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BOOK REVIEWS

Tectonic Evolution of South America. Edited by U.G. Cordani, E.J. Milani, A. Thomaz Filho, and D.A. Campos. 31st International Geological Congress. Available from Geological Society of America, P.O. Box 9140, Boulder, Colorado 80301-9140, U.S.A. 2000, 854 p., US $60 (paper).

The mineralogical and petrological richness of South America is outstanding. The continent hosts the type localities of nearly 200 minerals, as well as rocks that range from andesite to jacupirangite, and from itabirite to itacolumite. Mineral districts such as the Brazilian pegmatite fields of Minas Gerais, the spectacular rare-earth deposits of Poços de Caldas, the porphyry copper belt of Chile, the tin veins of Bolivia, the bizzare evaporites and brines of the Bolivian and Chilean salars, the polymetallic resources of Peru, and the emerald mines of Colombia have few counterparts elsewhere. Yet, the avid mineralogist-petrologist will only have his appetite whetted by the pages of *Tectonic Evolution of South America*. On the other hand, the nearly 4000 references cited are guideposts to more fertile fields.

Physically and intellectually, *Tectonic Evolution of South America* is mammoth. Weighing 2140 g, and 4.5 cm thick, it is the largest paperback of this reviewer's experience. With so much recent geological and tectonic information, culled from such diverse sources, this book is a *tour de force*.

Tectonic Evolution of South America [dedicated to Professor Fernando Flavio Marques de Almeida (b. 1916), the father of modern Brazilian geology] is organized geologically into five sections made up of a total of 25 chapters. The sections are: (1) Cratonic South America (5 chapters, 128 pages); (2) The Brasiliano Orogenic Cycle (8 chapters, 214 pages); (3) Phanerozoic Cratonic Cores, Marginal Belts, and Sedimentary Basins (3 chapters, 80 pages); (4) The Andean Belt (5 chapters, 232 pages); and (5) Minerals and Fossil Fuels Resources of South America (4 chapters, 161 pages). Individual chapters range widely in length, from 4 to 96 pages, and each closes with from one to 15 pages of references. A four-page list of the 66 contributors with their addresses is given at the close of the volume. No index is offered. Black-and-white maps, cross-sections, and isotopic and geochronological diagrams enrich the text. Photographs are limited to a single field view on p. 120.

The prevailing smoothness of style and grammatical accuracy of text written largely by contributors whose native language is not English is due to skillful editing by Dr. Marcus Waring di Valderano. His work must have been legion!

Errors are rare, and none found by this reviewer is serious. Some figures lack adequate legends (especially p. 154–157), and the spelling of place names on some maps is incorrect. The labels on the axes of the figure on page 272 are reversed.

The book was printed in Brazil with two justified columns to the page, and in rather small (9-point) type. However, the paper is an exquisite non-reflective pale beige stock, which greatly enhances legibility. In fact, the typography of the volume is far superior to that typically encountered in modern books.

Fundamentally, *Tectonic Evolution of South America* is an "arm-waver"; that is, one can ram into a single book only so much factual detail (stratigraphy, paleontology, petrology...). For an entire continent. The aim of the book here is broader: regional interpretations in the light of plate tectonics, in places including parts of other continents that once were contiguous. Arm-waving. Nevertheless, the result is admirable, and a huge leap forward from what previously had been available to the international reader. Being familiar personally chiefly only with the northern Andes, this reviewer found the syntheses (pages 453-480, 481-559, and 635-685) mostly satisfactory, though not everywhere consistent internally.

It is worthwhile to compare this volume with the last great attempt at a synthesis of South American geology [Jenks, W.F., ed. (1956): Handbook of South American Geology. *Geol. Soc. Am., Mem.* **65**]. The approach then used was geographic, and the broad view was limited to the geosynclinal paradigm. Apart from sedimentary basins with petroleum potential and mining districts, geological knowledge of the continent ranged from thin to nil. Worse, the tools for regional syntheses – the tenets of plate tectonic theory – were yet to be discovered, and geochronology was in its infancy. With the application of enhanced modern techniques of research to what was a poorly known region, it is not surprising that our understanding of South American geology to-

day is several orders of magnitude greater than it was a half century ago.

In summary, *Tectonic Evolution of South America* is today's premier book on South American geology. It is a must for any geoscientist in quest of a firm overview of the regional geology of this fascinating continent. The unusually reasonable price will make the book broadly accessible.

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Dolomitic and Ankeritic Carbonatites of Eastern Siberia. By Maina Y. Somina. Languages of Montour Press, Danville, Pennsylvania, 1999, 134 pages (in typescript format). US$32.00. (No ISBN is given). Translation by John C. Decker of the Russian original published in 1975 by Nedra Press, Moscow, USSR.

This book is a strong contender for being the most disappointing book on carbonatites that I have ever read; indeed, it is probably the outright winner. It was written twenty-six years ago, and its concepts, which had little validity even then, are now totally dated. It is concerned with some rocks that make up a small portion of three carbonatite – alkaline rock complexes in eastern Sayan, a region in Russia approximately 300 km northwest of the south end of Lake Baikal and about 200 km north of the Mongolian border. Two and a half pages of text, plus two tables, fail to give any clear idea of the form of the complexes or of the distribution of rock types within them (there are no maps), and so one first has to read their description (which does include maps) in *Alkaline Rocks and Carbonatites of the World*. **II**. *Former USSR* by Kogarko *et al.* (1995). They are known as the Bolshetagninskii, Nizhnesayandkii and Verkhnesayanskii and in Somina's book are given the names Large, Medium and Small massifs.

The title leads one to expect a discussion of the origin, emplacement and crystallization of dolomite and dolomite–ankerite carbonatitic magmas. Instead, most of the book is devoted to descriptions of the minerals that make up the dolomite and dolomite–ankerite carbonatites, which are themselves only a very small portion of these carbonatite – alkaline rock complexes, and to the geochemistry of the rocks. There are considerable discrepancies between Somina's estimates of the areas of ankerite carbonatite and dolomite–ankerite carbonatite in the complexes and those given in Kogarko *et al.*, which are in turn taken from the mapping and study of people such as Frolov and Kononova.

Somina considers that the dolomite–ankerite carbonatites have a metasomatic origin, referred to as dolomitization and ankeritization, but little or no evidence for this view, other than a few textures, is presented. Instead we are treated to bald statements rather than reasoned argument. For example, "Two main bodies of dolomitic and ankeritic carbonatites occur amid the calcitic carbonatites" and are connected to them "by gradual transitions through thick coronas of dolomitization and ankeritization of the latter". However, there are "instances where both types of carbonatites coincide" (presumably meaning that they occur together). Most carbonatite geologists today will have seen examples of calcite carbonatite, dolomite carbonatite, and calcite–dolomite carbonatite in close proximity and often in demonstrably intrusive relationship to each other. Somina offers as evidence of the metasomatic relationship the fact that "In dolomitized carbonatites, a typical metasomatic texture is observed. Characteristic of them is streaky and porphyroblastic development of dolomite, and also in the form of borders around calcite grains, and in interstices between them." Unfortunately, the photographs of these textures as reproduced in the present translation are completely useless studies in black and white but, in any case, there are no detailed descriptions of the textures. The only exception is a color plate that contains very clear illustrations of banded and deformed carbonatites that could be matched from a hundred other complexes around the world that today would be accepted without hesitation as magmatic. Indeed, the first of these color plates of alleged dolomite "porphyroblasts" in calcite is as good an example of dolomite "phenocrysts" in calcite as one could hope to find. Further argument for metasomatism is the presence of "a series of consecutive alterations of pyrochlore", yet the progressive alteration of early magmatic pyrochlore by late-stage magmatic processes in carbonatites is well documented today. As a general appeal to proof of metasomatism, there are frequent references to hematization of pyrite, concentrations of fluorite, hematized carbonatite of Rodberg-type, voids filled with aggregates of goethite and quartz, and veins of barite – fluorite – calcite, but all of these are common features of the late magmatic stages of high-level magmatic carbonatite complexes.

One is led inexorably to the conclusion that Somina confuses late-magmatic processes, in which magmatic liquids enriched in Fe, Sr, Ba, U, and the *REE* crystallize a series of veins and pipe-like bodies, with metasomatism. Perhaps, however, it is all a matter of terminology, for I recall long written discussions in the 1960s and 1970s with Russian geologists who were purportedly metasomatists, but when the debate was able to move from the pen to the outcrop, many of our differences disappeared as it became clear that we were de-

scribing much the same features but using different terminology. On balance, however, it seems more likely that Somina does consider the dolomite–ankerite carbonatites to have been formed from calcitic carbonatites.

Of course, some petrologists have made a similar case far more recently, but the weakness in the argument remains the same, that there must be a realistic source for magnesian fluids in order to achieve dolomitization. Yet it is patently absurd to try to erect any viable scheme for deriving such fluids from calcitic carbonatite magma. And if, as seems to be increasingly accepted, primitive carbonatite magmas are magnesian rather than calcic, there is no real difficulty in crystallizing dolomite and ankerite on their own or in various combinations with calcite. The need for a metasomatic origin of dolomitic carbonatites disappears, and a realistic source for the transforming fluids is almost impossible to find anyway, except in extremely minor amounts. I have to conclude, then, that Somina offers no convincing proof of metasomatism.

The largest part of the book is a series of descriptions of the minerals found in the carbonatites, but these are of little petrological value, although they represent a very substantial amount of work, X-ray diffraction, optical property determination, thermoluminescence, goniometric, thermogravimetric, *etc.*, all the stuff of classical crystallography that preceded modern instrumental analytical methods. Some chemical data are given, some of which appear to be wet-chemical analyses, whereas others are "semi-quantitative spectral determinations".

A section on the geochemical evolution of the carbonatites is based on the assumption that the rocks have a metasomatic origin. The "evolutionary stages" concept that has underlain much Russian writing on carbonatites is used here (CI, CII and CIII), but has been given the additions of C1 (dolomitic carbonatite), C2 (ankeritic carbonatite) and C3 (calcite – silicate).

Concluding remarks: It is interesting that the exhaustive compilation of Konova *et al.* makes no mention of Somina's work and accepts a magmatic origin of the carbonatites in all three complexes. At risk of showing prejudice, I have to say that I have little hesitation in accepting the interpretations of Kononova, and Kogarko's and Kononova's judgement of which work on eastern Sayan to include in the summary volume, for I have had the opportunity to observe their work for close to 45 years. Somina's book dates from a period in Soviet petrology (particularly the 1960s and 1970s) when metasomatism tended to ride supreme over magmatism, and carbonatite studies did not escape. I am reminded of a conversation with Korzhinskii in the Haliburton–Bancroft area of Ontario while standing on a splendid example of nepheline syenite gneiss having been intruded and partially assimilated by granite. "Oh no" he responded. "This is a very good example of nepheline syenite forming by nephelinization of granite". Truth may be in the eye of the beholder, but we tend to behold very different views of the rocks.

There are some curious examples of quaint translation such as "large-grained", "bicarbonate veins", "magnesiality", "ferruginality", and the quality of the black-and-white photographs is appalling. It seems very strange that the publishers could have failed to notice that they are essentially useless. Although the book is almost no value to modern carbonatite study, it is interesting that Somina noted the relatively large amount of fluorine in the rocks and speculated that this might have been an effective agent in moving elements within the complex. The important role of fluorine in carbonatite magma evolution is, of course, fully appreciated today.

It is difficult to understand why this book has been chosen for translation so long after its original publication date. It is not a book that I can recommend to anyone for it compares poorly with other Russian publications on carbonatite and makes no contribution to carbonatite studies that has any contemporary relevance.

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Lovozero Massif: *History, Pegmatites, Minerals*. By Igor V. Pekov. Ocean Pictures Ltd., Box 368, Moscow 103009, Russia, 2000, 484 pages, hardcover (ISBN 5-900395-27-8). Distributed in Canada and U.S.A. by Excalibur Mineral Co., 1000 North Division Street, Peekskill, N.Y. 10566, U.S.A.; telephone: (914) 739-1257; e-mail: excalibur@bestweb.net. US$79 plus $8 shipping within the U.S.A. and $16 to Canada.

The Lovozero massif in Russia's Kola Peninsula is one of the world's largest alkaline complexes, with an area of 650 km^2. Its agpaitic to hyperagpaitic rocks and their derivative pegmatites and hydrothermally affected rocks have yielded over three hundred mineral species, making the Lovozero massif one of the world's foremost mineral localities. Nearly half of the minerals are considered to be rare; 73 were first discovered in the Lovozero massif, and a third of these have yet to be found elsewhere. There are some thirty rare-earth minerals, and a long list of zirconium, titanium, niobium, thorium, lithium and beryllium minerals. Add some of the largest known crystals for their species, and the spectacular nature of some of the occurrences, and it is re-

markable that the Lovozero massif was almost unknown among mineralogists outside Russia until the first English-language monograph, a translation of *The Lovozero Alkali Massif* by K.A. Vlasov, M.Z. Kuz'menko and E.M. Es'kova, was published in 1966. Written in 1959, that monograph described the 108 mineral species then known from the Lovozero massif. In contrast, Pekov's *Lovozero Massif* contains descriptions of 341 species.

A word about the author. Pekov is an enthusiastic, young mineralogist at Lomonosov Moscow State University. He specializes in the mineralogy of the Lovozero and Khibiny massifs, and has described several new mineral species. His earlier book *Minerals First Discovered on the Territory of the Former Soviet Union* was reviewed in these pages (*Can. Mineral.* **37**, 779-781). Pekov is also an avid mineral collector. He brings a unique perspective to his latest book.

Lovozero Massif opens with a brief foreword by Academician Liya N. Kogarko (for whom the mineral kogarkoite is named), followed by an introduction, acknowledgements, and a list of abbreviations used in the text. The first chapter (18 pages), Review of Geography, deals with the natural environment and the physiography of the Lovozero tundra. With extensive quotes from the work of two early Russian geographers, and several black-and-white and color photographs, the chapter gives a vivid impression of this harsh yet beautiful Arctic land. Two maps are provided. One positions the Lovozero massif within the Kola Peninsula. Another locates its principal geographical features, most of which are also mineral localities, and the Karnasurt and Umbozero mines. I found myself frequently referring back to this map as I read subsequent chapters. The chapter concludes with a useful list of place names in both English and Russian.

The second chapter, Brief Geological and Petrological Review, is a 12-page summary of the geology and geomorphology of the Lovozero massif, with a description of the main rock types. The chapter includes a geological map of the Lovozero massif, and three pen-and-ink sketches illustrating some of the geological features. References are given to the extensive geological literature on the Lovozero massif.

The next chapter is a fascinating, if lengthy (94 pages) account of the Hystory [sic] of Study and Exploration of the Lovozero massif. Separate sections are devoted to the history of the Kola Peninsula up to the end of the 19th century, the discovery of the Lovozero massif in 1887 by a Finnish expedition, the pioneering geological, petrological and mineralogical investigations of W. Ramsay, the first Russian expeditions in the 1920s under A.E. Fersman (for whom the famous mineralogical museum in Moscow is named), the exploration and development of economic mineral deposits in the 1930s, and in the 1940s to 1960s, and the modern period of mineralogical studies, which continue to this day. This chapter offers insight into why, in the author's words, "the Lovozero Massif is one of the world's most explored alkaline plutons." It was the search for strategic metals. In 1934, exploration for eudialyte as a potential source of zirconium led to the discovery of loparite-rich lujavrites, which became the Soviet Union's main source of niobium. Their subsequent exploitation was carried out in great secrecy. Following World War II, the Lovozero massif was intensively explored for additional deposits of niobium, as well as for potential deposits of thorium, uranium, lithium and beryllium vital to the Soviet Union's nuclear weapons and energy programs. The Karnasurt and Umbozero mining complexes date from this time. Involved in the geological, mineralogical and geochemical investigations were teams from a number of organizations, often working independently of each other. It is interesting to note the presence of many female geologists and mineralogists, beginning with the very first expedition in 1920, at a time when very few of their counterparts in North America would have been similarly employed in the field. The people who participated in the investigations are a veritable who's who in the names of the minerals described in a later chapter of the book. Extensive quotations from their personal recollections and from their publications provide an immediacy to their experiences and scientific accomplishments. These and other accounts reveal the often arduous conditions faced by those working in the Lovozero massif in the earlier years. They also offer a political commentary on the times, such as the use of gulag prison labor in construction and mining. The chapter is richly illustrated with black-and-white archival photographs of people and places. A chronological summary of the main events in the geological investigation and industrial development of the Lovozero massif is provided at the end of the chapter; this summary will probably suffice for some readers.

The rare and unusual minerals for which the Lovozero massif is justly famous occur for the most part in hyperagpaitic pegmatites and related hydrothermally affected rocks. In the chapter on Pegmatites (62 pages), the author has selected 29 of the mineralogically most interesting for description. Many are characterized by extensive hydrothermal alteration and the occurrence of highly alkaline minerals, some of which are water-soluble. Included in the descriptions are the Yubileinaya pegmatite in the Karnasurt mine, which has yielded 13 new mineral species, and the Shkatulka pegmatite in the Umbozero mine, with its spectacular showing of rare minerals, including shkatulkalite. Several of the pegmatites exposed by underground mining operations are described here for the first time. The structural, textural and mineralogical features of the selected pegmatites are

presented in varying detail based on the literature and the author's own observations. Plan or sectional drawings of the pegmatites as well as color photographs accompany some of the descriptions. A quibble here is that the symbols denoting rock types and mineralized zones are not consistent from drawing to drawing, and some close-up photographs lack any indication of scale. In reading the descriptions, it is easy to get caught up with the author's enthusiasm in referring to the Lovozero massif as a "mineralogical paradise." Consider that part of the Sirenevaya pegmatite displayed a "combination of red-orange eudialyte, snow-white microcline, bright scarlet mangan-neptunite, dark-red villiaumite, lemon-yellow bornemanite, gilt-brown lomonosovite, lilac ussingite, black and green aegirine, lilac...terskite, smoky-gray analcime, and greenish sodalite [with] bright yellow-green and yellow prisms of belovite-(Ce), ...greenish brown grains of vitusite-(Ce), and ...nests of blue kogarkoite...among the ussingite." Then there is the remarkable size of some of the minerals, for example: aggregates of karnasurtite-(Ce) up to 10 cm across, eudialyte crystals up to 6 cm, zircon crystals up to 9 cm, gerasimovskite plates 10 cm across, litvinskite crystals up to 7 cm, vuonnemite plates 30 cm across, parakeldyshite crystals up to 3 cm, and incredibly, a mass of shomiokite-(Y) crystals estimated to weigh several tonnes, with individual crystals up to 10×25 cm in size. As the primary aim of the Pegmatite chapter is to acquaint the reader with the mode of occurrence of the rarer minerals described in the following chapter, no attempt is made to classify the pegmatites or to consider their petrogenesis; for this the reader is referred to the existing literature. A list of the minerals occurring in six of the pegmatites, including the Yubileinaya and Shkatulka pegmatites, is given at the end of the chapter.

More than half of the book is devoted to a description of the minerals of the Lovozero massif in a chapter titled Minerals (262 pages). A brief introduction outlining the intent of the chapter is followed by a List of Mineral Species With Estimated Level of Study. As the author points out, locality-based lists of minerals tend to include all reported species with little or no attention to the quality of the data supporting their identification. In compiling the Lovozero list, the author has evaluated the reliability of each species identification according to five categories: 1) minerals first discovered in the Lovozero massif and fully characterized (holotype material), 2) minerals whose identification is supported by at least one detailed description including chemical and X-ray-diffraction analysis, 3) minerals whose identification is supported by data deemed sufficient to be diagnostic, 4) minerals for which the available data are insufficient to establish the identification according to current species definitions or rules for nomenclature, and 5) minerals reported without documentation and whose identification is questionable. The author is to be applauded for taking a critical approach to such a listing of species, especially as species totals have become something of a bragging point about many localities, *e.g.*, Tsumeb, Franklin and Sterling Hill, the Khibiny massif, and Mont Saint-Hilaire. Of the 341 species listed for the Lovozero massif, including rock-forming minerals, 20 are in the "insufficient data" category, and 45 are in the "questionable" category. Several minerals identified by the author and others are reported for the first time.

For many readers, the mineral descriptions in the Minerals chapter will be the most useful and frequently consulted part of the book. These descriptions range from two lines to almost five pages in length. The shortest pertain to minerals that have been reported in the literature with little or no descriptive information. The longest are of minerals endemic to the Lovozero massif, newly discovered species, minerals found as world-class specimens, and rare minerals occurring in large concentrations or as unusually fine crystals. Arranged alphabetically by mineral name, each description is sectioned off by horizontal bars, with the mineral name in upper-case bold letters; this presentation makes it very easy to find a specific mineral. A chemical formula follows each mineral name. The descriptions vary in content, but generally begin with an account of the original discovery of the mineral in the Lovozero massif. A useful contribution here is that the author cites the various names and designations under which the mineral has previously been described in the literature (but unfortunately there is no index to these). Beside the original discovery locality, other significant occurrences within the Lovozero massif are also mentioned. The information for each occurrence typically includes the locality name, the geological nature of the occurrence, the general appearance of the mineral, such as color, crystal or aggregate size, and crystal morphology, the associated minerals, and references to the literature. Some of the minerals occur only as pseudomorphs, and for these the author discusses the paragenetic sequences and the stability of the minerals involved. Accompanying the mineral descriptions are 127 color photographs and 65 SEM photographs of mineral specimens, and 178 crystal drawings.

Cross-referenced in the descriptions of 210 of the minerals are results of 395 chemical analyses, of which 78 pertain to 57 minerals and are published for the first time. These analytical results are tabulated at the end of each description. They represent the only "hard" data in the book. Many of the analytical results are reproduced from Russian-language publications that are not easily accessible. The author offers comments on some of the compositions and on their crystal-chemical implications.

Mineral systematists may note that not all of the described species are listed in *Fleischer's Glossary of*

Mineral Species 1999. Several are more recently approved, new species: chabazite-Sr, fluoro-magnesio-arfvedsonite, korobitsynite, kuzmenkoite, litvinskite, manganonaujakasite and seidite-(Ce). The general names hornblende and scapolite are used because of uncertainty in the species present in the Lovozero massif. Beta-lomonosovite ("lomonosovite-beta") and tetranatrolite are retained as species names despite their discreditation by the CNMMN, which the author considers unjustified. The author also retains the name magnesio-ferrikatophorite, pointing out that this sodic–calcic amphibole with Fe^{3+} dominant in octahedral sites seems to have been overlooked in the 1997 report of the CNMMN Amphibole Subcommittee. Some Levinson modifiers are justifiably omitted; the identification of florencite is questionable, whereas the chemical composition of Lovozero donnayite indicates that it is cerium-dominant, with only minor yttrium, which would suggest a new species. Diacritical marks and special characters are missing from mineral names throughout the book. Of more concern is the improper use of hyphenated chemical prefixes for compositional variants, *e.g.*, Ca-aegirine, Mn-belyankite, Fe-rhodochrosite.

A substantial number of the chemical formulas in the chapter differ from those in *Fleischer's Glossary*. Some formulas contain what are obviously typographical errors, *e.g.*, misplaced subscript and valences in the arfvedsonite formula, no SO_4 in the nosean formula, missing site-vacancies (□) in the formulas for several amphibole-group minerals. In other formulas, there are differences in the elements assigned to structural sites, in the total anions or cations in a site, or in the representation of the structural frameworks, *e.g.*, silicate groups in allanite-(Ce) are represented as "$[Si_2O_7][SiO_4]O$" as compared to "$(SiO_4)_3$" in *Fleischer's Glossary*. Many of these formulas have apparently been transcribed directly from the author's *Minerals First Discovered on the Territory of the Former Soviet Union*. In a few cases, the chemical formulas have been revised on the basis of new data, *e.g.*, labuntsovite, raite, thorosteenstrupine and umbozerite. The abbreviation REE is used for rare-earth elements in some formulas. Puzzling is the author's adoption of formula units for zeolites that are different from those accepted by the IMA Zeolite Subcommittee: one-half of the formulas for the chabazite and gmelinite series, twice the formula for harmotome, and one-eight the formula for mesolite. Similar differences in chemical formulas can also be found in other published works. Whatever the relative merits of one formula *versus* another, there seems to be a need for a more systematic and universal approach.

The Minerals chapter concludes with twenty-nine pages of appendices. The first appendix is a list of Lovozero massif minerals by chemical group. The second lists the 73 species for which the Lovozero massif is the type locality, with the date and authors of the first description, the locality place-name, and the origin of the mineral name. Other appendices give a chronology of the new minerals discovered in the Lovozero massif, short histories of eight minerals described as new species from other localities but which were already known from the Lovozero massif, a list of minerals found for the first time in the territory of the former USSR in the Lovozero massif, a list, with references, of minerals whose crystal structure has been determined using samples from the Lovozero massif. A useful aid to identification is a table of fluorescent Lovozero minerals, which gives the color and intensity of response under short- and long-wave ultraviolet light for 44 species. A penultimate appendix, Giant Crystals, provides size and locality information on minerals that occur as unusually large crystals or aggregates. Almost as an afterthought, a final appendix gives the English translation of Saami words used in geographic names; this appendix should logically have followed the list of place names in the first chapter.

The book ends with an extensive list of references (500 entries). This is probably the most complete bibliography extant on the geology and mineralogy of the Lovozero massif. Unfortunately, the key to the abbreviations used for the titles of Russian periodicals is inconveniently placed at the front of the book. There is no subject index. Whereas mineral species are easily located in the Minerals chapter, a search of the text is needed to find any other information. It would have been nice to have an index to the people mentioned in the book.

Like so many publications emanating from Russia, *Lovozero Massif* would have benefitted from rigorous English-language editing. The text (some chapters are better than others) suffers from awkward construction of sentences, missing articles and incorrect conjugations. The occasional word is an unintelligible transliteration from the Russian, and some phrases are simply poorly translated. The reader is left wondering about mineral "visit cards," "lentiform crystals," and "minerals [that] are the most notorious object of note." Typographical errors average almost one per page. A glaring example is the bold-faced chapter heading Hystory [sic] of Study and Exploration. However, once the reader accepts the awkward English, the text reads along quite well.

Lovozero Massif is printed on glossy paper with the text in an easy-to-read 12-point font. Section headings in bold black letters, and subsection headings and caption backgrounds in blue, contribute to an attractive layout of this coffee-table book (22 × 29 cm). The quality of most of the color plates is very good.

Lovozero Massif is a very worthwhile addition to the growing number of mineral books devoted to a single

locality or geological area. Topomineralogies bring together a wealth of information that is otherwise scattered in the literature, or not recorded at all. The author of *Lovozero Massif* has ably succeeded in his aim of introducing this "mineralogical paradise" to a broad audience. *Lovozero Massif* is a book to enjoy. It is a must for anyone interested in alkaline rock complexes and their rare and unusual minerals. I recommend it.

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Gemstones: Symbols of Beauty and Power. By Eduard Gübelin and Franz-Xavier Erni, with photographic contributions by Erica and Harold Van Pelt. Geoscience Press, Inc., Tucson, Arizona, 2000 (English edition), 240 pages. US$ 49.95 (hardbound), (ISBN: 0–945005–36–9).

Geoscience Press does not normally indulge in books whose owners have difficulty in deciding between bookshelf and coffee table. This, however, is one of that genre. Its large size (30.3 × 24.5 cm), and gorgeous color photographs lean toward the coffee table, whereas its technical content, though not beyond the capabilities of the ordinary reader, might incline one to the bookshelf. It is a hybrid of sorts, created by authors having an aesthete's appreciation of beauty, while at the same time possessing academic qualifications in geoscience. Eduard Gübelin has a business of renown in Lucerne, but he is also Dr. Gübelin, a gemmologist with a worldwide reputation. Dr. Erni is likewise an academic, although his field is philosophy, and he practices journalism. He has written extensively on gemmological subjects.

This is not to say the text is without error, although it is possible that such inaccuracies as do appear may be more in keeping with the translation from German to English than with genuine faults (although no translator is listed in the credits). In fact, it is possible that the translation took place in the minds of the authors. I have never met Dr. Erni, but I know Dr. Gübelin, and his English is excellent. He is perfectly capable of writing such a book directly in English without benefit of external help. The text tends to give that impression, for although it is in clear, idiomatic English, one does occasionally encounter an archaic phrase or expression.

The book has an introduction, nine chapters (all except chapters 5 and 6 by Gübelin), a glossary, a bibliography, picture credits, and an index. It seems to be the fashion with many German publications these days to subdivide each chapter into several minor headings. For example, chapter 4, entitled Portraits of Ornamental Gems, is divided into nine subsections: The beauty of ornamental gems, Agate: fire and flames, Charoite: reed pipes from the Russian karst, Jade: metaphor for luck, Lapis lazuli: incarnation of the starry firmament, Malachite: master of the green shades, Rhodochrosite and Rhodonite, Sugilite: budding mallow spur, and Turquoise: morning fresh bloom of heaven. Such flowery descriptions will not appeal to the serious-minded scientist, but not all scientists are serious-minded, and those who do dip into these chapters will find some interesting material presented at a level well beyond that suggested by the headings.

The opening page of each of these subsections contains information bearing on varieties, chemistry, crystal system, habit, color, index of refraction, birefringence, dichroism, density, hardness, consistency (tenacity), occurrence, and extraction (*i.e.*, from parent rock, alluvial gravels, conglomerate, pegmatite, *etc.*). This is information at the level of the gemmologist, not the general public. The text describes the mode of development of each of the gem materials in nature, and its subsequent uses by man.

In order of presentation, the nine chapters are: Gemstones: their characteristics and their origin; Gemstones: their extraction and processing; Portraits of the gemstones; Portraits of ornamental gems; Gemstones: symbols of authority and power; Beauty, magic and medicine; The fascination of internal life; A passion for collecting; and Natural or not?

As might be expected from its heading, the opening chapter deals in summary fashion with the geological settings required for the development of gemstones. Whereas the explanations are relatively simple, they make no concession to the ordinary reader. Definitions of magma and some other terms are given, but there are anomalies. The caption to an illustration of a rather complicated crystal of diamond on matrix states that the diamond is sitting on an "ultramafic garnet-lherzolite". It probably is, but although the text goes on to explain that "magma" is derived from the Greek "magis", or kneaded mass, it doesn't explain "lherzolite", or "ultramafic" for that matter, either in the text or in the glossary.

Still, Gübelin packs a great deal of information into a few pages. A drawing of a plug of the earth's crust to a depth of some thirty kilometers uses fourteen colors and an equivalent set of numbers to describe the locations of formation of different gemstones and minerals as: early magmatic (chromite); liquid magmatic crystallization (topaz); residual crystallization (volatile elements); pegmatites (beryl, etc); pneumatolytic (scheelite, topaz); fissure solutions (barite, beryl); metamorphic–metasomatic [schists, skarns] (alexandrite); sedimentary (azurite, turquoise); hydrothermal boiling (fluorapatite); contact metamorphism (emerald, *etc.*); regional metamorphism (ruby); basement rock (an-

dalusite, sapphirine); extrusive volcanism (Australian sapphires, peridot); and kimberlites (diamond transport). In short, he manages to cram the full spectrum of gemstone formation into one third of a page of text and one drawing. The balance of the opening chapter deals in turn with basic notions of idiochromatic and allochromatic color, diffraction and interference color, scratch hardness, grinding hardness, toughness, crystal structures, streak, *etc.* Some explanations call for a bit of head-scratching. In a book presumably designed for the general reader, it is probably better to say, for example, that the structure of diamond is one of stacked carbon tetrahedra rather than "two face-centred cubes, one within the other, and displaced by one quarter of the body diagonals."

The second chapter deals with how and where gemstones are found, and how they are recovered from the varying deposits. A map of world occurrences provides useful reference for matching gemstones with geological conditions. The chapter carries on through cutting and polishing methods applied to gemstones, particularly diamond. Here again, the text includes words that are understandable, and look right at first glance, but are better related to German than English. For example, the use of "trippel" as a polish won't bother most gemmologists, who will recognize "tripoli" as the intended material, but it might confuse the general reader. A minor typographical glitch is the description of a standard pear-shaped gemstone cut as "pendelogue" rather than "pendeloque" throughout. German has few words borrowed from French, so it is understandable that a typesetter in Germany might easily confuse "q" with "g".

Each of the following chapters covers specific gemstones, first, with a short, intense description of their physical characteristics, then with a longer dissertation on their use, development, production, and disposition. Large, well-known gemstones of each type are described, and in most cases illustrated by superb photographs, primarily by the Van Pelts. Other photographs illustrate mining and cutting methods peculiar to particular species. The information in these chapters is fairly technical, and at times controversial. A case in point is Gübelin's description of the formation of agate. He says: "Its formation devolves from volcanic eruptions. In the boiling, flowing embers of lava, pea-sized to hundredweight drops of more or less pure silica (SiO_2) floated, with or without water content." He goes on to say that these crystallized to agate on cooling. The concept that agate formed from the crystallization of liquid segregations in magma rather than as a hydrothermal process of deposition in gas amygdules is not new, nor is it restricted to Gübelin. It was under consideration in the mid-twentieth century, and may still be in some circles today, but certainly it is not the explanation currently favored currently by most mineralogists.

In chapters 5 and 6, the focus is on the use of gemstones in such things as royal crowns, church reliquaries, *etc.* He carries on into the histories of famous jewels, seals, amulets and talismans, birthstones, and gemstones in medicine. Here we find information, for example, on the Topkapi Dagger, commissioned in 1747 and bearing three huge crystals of Colombian emerald in the hilt (and a clock beneath the finial emerald at the top of the handle!). Intended as a gift for Nadir Shah, ruler of Persia, the dagger never reached him, for he was assassinated in the same year.

The book ends with three short chapters on inclusions, collecting gemstones, and synthetics, composites, and imitations. Since Gübelin is famous for his work on inclusions in gemstones, it is small wonder that they show up here. He presents them as valuable diagnostic tools, and illustrates them with his own excellent photomicrographs. The section on collecting is a sort of grab-bag description of those unusual and rare stones that do not form part of the common notion of gems. Mention is made of amblygonite, ekanite, euclase, sillimanite, kornerupine, *etc.*, in each case giving the derivation of the name and a short description of the appearance of the gemstone. The closing section on synthetics outlines how each is created, and some indication of inclusions characteristic of the synthesis.

Of passing interest is the photograph on the dust jacket. This shows a jewelled dragonfly on a flower with a demantoid garnet at its center, and is the result of reworking a photograph published on the cover of Gems & Gemology, the journal of the Gemological Institute of America, Volume XXXII, No. 2, Summer 1996. It's amazing what digital manipulation can do.

This is a book that is hard to place. The photographs are magnificent, and probably worth the price alone. The text is intriguing, and at times controversial. In common with almost every modern text, it has a sprinkling of minor typos. On the whole, it is a text that, like many gemmologists, occupies a technical level between the layman and the mineralogist. It should find a home with anyone having a sound technical background and an interest in the provision, disposition, and history of magnificent minerals.

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