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BOOK REVIEWS

Emeralds of the World. Edited by G. Giuliani, M. Jarnot, G. Neumeier, T. Ottaway, J. Sinkankas and G. Staebler, English edition. Lapis International LLC, P.O. Box 263, East Hampton, Connecticut 06424, U.S.A., 2002, 99 p. US$26 + $3 shipping to non-U.S. addresses, soft cover (ISBN 0–971–5371–1–9).

In this second issue of *extraLapis* English, leading researchers provide insights into diverse intriguing aspects of the world of emeralds. Thanks to the late John Sinkankas, who was prevailed upon to assist in editing this volume, and to whom this issue is dedicated, the stamp of perfection is patently evident. In consequence, a very high standard indeed has been established with this publication.

The first 78 pages of *Emeralds of the World* provide an informative and elegant account of: etymology (Christa Behmenberg), museum pieces (Zak Swartz), mineralogy (Rupert Hochleitner), origin (Dietmar Schwarz, Gaston Giuliani, Guenter Grundmann and Maximilian Glas), notes on global occurrences, including Australia and Europe (Guenter Grundmann and Gaston Giuliani), Columbian, Brazilian and Asian emeralds (Dietmar Schwarz and Gaston Giuliani), African emeralds (Jan Kanis and Dietmar Schwarz), and American emeralds (Michael Wise). The last 20 pages deal with gemology (Dietmar Schwarz), defining emerald (see below), the age-old gemstone topic of emerald treatment (Lore Kiefert), the four R's of mineral specimen enhancement (Marc L. Wilson), emerald synthesis (Karl Schmetzer), the complex issue of emerald pricing (Marisa Zachovay), and a brief note on the "cut" named for emerald (Patricia and Michael Gray).

According to *Emeralds of the World* (p. 22), it matters not if you disagree with the Gemological Institute of America's definition of emerald as "...a variety of the mineral beryl ($Be_3Al_2Si_6O_{18}$), which has the following characteristics: light to very dark green to strongly bluish green to slight yellowish green. Stones with a colour too light, desaturated, or yellowish to be called emerald would be considered green beryl". It seems that other experts, among them New York specimen dealer Laurence H. Conklin, Dietmar Schwarz of Switzerland, and Karl Schmetzer, Germany, likewise consider that definition impractical, and correspondingly provide alternative perspectives. It seems that the ultimate responsibility for deciding whether a particular beryl is an emerald rests with the individual. Empirically, it seems that there is no way to satisfactorily measure the definitive color saturation.

Impossible as it has been for this reviewer to select highlights of this volume, the *collector approach* (based on their appearances) to the classification of emerald deposits, with geological profiles sketched and described by Guenter Grundmann (p. 22-65), provides an invaluable centerpiece. As a result, *Emeralds of the World* provides a spectacular abbreviated glossary of many of the world's significant emerald-producing deposits. These include, of course, selected localities in Columbia (with 60% of the world market, still the top producer), Brazil, Africa (Egypt, Nigeria, Tanzania, Mozambique, Zambia, Zimbabwe, South Africa, and Madagascar), Asia (Pakistan, Afghanistan, and India) and, last but not least, emeralds of North Carolina, U.S.A.

With 20% of the world's production, Africa ranks as the world's second richest emerald- producing continent, this despite unstable political and economic situations in countries like Madagascar, Zambia and Zimbabwe. I was interested to learn that emeralds from Sandawana mine, Zimbabwe, at 2.6 billion years of age, are among the oldest known. In Zimbabwe, the type of mineralization falls into the category of "Pegmatite and Greisen with Schist"; more specifically, the emeralds occur in pegmatites and phlogopite schist. Younger by far are the emerald localities of Columbia, where apparently 135 Ma ago an inland sea engulfed what are the present-day emerald districts of Columbia. These types of deposits fall into the category of "Black Shales with Veins and Breccias". The presence here of emerald in vugs together with carbonates, pyrite, and albite obviously stands in strong contrast to Zimbabwe emerald. To suggest that Columbian emerald has a special character would be a classic understatement. Further to the numerous gemmological features that distinguish Columbian emerald, it seems that in at least one district, emerald occurs in a black shale horizon as pseudomorphs of calcitic gastropod shells. Seeing is believing! At least as remarkable is the fact that since the Spanish conquest, there evidently have been only a few insignificant new deposits discovered. Stated otherwise, the nearly 200 emerald localities in Columbia were practically all known well before the 16th century conquest.

In relation to almost any other mineral species, emerald, whether Columbian or not, is the most expensive stone, a result perhaps of simple supply and demand. This “king” of the beryl family forms under totally different conditions than other varieties of beryl. Nor, by comparison with other types of beryl, are emeralds particularly noteworthy for size. However, in price they are right up there with the finest colorless diamond, for a superior-quality emerald may exceed US$15,000 per carat (200 mg of stone). Marisa Zachovay reports that the highest price ever paid for an emerald was at Christie’s in Hong Kong on May 2, 2000, when US$1,149,850 was paid for a 10.11 carat Columbian stone set in a ring. Bigger in this case is obviously better, and green is glorious. Pliny had it right over 2000 years ago when he promoted emerald-green as the most beautiful color of all. Across the pond, Cleopatra doubtless echoed his sentiments, for in Egypt’s western desert, some of the earliest emerald mining is believed to have taken place. Indeed, since prehistoric times, emerald seems to have been one of the most highly valued gemstones.

Emeralds of the World is a thoroughly delightful read. Unbelievably easy on the eyes, it scores on all counts: indexing, layout, presentation, text, illustrations, and referencing. This is a valuable collector’s issue. All things considered, extraLapis 2 is a beautifully packaged and richly balanced work of art.

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Das große Lapis Mineralienverzeichnis (fourth edition). By Stefan Weiß, Rupert Hochleitner and Hans-Jürgen Wilke (2002). Christian Weise Verlag, Orleansstraße 69, D-81667 München, Germany. 287 pages (ringbound) + 42 pages (softbound). ¤19.80 + postage. ISBN 3–921656–17–6.

The contents and format are similar to the first edition, reviewed in *The Canadian Mineralogist* **29**, 599-600 (1990), and to the third edition, reviewed in *The Canadian Mineralogist* **37**, 781-782 (1999). The advertisement claims over 2,000 additions and corrections. About 200 new minerals and a few old varietal names have been added. For instance, Rosaquarz is differentiated from Rosenquarz. The white space at the end of each letter has been eliminated (a good decision), so that this section of the book is only two pages longer. Many typographical errors in the third edition have been corrected; however, the incorrect spelling of “Uytenboogardt” survives on page 153.

Rather than a 15-page overview of the chemical-crystallographic classification as an appendix, a separate booklet is given. The advantage is that one can look at the data in the ringbound volume at the same time as the classification list. A separate number is given for every mineral, in contrast to Strunz & Nickel (2001), who only give a number for each group. The classifications are different. For instance, Strunz & Nickel (2001) classify arsenic as an element (group 1), whereas *Lapis* classifies arsenic as a sulfide (group 2). Personally, I think this classification has outlived its usefulness, and a crystallographic classification like PSC–H should be used.

Hypothetical IMA-approved minerals such as aluminotschermakite and ferriferrotschermakite are included (occurrence too high for an imaginary mineral). A few minerals with polytype symbols (heterogenite and zirconolite) are given as separate entries; however, all polytypes (structural variety) with individual names, such as orthochamosite, are given. Some chemical varieties are given, such as the intermediates (albite to anorthite) in the plagioclase series. Most polymorphs (mineral species) are given as a separate entry, except *P*-veatchite, gersdorffite-*Pa*3, gersdorffite-*P*213, and gersdorffite-*Pca*21. Joesmithite is left out of the ringbound volume, but remains in the softbound one. The reason given for this selection is that no mineral collector can identify these minerals without an X-ray diffraction determination.

Polytype symbols are not given in italics as required by IMA, and Tc has been used instead of *A* for the triclinic (anorthic) system, except for page 6. The polytype symbols on page 6 do not show any numbers as subscripts as required by IMA. An explanation of the polytype symbols is needed in the introduction.

The trigonal system is based upon a three-fold rotation axis as an essential element of symmetry, whereas the rhombohedral Bravais lattice is based upon a point translation. They are not identical as stated on page 6. The structural varieties of analcime and lazurite caused by order–disorder and incommensurate structures, respectively, are not polymorphs as claimed on page 6.

Some common chemical (*e.g.*, ferro, magnesio) and crystallographic (*e.g.*, klino, para) prefixes are hyphenated from the rest of the mineral name. A mineral name cannot be subdivided. A hyphen (ASCII-45) is computer sorted before a (ASCII-97), so that the alphabetical order is distorted. For instance, paraumbite would appear on page 197 rather than page 194. A hyphen uses one extra character, which is important in a book of tabulated names. Therefore, these hyphens should be deleted.

A second entry has been made for some entries to give diacritical marks; however, in the case of černýite, rosickýite and zýkaite, the names have been misprinted as Ceryn, t, Rosick, it, and Z, kait. The ASCII character 143 "Å" should be used rather than ASCII character 97 "*A*" with halloysite, since the Å represents Ångströms (distance) rather than the *A* for anorthic (triclinic system). Natrium-meta-autunit is used rather than the IMA approved metanatroautunite. Potassium-Alaun is an English–German mixture.

Most group names are given; however, orthopyroxene is given but orthoamphibole is not. Other missing groups include feldspathoid, pyribole, pyroxenoid, and thiospinel. For group names, a classification number should have been given so that the reader could go directly to the softbound volume. Celsian is classified as an alkali feldspar on pages 82 and 126; however, Ba is an alkaline earth.

Algodonite, Cu_6As, and allargentum, Ag_7Sb, have only two crystallographic sites, so that the formulae are misleading. Members of the kaolin and serpentine groups have a 1:1 layer structure in contrast to the chlorite family, which has a 2:1:1 layer structure. The formulae of the kaolin- and serpentine-group minerals have been doubled to look like the formulae of the chlorite group, which is wrong. The formula of sanidine is similar to microcline, so that it is not possible to ascertain that the Si–Al are disordered in sanidine.

Many minerals in the thiospinel group have been given valences based upon ionic bonding; however, these minerals have metallic bonding, so that these numbers are wrong.

Although written in German, the English-only reader will be able to understand the tabulated data. The professional mineralogist may be disappointed; however, the amateur mineralogist will find this inexpensive book very useful.

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Tropical Glaciers. By Georg Kaser and Henry Osmaston. Cambridge University Press (International Hydrology Series), 2002, xx + 207 pages, with map in pocket. US$110. ISBN 0–521–63333–8.

Mineralogists awaken! We need better PR. Perhaps we can learn useful techniques from the Quaternary geologists. They've been resiliently successful for a long time. In the 19th century, they electrified the public with the then brand-new notion that much of North America and Europe were covered in the not-too-distant past by successive surges of glacial ice, kilometers thick. Reports of forests overridden by drift, frozen mammoths, and tigers in tar pits aroused universal interest. In the mid-20th century (when I was a lad), popular lectures on "Are we on the verge of a new ice age?" filled museum auditoriums. Now, at the opening of the 21st century, the quaternarists continue to capture the limelight with the subjects of global warming and climate change, and how to prod the geological record for clues to sharpen prophecies. The layman is captivated by these issues, and he (or she) reads about them with great frequency in newspapers and popular magazines, and is exposed ceaselessly to them by the electronic media. Ask someone on the street: "What are greenhouse gases", and probably you'll get a reasonably cogent answer.

We, in the mineralogical community, are lagging badly. Again, on the street, ask: "What is a mineral?", and probably you'll receive a vague response like "anything that's not animal or vegetable". Worse, perhaps the day is coming when minerals will be viewed across the board as dangerous substances (just as many folks view all chemicals as toxic). Over the past few decades, minerals have received particularly bad press: acid drainage from mine waste, smog from coal-fired power plants, radon, asbestos, and arsenic in groundwater are but a few of the dismal examples. Asbestos is an issue that rankles deeply. Certainly asbestos-removal programs, now in vogue, are not only frightfully expensive and invasive, but more dangerous in the short and long term than just leaving the stuff where it is. MAC has taken a step in the right direction with its Special Publication 5: "The Health Effects of Chrysotile Asbestos". It is now time to produce a more accessible version, perhaps beginning with "What is a mineral?", for wide distribution in secondary schools. Yes, we need to upgrade our PR!

Back to our glacial friends. How are they doing? Quite well, thank you. Recently, they've been blessed by the salient topics of global warming and climate change. Furthermore, over the past 25 years, Quaternary researchers have been endowed with two major new tools: 1) The interpretation of long ice cores, chiefly from Greenland and Antarctica, and 2) the study of glaciers found at high altitudes in the tropics. Both tools are of fundamental importance to the topics of the day, something that the quaternarists don't ever allow their readers to forget. It is the second of these two new research tools that is the subject of the book here under review. A recent article in *Science* [Ice man: Lonnie Thompson scales the peaks for science: *Science* **298**, 518-522 (2002)] offers an outline of the excitement of this field, seen through the careers of the husband-and-wife team Lonnie Thompson and Ellen Mosely-Thompson.

Tropical Glaciers opens with a short preface stressing how work in tropical highlands has often been rendered difficult or even impossible because of guerilla movements or civil wars. The preface is followed by a 12-page prologue by Georg Kaser outlining his experience with the development and artificial draining of a proglacial lake in the Cordillera Blanca of Peru. This offers a broad and personalized overview of the book.

The text is presented in three parts, the first two of which are subdivided into chapters. Part I (by G. Kaser) is titled "The nature of tropical glaciers", and opens with an introduction to tropical glaciers and where they are found: on the equator in Ecuador, within 50 km of the equator in Africa, 450 km in New Guinea, and farther afield in Peru (71% of the world total), Bolivia, Colombia, and Venezuela. The last 34 pages are the most demanding of the entire book: a quantitative (as far as is possible) analysis of accumulation, ablation, and vertical mass-balance profiles of tropical and mid-latitude glaciers. Putting aside the differential equations, one learns that tropical glaciers are distinct in that they have unique vertical mass-balance profiles, that because of an unchanging 0° isotherm (*i.e.*, an absence of winters), they undergo ablation throughout the year, they have relatively short tongues (perhaps chiefly because of their steep gradients), and they are particularly sensitive to climate change.

Part II, "Modern glacier fluctuations in tropical high mountains" (also by Kaser) opens with a chapter on the Ruwenzori Mountains, which is supplemented by the large (87 × 58 cm) glaciological map (scale, 1:100,000; contour interval, 500 feet) folded into a pocket on the inner rear cover of the book. Glaciers on Ruwenzori shrank from 6.5 km^2 in 1906 to 3.8 km^2 in 1955, and catastrophically to 1.8 km^2 by 1990. Comparison of the marvelous photographs taken by Vittorio Sella in 1906 (Figs. 6.7.2, 6.7.22, 6.8.10, 6.8.12, 6.8.14, 6.8.16, and 6.8.18) with corresponding modern images (Figs. 6.7.4, 6.7.24, 6.8.11, 6.8.13, 6.8.15, 6.8.17, and 6.8.19) reveals that thinning was just as important as areal reduction. A weak readvance may have taken place in the early 1960s, but it is poorly documented. The second chapter deals with the Cordillera Blanca of Peru, where retreat has been less dramatic than at Ruwenzori. The Cordillera is singularly inaccessible, and quantitative studies began only in mid-century. Nevertheless, glaciers there seem to have shrunk in area by no more than 20% from the 1920s through the 1990s. The final chapter of Part II treats the possible causes of glacier fluctuations (retreat, above all) in the tropics. Interpretation is hampered by the absence of long-term historical records and a paucity of reliable meteorological data. All tropical glaciers, save those in the Cordillera Blanca and those in the Cordillera Real in Bolivia, have undergone more wasting than have benchmark glaciers of the Austro-Italian Alps. Five combinations of causes (air temperature, relative humidity, cloud cover, and several other parameters) are examined mathematically. Albedo, possibly of keystone importance, was not taken into account owing to its excessively complex causes and consequences (p. 137). Physiography, also omitted, may play a key role as well. In short, different authors have attributed mass changes to different causes. In part, such discord may be amplified by poor data. Kaser concludes that a decrease of air humidity, rather than increased temperatures, has been the chief cause of retreat.

The final part covers former Quaternary tropical glaciers, with nearly exclusive focus on the East African mountains where the author, Henry Osmaston, began fieldwork more than a half century ago. Central to the subject is the determination of ancient ELAs (~firn altitudes), a task that takes into account not only temperature, but also humidity, glacier size, physiography, and other factors as well. Air photos are useful tools, but interpretations commonly vary from one physiographer to another. Fieldwork offers the most reliable guide. Part III concludes with a summary of 27 specific points.

The book ends with a single-page "prospect", followed by nine pages of references (about 450 in all) in small type, and a three-page general index.

The text is clear and reads well, enhanced by large type and well-spaced lines. Most of the figures are clear, though Fig. 4.2.3 is inadequately explained, and some of the maps (Figs. 6.1.1, 6.4.1, *etc.*) could have been improved by proper labeling and the placement of marginal geographical coordinates. In their bare-bones versions, they are hard to relate to the large map in the pocket. Ecuador is misspelled in the tables. A reworded "prospect" (p. 193) might better have been placed at the opening of the book. Finally, it is unfortunate that a table of abbreviations doesn't appear earlier than p. 149, where it is a mere footnote. Sentences like: "...such statistical tests on the ELA estimates obtained by whatever method, THAR, AAR or AABR, can show..." are daunting for the non-specialist.

In summary, this is a fine book. It is an elegant, quantitative treatment of an important subject in a field of major human concern. With its numerous allusions to global warming and climate change, it strikes the right chords (mineralogists concerned about professional PR, take note!). It is a shame, though, that the high price of this significant book will keep it off the shelves of many researchers.

Meteorite Hunter. By Roy A. Gallant. McGraw-Hill, New York, 2002, xlix + 237 pages, US$24.95. ISBN 0–07–137224–5.

Tunguska! Arguably an exceptionally bizarre natural catastrophe and "the cosmic mystery of the century" (p. xl), it grips the imagination of scientist and layman alike. The event took place in central Siberia (60°55' N, 101°57' E) at 7:15 a.m. on 30 June, 1908, when a fireball brighter than the sun and descending northwestward, exploded some 5 km above the surface with the force of 40 megatons of TNT (10^{23} ergs), felling trees over a tract of 2150 km^2 (precisely four times the area of the Island of Montreal). The blast was seen and heard as far as 700 km away. Unusual colorful sunsets followed over a period of a month throughout the northern hemisphere. The event is the subject of hundreds of scientific papers, more than 1000 popular articles, some 60 novels, non-fiction books, movies, TV documentaries, and even poems (p. 208). And yet the cause of Tunguska remains unknown. Twenty years ago, I read an engrossing book[1] in which the author proposed that the blast had been caused by the explosion of a nuclear reactor aboard an errant visiting spaceship (first proposed by Soviet sci-fi writer Alaksander Kazautsev in 1946). Other causes that have been proposed, in approximate order from the outrageous to the probable, are a laser beam fired from a distant planet, a small black hole, a pocket of anti-matter, a small asteroid, a meteor, and a comet. For up-to-date information, try the Tunguska website: www-th.bo.infn.it/tunguska, or see two recent short articles in *Science*[2].

Tunguska takes up but one of the eight chapters that make up this engaging and at least partly geological book. The first seven deal with visits to sites of young and ancient falls: Tunguska, Sikhote-Alin (an iron meteorite, 12 February, 1947), Chinge (another iron meteorite that probably fell on glacial ice, 10,000 to 25,000 years ago), the ridge in Maliy Izhat (the "type locality" of pallasite), Tsarev (80 km east of Volgograd – ex-Stalingrad – a large stony meteorite, December, 1922, of which more than a tonne of samples has been recovered to date), Popigai (a 100-km wide, 36 Ma astrobleme in northern Siberia, adjacent to the Laptev Sea, and home to suevite and "tagamite"), and Teleutskoye (site of the explosion of a stony (?) meteorite on 9 May, 1904). The final chapter, titled "Target Earth!", deals with one of the day's major non-issues (this reviewer's opinion): how to avoid NEOs (near-Earth objects). It is a love-in with monstrous technology. The book closes with six pages of references (about 80 in all), a conversion table (metric to "standard units"; the author is not Canadian), and two pages of biographical notes on the author's long and varied career. No index is provided.

All this is preceded by nearly 50 pages of other things: an eight-page foreword by Academician N.V. Vasiliev that overemphasizes the relevance for Earth of the Shoemaker-Levy-9 event (it ignores the primary significance of Jupiter's huge gravitational field), a five-page introduction by V.A. Bronshten, a 15-page preface by the author, and finally, seven pages of acknowledgements. In all, pages ix through xlix!

The author, Roy Gallant (a New Englander born in 1924) deserves praise, for despite his years, he has put down neither his pen (he is an inveterate popularizer of science), nor his boots (he is an unstoppable traveler). On the book's dust jacket, he is referred to as the "Indiana Jones of Astronomy". He deserves the appelation. His success through a decade of expeditions in the Russian wilderness is largely attributable to his "Girl Friday", Ekaterina Rossovskaya ("Katya the Remarkable", p. xxxix). This is warmly acknowledged. Not only was Katya an indispensable interpreter, but she really understood the system and got the author and those who accompanied him out of all sorts of improbable situations that are described delightfully.

Meteorite Hunter is a popular book and not a scientific treatise. Accordingly, I shall be gentle in my critiques. I gather that the accounts of the seven chapters are chronologically linear, but it is not everywhere evident. Although dates are precise (months, days, here and there even hours and minutes), one must dig for years. The double-spread map of Russia is repeated (p. xlvii–xlix and 236–237) and not all places referred to in the text appear. The preferred spelling is traps (not trapps, p. 180). "Melt rock of a telltale type known as plagioclase feldspar" (p. 210) is an unfortunate slip. No reference work in my library had "taganite" (p. 166 – apparently some sort of melt rock). My severest criticism is that the reader must await p. 151 to find a rudimentary classification of meteorites. This should either have been presented at the opening of the text, or as an appendix.

Meteorite Hunter (subtitled "The search for Siberian meteorite (sic) craters") is a delight to read. It's not that strong on science, although it gives an idea of how to calculate the orbital elements of an impacting body based on dispersal-zone orientation, the size of the strew field, and visual observations, and you'll learn what are rhegmaglypts! On the other hand, the book is filled with wonderful first-hand impressions of Russian culture and society, right down to the recipe for taking a banya (p. 141–142), the Russian equivalent of the Finnish sauna. In short, *Meteorite Hunter* is first-rate bedtime reading for Earth scientists.

References

1. BAXTER, J. & ATKINS, T. (1976): *The Fire Came By.* Doubleday & Company, Garden City, N.Y.

2. *Science*, v. 285, p. 1205 (1999); v. 297, p. 1803 (2002).

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Wilson "Snowflake" Bentley Digital Archives. Volume 1: The Man and his Images (1999). The Jericho Historical Society, Jericho, Vermont 05465, U.S.A [www.snowflakebentley.com]. US$40.

Whew! The blizzard is over! It is February 23rd, and we in Montreal were promised up to 30 cm of the white stuff. Actually, we received "only" 24 cm, but still, that amounts to gazillions of snowflakes, and if we are to believe Wilson "Snowflake" Bentley (1865–1931), no two of those snowflakes are identical.

This is not a review of a recent book. Rather, it is a review of a recent CD-ROM on the Wilson "Snowflake" Bentley Digital Archives. This is Volume 1, entitled The Man and his Images. It was issued by The Jericho Historical Society in 1999 to popularize the work of this remarkable local hero, who explored photographically the beauty of snowflakes in Jericho, Vermont, close to Burlington. The images presented, however, are based on a book that appeared in 1931 and entitled "Snow Crystals", by W.A. Bentley and W.J. Humphreys. The book was prepared to ensure that Mr. Bentley's lifetime achievements in this challenging area of photomicrography would be preserved for future generations. The recently issued CD-ROM follows in the same vein, with 1000 selected snowflakes from the 2453 illustrations presented in the book, and 5381 in the archives.

Just how challenging was this work? As his coauthor aptly put it, "taking fine pictures of worthwhile snow crystals requires good judgment, quick decision, speedy action, and great skill. They blow away and even melt away cringingly at the faintest breath, nor can they long endure the radiated heat from a nearby human body. Hence it is that skill and speed are of the very essence of success in photographing the snow crystal that but a moment is here then gone forever." A self-educated farmer, Bentley attracted world attention with his pioneering work in the area of photomicrography of snow crystals. He adapted a microscope to a bellows camera, and after years of trial and error, he became the first person to photograph a single crystal of snow in 1885. As a result of his work over the years, he ventured the opinion that no two snowflakes are exactly alike.

On the CD-ROM, produced by Peter Wolf PhotoGraphics, the user can find complete biographical information, including a three-minute film clip of "Snowflake" Bentley at work, outside at this time of year, in 1917. There is also a section entitled Fun with Flakes, where the user can try to Match the Flakes, or Catch the Flakes, or answer a quiz about Bentley trivia. There is even a Snowflake screensaver available. But the *raison d'être* of the CD, as of the book, is the collection of photographs of individual snowflakes, here arranged in ten screens, each showing one hundred thumbnail snowflakes (each a .jpg file).

The detail is exquisite! The panels of one hundred thumbnails are arranged in an ordered fashion according to degree of undercooling at the point of growth. What a petrographer would call an idiomorphic or euhedral crystal characterizes the first panel. In these cases, the mineral (yes, ice is a mineral, but unfortunately, this important fact is not mentioned once!) grows outwardly along the six axes of symmetry in a plane-by-plane "slotting in" of the H_2O molecules, and the outer shape of the resulting crystals are perfect hexagons. However, there may have been periods of more rapid growth, followed by resorption (melting), followed by renewed rapid growth before the final stage of slow growth. The variety is endless. Snowflakes closer to the end of the collection are all highly skeletal, showing signs of incomplete filling of volumes, only the six "rays" of the crystal having had a chance of grow on a nucleus as a result of the greater degree of undercooling. The fractal dimension of growth is strikingly developed. One can also see signs of resorption of the lacy dendrites, in some cases leading to roundish stubby protrusions. Some of the high-number photos are real oddballs that defy a simple explanation. I suspect twinning in some instances, but remain totally baffled at the morphology of some others.

As soon as I received the CD-ROM, I downloaded fifteen representative images, ordered them in a sequence from low to high degrees of undercooling, and used them in a lecture to beginning petrographers about the shape of crystals and possible interpretations of events during their life history. I am impressed at the collection of images, and contend that it has great didactic merit. "Snowflake" Bentley would have been proud, and perhaps somewhat surprised, to see his work used in this way in a course in mineralogy. Unwittingly, he has provided us who teach about growth of rock-forming minerals in high-temperature environments with an unusually detailed photographic account of the exquisite beauty of one thousand crystals of a simple mineral, the fascinating interplay of growth and dissolution, the many complexities that arise, and even the symmetrical entrapment of melt inclusions (tiny pockets of water!) that are the signal of periodic spurts of growth. Awesome stuff!

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