student will be on thin ice trying to grasp the concept of crystal structure (p. 80) with no knowledge of crystallography, or the significance of the third column of Table 4.2, where crystal systems and space groups are listed, or the screw axes presented in Figure 4.36 and rotation axes in Figure 4.39.

The last time that I taught introductory Mineralogy (in 2001), I used the order of topics presented in *The Manual of Mineral Science.* Unlike the author's proclamation of success, I found the result disappointing. The course resembled all too much Chemistry 101 with a new twist. The beauty and special attraction of mineralogy were greatly enfeebled. However, as Prof. Klein rightly points out in his Preface, the first seven chapters of *The Manual of Mineral Science* (those that precede the chapters on systematic mineralogy) are independent of one another and can be covered in an order of the instructor's preference. My personal choice of sequence would be 1, 5, 6, 2, 3, and 4 (see below). Also, and this is capital, individual chapters are amenable to highgrade mining; that is, the instructor can select parts and omit others, all the while maintaining continuity. *The Manual of Mineral Science* is unusually flexible in this sense, a reflection of the long evolution of the text and the skill of the author.

Let there be no doubt, "Dana" is the premier mineralogical textbook in North America. Rare are mineralogists who have not been exposed to "Dana" in the classroom or as a reference in the lab. This broad exposure is merited: "Dana" has always been under the stewardship of prestigious authors (I shall summarize the history of "Dana" and its various manifestations at the conclusion of this review). Beginning with the 21st edition, this text has been subjected to rigorous peer review, a policy that should be taken seriously by all publishers in the Earth sciences.

To dwell on the nitty-gritty of *The Manual of Mineral Science* would be to waste the time of the reader of this review: this textbook is a tested product in which the user can have confidence. I shall, nevertheless, summarize succinctly the presentation.

The bulk of the text is in 14 chapters, each headed by a useful 10 to 20 line introductory statement, and concluded by a list of references and selected readings. Also, sprinkled through five of the chapters are 13 "Boxes", each touching on a specific topic. The first chapter is a short (16 pages) introduction. The second, "Physical properties of minerals in hand specimen" covers habit, luster, streak, and on through piezoelectricity. The third chapter, "Elements of crystal chemistry", deals with bonding, coordination, composition, and chemical calculations. Chapter 4, "Mineral reactions, stability, and behavior", treats also polymorphism, exsolution, metamictization, twinning, and a detailed discussion on color. A background to crystallography is presented in the fifth chapter, and a detailed treatment of point and space groups occupies most of the sixth. The seventh chapter, "Analytical methods in mineral science", includes discussions in varying detail of optical methods, and the alphabet soup SEM, XRD, XRF, TEM, FAA, EMPA, SIMS, and AFM. Chapters 8, 9, 10, and 12 expose the student to the crystal chemistry and systematic description of some 200 of the commonest minerals. Minerals are covered using the well-established Dana system, running from native elements through the silicates. Individual minerals are described in a useful and logical fashion: name, formula, crystallography (with strongest X-ray-diffraction lines), physical properties, composition and structure, diagnostic features, occurrence, use, name, and similar species. The last of these chapters, "Rock-forming silicates" (a misnomer; a few examples, especially hemimorphite and chrysocolla, are not rock-formers) is organized structurally and is preceded by a particularly useful chapter "Crystal chemistry of rock-forming silicates". In chapter 13, the author discusses gem minerals. Here, the long history of disaster that has accompanied the Hope diamond is mentioned on p. 567. That gem, presented as a gift to the Smithsonian Institution (Washington, D.C.) by Harry Winston, has been on display in the National Museum of Natural History since the 1970s. Is the Hope the cause of the administrative misfortune of that museum (11 Directors in the past two decades)? The final chapter is made up of three determinative tables [minerals arranged by physical properties (29 pages), by specific gravity (2 pages), and a pair of pages where nonopaque minerals and synthetic equivalents are listed in order of index of refraction]. The text concludes with a 14-page mineral index, a 9-page subject index, and a few pages of miscellaneous matter, including a Michel–Lévy chart in color. A dozen color plates illustrate 72 minerals, from native gold to the zeolite stilbite, and a panoply of gem minerals. The text is supplemented by a CD–ROM (cross-referenced in the text) with four modules: I Crystal and mineral chemistry; II and III Crystallography, and IV Systematic mineralogy. Mac and PC installation data are printed on the inside front cover.

As I stated earlier, this textbook, with its long and illustrious history, is a proven product. There are, however, a few shortcomings and points to bring up. It is disappointing that the book is printed in sans serif typeface. Serif typeface is far easier to read; the serifs (feet) add character to the letters and enhance recognition, which in turn increase reading speed and comprehension [*Suggestions to Authors of the Reports of the United States Geological Survey*, 7th edition (1991), p. 244]. Then one finds, of course, the curious typos. A few are: HGS (for HgS, p. 362); glaxucophan (for glaucophane, p. 526); Mosman (for Mossman, p. 530); Louis Emmanuel Gruner, a nineteenth-century French chemist (for Grüner, nineteenth century, p. 525); Figure 2.4 is repeated (as Figure 5.1); and so on. None are serious, except perhaps to Dr. Brooke T. Mossman of the Department of Pathology, University of Vermont (USA). Then, the scales on Fig. 3.1(a) are not linear, as is implied, and the back-and-forth discussion of twinning (p. 20, 155, and 208) is bewildering. The piecemeal introduction of Hermann–Mauguin notation is murky; a unique and illustrated section devoted to this universal and useful symbology would greatly aid the student to understand clearly the concepts of symmetry. The seventeen pages (292–309) dedicated to optical microscopy add little and could be reduced to a single page giving the advantages of the method and listing the information on non-opaque minerals to be obtained in thin section or by immersion in oils. Discussion of the grotesquely overblown asbestos issue in a box (rather than hiding it in columnar text on p. 527 and 529–530) would add societal impact to the book. On the other hand, quartz as a carcinogen (Box 12.3) borders on the outlandish. After all, don't most of us wear wrist watches or possess kitchen clocks that proudly proclaim "quartz"? Finally, although the CD–ROM is flashy and well concocted, I'm unconvinced that it will be helpful to all. Manipulation of real pearwood models to appreciate the elements of symmetry will surpass the usefulness of the virtual screen for the serious student.

It is, however, the positive that characterizes *The Manual of Mineral Science.* It is an accurate, clearly written textbook that is instructor-friendly. Entire chapters as well as their subdivided topics can be exploited in a sequence comfortable to the instructor. It is eminently suitable for a standard introductory course, although the full content of the book exceeds that which can be covered in a single semester.

Let me conclude with a few words on what is "Dana". James Dwight Dana (1813–1895) was one of North America's leading mineralogists and geologists of the 19th century (*GSA Today*, Feb. 2003, p. 20–21). In 1837, he published the *System of Mineralogy,* a carefully documented orderly reference to all known mineral species. The *System* went through six editions and the last, published in 1892, is possibly the premier classical mineralogical *oeuvre* in the English language. A seventh edition, published in three volumes between 1944 and 1962 remained incomplete, lacking the silicates. A somewhat diminished eighth edition appeared in 1997 (*Canadian Mineralogist*, vol. 36, p. 935–938).

With the success of two editions of the *System* behind him, J.D. Dana prepared a 430-page textbook titled *Manual of Mineralogy,* with the first edition appearing in 1848. In the publishing trade, where appreciation is measured in numbers, the *Manual* surely ranks as the most successful text of all time in the Earth sciences! Through a period of 155 years, it has gone through 22 editions and countless reprintings (though the numbering of editions was confused in the early years). Already by the 13th edition in 1915, Wiley announced that more than 30,000 copies had been sold. With the explosive growth of petrography brought about by the widespread use of the polarizing microscope late in the 19th century, J.D. Dana added rocks to the *Manual* for the 3rd edition in 1878, and changed the title to *Manual of Mineralogy and Lithology.* In a revision (the 9th edition) eleven years later, the title was changed to *Manual of Mineralogy and Petrography.* J.D. Dana died in 1895, and his son Edward Salisbury Dana, author of the magnificent 6th edition of the *System,* took over as sole author. For the 13th edition of the Manual (1912), the younger Dana turned over authorship to William E. Ford who, like the Danas, was a professor at Yale University. In deference to the large number of petrographic textbooks that had by then become available, the title reverted to the original *Manual of Mineralogy.* For the 15th edition (1941), authorship slipped eastward, from Yale to Harvard, when Cornelius S. Hurlbut, Jr. took over the task. From the 19th edition (1977) through the 21st (1993), Prof. Hurlbut shared authorship with Prof. Cornelis Klein. Prof. Klein assumed sole responsibility for the edition here under review, taking authorship westward across the continent to the University of New Mexico.

The third "Dana" is the *Textbook of Mineralogy,* in this reviewer's eyes one of the most underrated of all books in the Earth sciences. More detailed than the *Manual,* yet serving as a bridge to the *System,* the *Textbook* went through four editions: the first two (1877 and 1898) under the authorship of the younger Dana, and the last two (1921 and 1932) under the stewardship of William E. Ford. The fourth edition has gone through more than 20 printings.

Tomas Feininger
Département de géologie
Université Laval
Québec (Québec) G1K 7P4

The Geology, Geochemistry, Mineralogy and Mineral Beneficiation of Platinum-Group Elements. Edited by Louis J. Cabri. CIM Special Volume 54, Canadian Institute of Mining, Metallurgy and Petroleum, Suite 1210, 3400 de Maisonneuve Boulevard West, Montreal, Quebec H3Z 3B8, Canada. 852 pages, US$150/CDN$220 for non-members, US$100/CDN$140 for members, US$ 70/CDN$100 for students (hard cover). ISBN 1–894475–27–5.

Following the rapid escalation over the past decade in the worldwide demand for platinum-group elements (PGE), in particular platinum and palladium, together with the high prices these noble metals currently enjoy, there has been a concomitant dramatic rise in exploration around the globe for potential PGE deposits. This unprecedented resurgence in interest in the PGE and in aspects relating to their geology, geochemistry and mineral beneficiation has prompted editor Louis Cabri to compile a masterful successor volume to the *CIM Special Volume 23* that he edited over twenty years ago (Cabri 1981, reprinted in 1989).

The present volume is welcomed for a number of reasons, but before elaborating on these, some particulars about the book are warranted. Twenty-six papers are included in this mammoth 852-page work, written by 61 authors and coauthors from 10 countries around the world, most, but not all of whom are from PGE-producing countries. In his Preface (which by the way provides a useful summary of the book and its formulation following from the 8th International Platinum Symposium held in Rustenburg, South Africa, in 1998), Cabri makes the point that the volume offers, for the first time, a truly international collection of contributions from authors in both western and eastern affiliations. Western geoscientists can now gain an appreciation of PGE occurrences hitherto accessible only in the Russian and Chinese scientific literature. Not only this, but the volume's contributing authors are drawn from a wide spectrum of backgrounds. Included are thirteen senior authors from academia, nine from industry, and four from governmental organizations. The inclusion, at the end of the volume, of brief biographies of all the authors demonstrates that these contributors are among the most knowledgeable in the fields of PGE geology, mineralogy, geochemistry, and the beneficiation and metallurgy of PGE ores.

The list of 26 papers is arranged in three groups. The *First Group* comprises contributions on Analysis, the Platinum-Group Metals, Phase Chemistry and Geochemistry. The *Second Group* deals with PGE Ores and PGE Mineralization, and the *Third Group* of papers include those on Beneficiation and the Metallurgy of PGE Ores.

In a review of this nature, it is difficult to provide a summary of the wealth of information provided in each paper. Overall, the book provides a massive amount of detail, not only on PGE mineralization and PGM mineralogy, but also on the geological setting and character of numerous geological environments, and on the mafic-ultramafic complexes that act as host to most of the world's platinum–palladium deposits. Following the Preface, the first six papers of the first group provide comprehensive reviews for analysts, mineralogists, phase-equilibria enthusiasts, and geochemists. Cabri's personal contribution on *The Platinum-Group Minerals*, which amounts to 118 pages of the text, has to be singled out as a review of encyclopedic proportions. He lists a total of 109 platinum-group minerals, each dealt with separately, and including ideal formula, definition, crystallographic data, X-ray powder-diffraction data, physical and optical properties, reflectance data, some electron-microprobe data, and information on locality and occurrence.

The next 17 papers make up the second grouping and cover aspects of PGE mineralization in magmatic and volcanic settings around the globe. In all of these papers, the geological aspects alone are absorbing and should provide the exploration geologist with many ideas for developing target-selection strategies. Succinct summaries are given of many of the host geological environments in which PGE mineralization has been recorded, including well-known producing regions such as the Bushveld Complex, South Africa, and Noril'sk, Russia. Lesser-producing regions for which geological descriptions are provided include Sudbury and Lac des Iles, Canada, Stillwater, U.S.A., and the Great Dyke, Zimbabwe. Exploration in recent years has begun focusing on other potential PGE mineralization, and descriptions are provided of PGE showings in places as far afield as northern Finland, the Kola Peninsula, China, Canada (Coldwell Complex, Ontario, the Fox River Sill and Bird River Belt, Manitoba), the U.S.A. (Alaskan-type complexes and the New Rambler occurrence, Wyoming), and the North Atlantic Igneous Province (Skaergaard, East Greenland and Rhum, Scotland). Mostly, these occurrences are in mafic-ultramafic igneous complexes, but descriptions are also given of occurrences associated with Archean and Proterozoic komatiite-hosted Ni–Cu–PGE deposits. Described last are PGE placer deposits of the type spatially associated with ultramafic-mafic complexes of the "Alaskan" type, in tectonic belts like those of the North and South American Cordillera and the Ural Mountains.

In the third group, the final three papers in the volume are directed toward beneficiation and processing (extractive metallurgy) of PGE and PGE–Ni–Cu ores, the first in the Noril'sk–Talnakh region of Russia, and the second on the PGE ores of the Bushveld Complex in South Africa.

Although I have never personally studied PGE deposits, despite having the Bushveld Complex only 50 km north of my office at the University of the Witwatersrand, in Johannesburg, I have taken a great interest in Bushveld-related geology over the years. The recent explosion of exploration activity and increased mining activity in this unique layered intrusion have also been followed closely, and many staff and students at Wits University are currently involved with Bushveld-related research. My own interests, in contrast, have led me to examine Archean layered ultramafic complexes (where, as yet, there is no recorded PGE mineralization). Hence I have become familiar with mafic-ultramafic intrusions and the specialized literature on igneous intrusions. I can therefore unhesitatingly recommend the new Cabri volume as the obvious starting point for anyone (and this includes seasoned exploration geologists, academic researchers, metallurgists, geochemists and students) wishing to gain an understanding of the issues relating to the nature and geological location of Pt–Pd mineralization. The papers in this work supply excellent overviews, and comprehensive lists of references provide additional reading for those seeking further details.

In summary, this volume is, in my view, an outstanding reference work on a range of topics on PGE geology and mineralization. An impressive amount of data is easily accessible in a single reference work that is well written, well illustrated and well structured by an editor and contributors who have clearly devoted an enormous amount of time and effort to sharing their knowledge and experience, thereby ensuring that the final product will remain an enduring encyclopedic reference for years to come.

Should any endorsement be needed concerning the merits and scope of the CIM Special Volume 54, the reader is referred to two other recent reviews of the latest Cabri volume. The first is a comprehensive review by A.J. Naldrett (Nov. 2002 issue of *Economic Geology*, Vol. 97, No. 7, p. 1609–1612), who dissects the volume paper by paper, and in so doing draws attention to some of the issues that enthuse petrologists and geochemists in particular. A further review by B.R. Lipin is available online in *Mineralium Deposita* (Springer-Verlag, 20 February, 2003). Both these reviewers unanimously agree (and I concur) that no one interested in the subject can afford to be without a copy.

Carl R. Anhaeusser, Professor Emeritus
Economic Geology Research Institute
School of Geosciences, University
of the Witwatersrand,
Private Bag 3, P.O. WITS 2050,
Johannesburg, South Africa

Applied Mineralogy in the Mineral Industry. By W. Petruk. Elsevier, Available from Amsterdam or New York, 2000, 268 pages, hardbound, (17 × 24.5 cm). $US154.50, €133.87. ISBN 0–444–50077–4.

This book was written to share what Dr. Petruk had learned "… about the role, applications and benefits of applied mineralogy" since 1960, when he joined the Mineralogy Section of the Mineral Sciences Division at the Mines Branch, Department of Mines and Technical Surveys in Ottawa. At that time, besides expertise in identification and measurement of ore minerals by reflected-light microscopy, mineralogists relied heavily on X-ray diffraction as a determinative technique; consequently, two crystallographers worked closely with the mineralogists in what became arguably the best-equipped mineralogical laboratory in Canada during that period. However, as Dr. Petruk relates, an "… evolution in applied mineralogy related to processing began in the mid 1960's ". This evolution, proved in fact to be a revolution, due to the advent of the electron microprobe, which permitted mineralogists to accurately determine compositions without having to extract small quantities for X-ray diffraction or larger amounts for bulk chemical analyses. Because one of Petruk's primary roles was to work closely with the Mines Branch's mineral processing engineers, he developed a keen interest in measuring physical aspects of minerals, such as size, and was aware of the development of the QEM*SEM image analysis system in Australia for determining mineral quantities and liberation. Thus Petruk, together with Paul Mainwaring (who had an electron-microprobe operator's background) in the Mineralogy Section, subsequently developed a less expensive and more versatile SEM-based image-analysis system. The application of this system, combined with the expertise and innovations of others in the Mineralogy and Crystallography Sections, made the Mines Branch (now CANMET) widely known in the field of applied mineralogy over a period of about three decades.

The book is divided into ten chapters, followed by a reference list, and by subject and mineral indices. Chapter 1, on "General Principles of Applied Mineralogy", begins with techniques for the characterization of minerals and synthetic phases, and lists the different types of equipment that can be used to accomplish this. The mineral characteristics to be determined are listed, leading to minerals and trace elements in four different ore-types: base metal, tin–tungsten, porphyry copper, and iron ores. The descriptions of minerals in base metal, porphyry copper, and iron ores are repeated in Chapters 3, 7, and 8, respectively. This section is followed by discussions on mineral quantities, size distribution, mineral liberation, textures, mineral associations, and the search for rare minerals.

Chapter 2 consists of brief overviews of "Instruments for Performing Applied Mineralogy Studies". These instruments are discussed in the following order: a) Optical microscopes; b) X-ray diffraction (referred to as "diffractometer", although Debye and Gandolfi cameras are included but not identified *per se*. No mention is made of the Rietveld method for quantitative analyses); c) Scanning electron microscope (SEM) with energy dispersive spectrometer (EDS) (contains a useful table of average atomic numbers for selected minerals, but no mention of pitfalls due to overlapping X-ray peaks) and electron microprobe; d) Proton-induced X-ray emission (PIXE) analyses, wherein PIXE analyses, which are performed in over 200 laboratories, are not differentiated from micro-PIXE. The latter is more specialized and requires a mineralogically useful sample chamber. This is important because the statement referring to "The PIXE …" on page 37 is misleading; e) Secondary ion mass spectrometer (SIMS) and time-of-flight SIMS (ToF–SIMS); f) Laser ionization mass spectrometer (LIMS) and ToF–LIMS; g) Cathodoluminescence, including from the literature a list of minerals with their cathodoluminescent colors; h) Infrared spectroscopy, and i) Image-analysis systems are discussed at length. However, Petruk does not clearly identify the CANMET system *per se* (it is described as MP–SEM–IPS on p. 15), nor does he directly compare the speed and higher resolution of the MP–SEM–IPS with that of the QEM*SEM. Not mentioned is the "black box" type of configuration for the QEM*SEM, which is suitable for production-line analyses of an individual ore-type, whereas the MP–SEM–IPS can accommodate programming measurements for different ore-types.

Chapter 3 is devoted to the mineralogical characterization of volcanogenic massive sulfide ores, particularly those of the Bathurst–Newcastle area, New

Brunswick. This chapter gives a good account of the complex mineralogical characteristics of these ores and their impact on mineral processing. Applied mineralogical study by various groups of workers over the period 1977 to 1994 led to greatly improved understanding of the behavior of these ores during processing.

Chapter 4 is a case study in which the mineralogy of volcanogenic base metal deposits in the Flin Flon – Snow Lake areas of Saskatchewan and Manitoba is described. Descriptions of the ores and their mineralogy are followed by the results of applied mineralogy of samples from the Trout Lake concentrator. These results were obtained mainly by image analysis, together with some SIMS analyses of pyrite and arsenopyrite.

Relationships between mineral characteristics and floatability are described in a relatively short Chapter 5. Three chalcopyrite products are examined to explain the flotation test results, and one case study is used to examine the reason for low pentlandite recovery in a serpentine-rich ore from the Birchtree deposit, Manitoba.

Chapter 6, devoted to the applied mineralogy of gold, begins with a description of gold mineralogy, followed by descriptions of textures and microstructures of gold mineralization. This section is followed by a rather disjointed description of some types of gold deposits. A rather too brief section follows on characterizing gold ore with respect to processing; included are some recipes describing different procedures. Next, processing gold ores is focused on the description of four different types of gold deposit under the heading of "heap leaching", concluding with bioleaching. The final section in this chapter is devoted to case studies of two Canadian deposits.

Chapter 7 is devoted to porphyry copper deposits, beginning with the characteristics and mineralogy of these deposits. There follows a discussion of applied mineralogy related to mineral processing. Suggested procedures follow those described earlier for other types of ore. This section concludes with a brief discussion of the identification of ore minerals, stressing both the difficulty of distinguishing various gray minerals under reflected light and the two different approaches that may be taken to distinguish the minerals when using SEM-based image-analysis systems.

Chapter 8, "Mineralogical Characteristics and Processing of Iron Ores", is limited to detailed descriptions of some investigations of iron ores from the Labrador Trough (Newfoundland and Labrador) and Quebec, as well as the Minette-type oolitic sedimentary ironstone in the Peace River area, Alberta. Petruk provides good descriptions of the mineralogy and mineral processing, as well as case studies reflecting his personal experience and involvement in optimization and processing improvements of these ores.

In Chapter 9, Petruk discusses investigations of industrial minerals, with descriptions of particular minerals and phases such as graphite, talc, wollastonite, garnet, quartz, "asbestos", and airborne dusts.

Lastly, in Chapter 10 Petruk discusses tailings and waste rock piles, where applied mineralogy has made important contributions to understanding the oxidation reactions and remediation of acidic water drainage.

The 30-page reference list at the end of the book includes many of the author's unpublished CANMET reports. The final two sections consist of a subject index and a mineral index.

This book suffers from ineffective editing by Elsevier, in view of numerous typos. It is also clear to this reviewer that Elsevier could not have been seriously involved in assisting the author in other ways, such as by organizing the chapter to avoid duplication and by including more cross-referencing among them. Thus, most of mineralogy in Chapter 4, describing mineralogical studies of volcanogenic base-metal deposits in the Flin Flon – Snow Lake areas, and the applied mineralogical studies of samples from the Trout Lake area, could have been included in the previous chapter on volcanogenic base-metal deposits. Why, too, is bioleaching discussed under three different subheadings (pages 128, 130 and 131)? Relationships between mineral characteristics and floatability (Chapter 5) scarcely deserves a separate chapter, for they might have been included in Chapter 1, especially in view of its limited content. Unfortunately, there are no cross-references in Chapter 7 to Chapter 6, which has a general description of porphyry copper deposits (p. 121), or to the processing of the Mount Polly, Mt. Milligan, Andacolla, and Barneys Canyon porphyry copper deposits as described on p. 131 of Chapter 6.

Sadly, most photomicrographs lack a scale (Figs. 1.1a, 1.1b, 3.3 a, b (also poor resolution), 3.4 (also not focused), 6.1 to 6.4, 6.15, 6.19, 6.20, 7.1, 7.2, 8.1b, 8.2a, 8.2b, 8.3, 8.4, 8.6, 8.7, 8.8, 8.24 to 8.26, 8.40, 10.2 to 10.12) and many have poor contrast or resolution (*e.g.*, 6.7). PIXE is the acronym for proton-induced X-ray emission (not proton-induced X-ray analyzer, as given on page 1). On pages 5 and 6, it seems that the author means to refer to the Strathcona deposit, not the "Westmin" deposit (after the previous owner). The reference to Stern (1998) on page 38 is out of context since that publication refers to SHRIMP analyses, using a distinctly different instrument from dynamic SIMS (Chapter 2). In Chapter 6, there is a heading of a deposit type called "invisible gold" (which is not a deposit type) and which includes the Olympias deposit (Greece). Actually, this deposit is not a true gold deposit, but a Pb–Zn sulfide skarn (Kalogeropoulos *et al.* 1989), which happens to have significant invisible gold. Also in Chapter 6, the author refers to gold minerals as "gold-bearing minerals", which is unusual. Zvyagintsevite is listed under "Gold alloys, *etc.*", but it is a Pd mineral that in some cases contains gold, as do several other Pd minerals, not listed here. One wonders if the author is describing zoned arsenopyrite crystals from the Red Lake area (p. 119), rather than "...layered, and some of the layers enriched in gold". In Table 7.2, where he lists supergene minerals, covellite appears twice, first as CuS, then as yarrowite and spionkopite. Cubanite, a fairly common Cu sulfide in many deposits, is not included in Table 7.3, whereas rare minerals such as geerite, spionkopite and yarrowite are listed. Also in Chapter 7, it is unclear to this reviewer why a liquid of 2.96 specific gravity should be used to concentrate As-bearing sulfides, whereas a liquid of 3.33 specific gravity is indicated (p. 123) for gold ores. Although descriptions of studies of specific minerals in Chapter 9 are evidently limited to the author's direct experience, it would have been worthwhile to refer to the wide use of the PIXE technique for monitoring airborne dusts and other particulates. Description of greisen-type tin–tungsten deposits on page 6 does not appear in the index under greisen, tin, or tungsten. Yarrowite and spionkopite are not listed alphabetically in the mineral index, but occur under covellite.

Readers looking for a global overview of Applied Mineralogy will be disappointed, since this book is largely limited to Petruk's studies, which rarely dealt with world-class deposits. Some might question the "recipe"-type format used in the different chapters; this results in repetition and supplies little explanation or discussion of why different approaches are recommended. However, Petruk is commended for putting together a document describing his work in applied mineralogy during a period when important advances were made to quantification and application of the results to mineral processing. Thus, the strengths of the book include exposure to his personal views for solving problems in applied mineralogy for specific ores. The book should be in the libraries of mining companies that process the ores and ore types discussed therein, as well as those of university and government laboratories with strengths in mineralogy and mineral processing. Unfortunately, the high cost of the book might discourage individual mineralogists, mineral processing engineers, and poorly funded libraries from adding the book to their shelves.

Reference

KALOGEROPOULOS, S.I., KILIAS, S.P., BITZIOS, D.C., NICOLAOU, M. & BOTH, R.A. (1989): Genesis of the Olympias carbonate-hosted Pb–Zn (Au–Ag) sulfide ore deposit, eastern Chalkidiki Peninsula, northern Greece. *Econ. Geol.* **84**, 1210-1234.

Louis J. Cabri, Consulting Mineralogist
99 Fifth Avenue, Suite 122
Ottawa, Ontario K1S 5P5

MinIdent for Windows, version 3.00 Professional, database 1.0. By Dorian G.W. Smith and Michael D. Higgins. Micronex Mineral Services Ltd., 4356–148 Street, Edmonton, Alberta T6H 5V5. 2003. One CD–ROM.

Preamble

The geography of my office, and quite possibly yours too, reflects not only a diversity of interests but also the passage of the years and the staggering growth of the literature of science. I might well argue that with no more than 5 to 30 well-chosen books, a mineralogist is well prepared to tackle the identification of rocks and the minerals of which they are composed. For common, or distinctive, or particularly well-developed mineral specimens, no more than a hand lens and microscope are needed. However, the well-documented rise in the number of accredited mineral species makes it inevitable that now and then, one will encounter a mystery species, whether in thin section, or crystal-lined vug, or a sand-grain-sized sample. The evolution of microprobe technologies, since their inception in the mid-20th century, has probably been the greatest driving force in the flood of new mineral descriptions. Personal computers are also a mature technology, the CD–ROM is the preferred method of data storage and dissemination for many users and publishers, whereas Internet-hosted methods of distributed data-sharing are still at an earlier stage of development. The availability of compilations of mineral data on CD–ROM is, at least potentially, a key component of the Earth sciences "toolbox".

The production of a database may start innocently enough, and some of them are pleasingly finite: a virtual periodic table of the naturally occurring elements has been static for years. But others have no obvious end: bibliographies, active museum catalogues, and anything for which a new day or year invites a new record of one or more phenomena. The larger annotated bibliographies, such as *GeoRef*, are one source of mineral data, but commonly indirect, necessitating a trip to the library to find, or at least verify, the essential facts. The world's premier catalogue of meteorites, still a paper product, is also available as a CD–ROM. In terms of systematic mineralogy, the current offerings vary from compilations of photographs to gazetteers to expert systems aimed specifically at mineral identification. Enter MinIdent–Win, the principal topic of this review.

MinIdent–Win

The MinIdent project was initiated in 1980. The originator is Dorian Smith, a practicing mineralogist and meteoriticist, a professor at the University of Alberta in Edmonton. The utility of the database has been described in a number of publications (*e.g.*, Smith & Leibovitz 1986, Goble & Smith 1988). Mineralogists *in the know* have long used various releases of MinIdent, but the DOS-based versions used a rather arcane system for data entry and *matching* (the preferred MinIdent term for the comparison of user-entered properties of an unknown mineral with all or part of the MinIdent database). Past users will note that the new Windows interface (MinIdent–Win, but hereafter referred to simply as MinIdent), engineered by Michael Higgins of the Université du Québec à Chicoutimi, is more intuitive than its predecessors.

MinIdent is essentially a compilation of published data on real samples, as opposed to a collection of theoretical, ideal compositions and physical properties. It currently contains 5,505 records on minerals, totaling 5,138 discrete species. The latest compilation is said to be based on 604,427 data items, 19,041 sample records, 9,528 general records, 2,353 synonyms, 596 sets of hand-specimen data, and 601 high-resolution images (each with its own thumbnail image, which speeds download of Web-based subsets of the database).

The database lists the physical and chemical properties, plus sketchier data on mineral localities and the original literature, for every known mineral species. The interface is easy to use, with immediate access to a taxonomic "tree" structure of 64 mineral groups. Some of these groupings are very large, silicates being an extreme example, and the tree branches conveniently into small, more closely related groups of minerals, such as cyclosilicates. Scanning a few of the mineral families, it is both instructive and intimidating to note how many of the species are "um" (unnamed mineral) forms with year and serial numbers, *i.e.*, species noted but not fully authenticated and approved by the International Mineralogical Association, particularly in the case of ore minerals. Many unnamed mineral species are represented: of 120 tellurides, a scary 68 are in the "um" category. The "um" clan are also abundant in other classes, including silicides, arsenides, antimonides and selenides.

Mode of Use

So, how does it work? To my way of thinking, there are two principal modes of operation for a database such as MinIdent. It can be used to zero in on the identity of a mystery mineral, and it can be used as an encyclopedia, a convenient warehouse of information on a particular mineral group or species.

The program installs itself from CD–ROM, taking 10 minutes to load the full version, images included, onto the hard disk of a Pentium–II computer. An icon on the Windows desktop makes for ease of access. The contents of the full version occupy 104 MB. During operation, a variety of temporary files generate files that sprinkle the desktop (visible only when the program is minimized), disappearing when MinIdent is closed. The "family tree" of mineral species makes access to a particular mineral group very simple. Individual minerals are easily retrieved. The database contains hand-specimen properties for almost 600 of the more-common minerals. Identification can be conducted by hand-specimen properties alone or in conjunction with instrumental data (such as optical, XRD or microprobe results). The data are arranged under four broad headings: optical and structural properties, chemistry, physical and other properties, and hand-specimen characteristics, often with additional pages of notes and images, 4–6 pages of text and data for each mineral. There are two methods of searching for the identity of a mineral, MATCH (which is fast, seeking exact values for parameters that the user has determined, and usually delivers a few possibilities, or no name at all) and IDENTIFY (which is slower, evaluates each parameter over a given range, and incorporates ranking algorithms to give the best candidate minerals a "score" out of 1,000, delivering a list of possible fits beginning with the best apparent fit); the chemical data should not be listed too precisely, lest unusually high or low values confuse the matter of identification.

Minerals can be sought by typing the first few letters alone, producing a list of both approved names and synonyms (which are flagged as such). Three levels of on-screen help are available. There is currently no users' manual, but some of the relevant on-board help can be printed, and some of these may eventually be compiled as a manual file that could be printed if required.

There are linkages between related fields, as between optical properties and crystal symmetry. There are cut, paste and print facilities to make Windows users feel at home in a way that was not possible on the precursor MinIdent– PC. Users can create and to some extent integrate their own collection and research databases and images with the program, a feature I have not yet had time to test.

Microanalysts, particularly the operators of electron microprobes and microscopes, will enjoy several features of MinIdent–Win. These include a) the ability to configure probe-data files to input for automated identification, b) the average atomic number (Z) is listed for each mineral, facilitating interpretation of grey scales on back-scattered electron images, and c) some data are provided for reported cathodoluminescence in minerals.

When wearing my "applied mineralogist" hat, I commonly have a visual compilation of optical properties for a mineral in polished section, and in some cases, particularly ore minerals, some basic checks on the major-element composition, as provided by a glance at an energy-dispersion X-ray spectrum. With a little practice, it is possible to input chemical constraints to MinIdent without having results of a quantitative analysis. For a given mineral family, one can choose to scan the "family tree", or conduct a search using fragments of formulae (one way of finding 357 carbonates, for example).

Quality of the Product

The images differ in their impact, depending on the species involved. Hand specimens are featured where possible, and in some cases of rarer minerals, there are photomicrographs. I think that the four of graphite and two each of native gold, zircon and sodalite work very well, but the four for quartz feature the species of interest more as a matrix for other minerals. A nice feature, additional to a descriptive caption of each full-size image, is a searchable keyword field. This can be useful for teaching purposes, *e.g.,* 22 images of minerals with acicular habit, including a splendid acicular malachite on goethite from Bisbee, Arizona, or 13 images with botryoidal samples. The image keywords produce a few "hits" on some of the more famous localities, but the search is capricious, *e.g.*, Mont Saint-Hilaire (5 images), Nanisivik (3), Tsumeb (4), but none for Noranda, Timmins or Hemlo.

Some of the ranges for minor elements look rather extreme, a matter that can only be resolved by returning to the original literature: two minerals with high minor-element maxima are corundum and pyrite. Possibly some of the older data on crushed mineral separates may pertain to discrete mineral inclusions (rutile, hematite, *etc.*) and attached gangue (especially silicates) in cases such as corundum.

The resources include one or more citations for each mineral. These are presented in abbreviated form, such as a journal name, volume number and page. Clicking on the reference section brings up an alphabetical list of principal sources for the data in MinIdent. Although the database is not intended as a bibliography, this is clearly an aid to further research.

Errors

In a database of this size, mistakes of every form are just about inevitable, from trivial "typos" to more insidious numerical errors. I found a number of errors, omissions and inconsistencies while examining the beta-test version of MinIdent–Win in March 2002. The question of omission will not be pursued here, as there will always be omissions in works such as this, until the end of time! I'll just point out one error, new to me, as an example of the myriad tiny slips which are possible in a compilation as ambitious as this one. A plausible composition for verbeekite ($PdSe_2$) is given in weight percent. A simple mouse click should convert the on-screen values to atomic proportions, but this does not happen on my test version, although it works fine for umangite, another selenide. The reason is that the basis for calculation is listed as two atoms of *sulfur* instead of *selenium*, and so the calculation cannot proceed. Now the Micronex web site (see below) should in due course host a users' group. If the users develop a strong liking for the product, hopefully the feedback to the compilers will in time eliminate most of the remaining errors. Granted, it is very hard to spot most numerical errors unless one is working in detail on a given mineral, but the error level in the latest MinIdent–Win appears low, and certainly did not interfere with my enjoyment of the database.

Availability

MinIdent is available from Micronex, www.micronex.ca, fax (780) 430–7873, e-mail micronex@compusmart.ab.ca. MinIdent–Win will be fully upgradeable *via* the Micronex website, which is currently (February 2003) under construction. The international release prices are US$299 for the full Professional Edition, US$149 for the Collector's Edition (which lacks the unnamed minerals) and US$99 for the Student Edition (a 4-year license).

Other Products

A number of mineral glossaries are available *gratis* on the Internet, mostly related to serious mineral dealers. These can be handy for quick checks on the nature of a mineral, but in no way compare with the detail in MinIdent. The latter is billed as "the world"s leading software for mineral identification". There are a number of alternative products available, and I have time here to briefly examine but one, MDAT–Lite, a streamlined version of the larger *MDAT*. Other products include *Mineral*; the *Fersman Museum mineral database*, available from Excalibur; and the Los Angeles Museum's *Photographic Guide to Mineral Species*.

MDAT–Lite 4.1. By Alexander R. Hölzel, Matident e.K., Ulmenring 11, D–55270, Uber-Olm, Germany. 2003. One CD–ROM.

MDAT–Lite 4.1 is another mineral database available on CD–ROM, and the parent MDAT product has, like MinIdent, been around for a long time. However, the focus is more bibliographic than MinIdent, and thus in principle a complementary product more than a direct competitor. The database stems from the author's Systematics of Minerals book (original edition: Hölzel, 1989), which is still available. Operating under Windows, MDAT–Lite is based upon the AskSam database management system (version 3.0g). It loads easily onto hard disk, occupying some 34 MB of space and requiring 4 MB of RAM. It contains 4,452 records, including 4,083 named, recognized mineral species. The bibliography of 84,000 records is a significant attraction. The 4.1 version also includes 900 crystal drawings.

Four search modes are provided, with a choice of an index, a free-form search line, pre-programmed searches and Boolean operators. The program is fast, and very simple to use in the "encyclopedia" mode alluded to previously. The search-line can be used to search for any data in any record, including localities, so queries such as "Tsumeb and Ge and Cu" will instantly zoom in on very specific linkages, provided the question is formulated correctly. There are indeed many more references than in MinIdent, although because they are in abbreviated formats similar to MinIdent, there is no easy way to know which of many references might be most useful. One exception: additional information is commonly provided for the first description of a new mineral.

MDAT–Lite is available from Matident e.K., www.matident.com, fax 011–49–6136–88970, e-mail hoelzel.mineral@t-online.de. Price inclusive of shipping: for commercial users the rate is €179 in the E.U., €162 (currently CAN$263) elsewhere, whereas for private use, the discounted rate is €73 in the E.U., €70 (CAN$114) elsewhere.

Conclusions, and the Future of Mineral Databases

MinIdent–Win is an excellent source of mineralogical data. As a one-stop source for technical data on discrete mineral species, it surely sets the standard to follow. If a more limited repertoire is all you need, or if you are mostly interested in following the literature, MDAT–Lite may be your choice. Just about anyone with a professional or hobby interest in minerals could use these databases: Earth-science professionals and materials scientists of many disciplines, as well as mineral dealers, collectors and prospectors.

What next? A feature that I would like to see in the next version of MinIdent–Win is a "virtual Kerr". By that, I hark back to the time when the works of Pough, Kerr and Deer *et al.* (or some equivalent set of reference works) answered most of your questions. In practical terms, I would like to see a synonymy built into the data structure, so that instead of providing quantitative measures for properties such as index of refraction, say, one could start with the simple visual observation: low, medium or high relief. Birefringence is one of relatively few optical properties that can be readily quantified by inspection, and with some confidence if a number of grains are available for comparison. The data are already entered and checked: enhancement of the software should enable questions such as "length-slow, high relief, pinkish brown, very high birefringence, so...(?)" be interpreted by the software (which would have to define some arbitrary boundaries, such as that between low and medium relief). The appearance of minerals, most famously the color of ore minerals in reflected light, is of course due in part to intangibles: the host minerals to the grain of interest, the light source used, a greasy lens surface.... Perhaps this is why MinIdent prefers the quantitative; no doubt the resolution of this question is not as easy as it seems.

The pricing of these databases is reasonable, considering the amount of work they represent, from initial design through compilation to the engineering of the publishable (or web-resident) versions. Consider the papery alternative. Most of my immediate questions in applied mineralogy and petrology can probably be answered by no more than 25 books (to save space I have posted them at *http://www.turnstone.ca/petworks.htm*). The set of 25 books, if you can find them all, would be a bargain at CAN$1,000, which is still more than any two mineral databases that I'm aware of.

The list of books in itself raises a further question about databases in general. *Download it soon*. I plan this to be a long-term document, like most of the material on my web site, but the bottom line is that most web sites are probably no more permanent than their authors, which perhaps is how it should be. There are already Internet archiving systems at work, and it is easy to envision new kinds of cyber-editors, collecting and evaluating all materials posted on a certain well-defined subject area, and saving copies for the long term. Meanwhile, keen mineralogists will benefit from the appropriate versions of MinIdent–Win, MDAT and other such products that we lack space to review here. *Chacun a son gout.*

Compilation and quality control of databases as large as MinIdent and MDAT represent an enormous amount of work. Maybe, as with books, one can never have too many of these things! If they are well-compiled, they should be published. In this digital age, illustrated catalogues have never been easier to marshall, imprint and disseminate.

References

DEER, W.A, HOWIE, R.A. & ZUSSMAN, J. (1966): *An Introduction to the Rock Forming Minerals*. Longmans, London, U.K.

GOBLE, R.J & SMITH, D.G.W. (1988): MinIdent: an application to the identification and classification of amphiboles. *Mineral. Petrol*. **38**, 213-227.

HÖLZEL, A.R. (1989): *Systematics of Minerals* (1st ed.). Systematik in der Mineralogie, Ober-Olm, Germany.

KERR, P.F. (1959): *Optical Mineralogy* (3rd ed.). McGraw–Hill, New York, N.Y.

POUGH, F.H. (1970): *A Field Guide to Rocks and Minerals* (2nd ed.). Constable, London, U.K.

SMITH, D.G.W. & LEIBOVITZ, D.P. (1986): MinIdent: a data base for minerals and a computer program for their identification. *Can. Mineral.* **24**, 695-708.

Graham C. Wilson
IsoTrace Laboratory
University of Toronto
Toronto, Ontario M5S 1A7