Canadian Mineralogist
Vol. 24, pp. 593-595 (1986)

BOOK REVIEWS

STRUCTURAL CHEMISTRY OF SILICATES by Friedrich Liebau. Springer-Verlag, Berlin, 1985. 347 pages, 136 figures. $57.00.

In the last 10 years, there have been many books, often resulting from a society short course, which have addressed the crystal chemistry, mineralogy and petrology of particular groups of rock-forming minerals. This has been a boon to the education process, and has emphasized the coherence of crystal chemistry, mineralogy and petrology as subdisciplines of geology. However, such an approach does lead to the neglect of topics that are considered irrelevant by related subdisciplines. In particular, the crystallography of non-rock-forming minerals has not received much attention. This situation is now changing, and the crystallographic community is fortunate that Professor Liebau has employed his considerable experience to produce a coherent account of the structural chemistry of silicates. Here is a detailed treatment of the structural topology of both natural and synthetic silicate compounds, together with a consideration of the factors that affect the detailed conformation of these structures.

The author begins with a brief account of the nature of the silicon–oxygen bond, presenting both ionic and covalent *models* as well as a survey of the general geometry of bonds in silicates. The classification of silicates is discussed in some detail, with the pros and cons of the various schemes clearly laid out. The author's extension of the classical Bragg – Náray-Szabó classification is used throughout the book, facilitating examination of the factors that affect the geometry of the silicate part of the structure. Essentially, this describes silicate anions with seven geometrical–topological parameters that characterize the co-ordination and polymerization of [SiO_n] polyhedra. This comprehensive scheme is then condensed somewhat to order and classify real structures. A survey of the various types of observed silicate anions is given, leading to some generalizations concerning the topology of silicate structures. An extensive (~100 pages) examination of the effect of non-tetrahedral cations on the geometry and topology of silicate anions concludes the book.

Even the most well-read person can only be impressed by the enormous array of fascinating patterns adopted by silicates, and by the superb illustrations of structures given here. The book is well-conceived and well-produced; it belongs on the desk of every serious crystallographer.

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ALKALINE RING COMPLEXES IN AFRICA. R. Black and P. Bowden, editors. Journal of African Earth Sciences, volume 3, numbers 1–2 (1985). Pergamon Press, Oxford, England. 280 pages, $46.75 (US).

The magmatic episodes in much of the continent of Africa, the second largest land-mass on our planet, are relatively poorly characterized. In particular, this continent contains type examples of alkaline and carbonatitic ring-complexes; they are considered so because of their relatively young age, excellent exposure, absence of complications owing to younger events, and presence of mineralization. A careful characterization of such pristine complexes can thus provide insight into the probable mode of magmatic evolution of more ancient and less well-exposed examples, like the ones that we must deal with in this country.

Alkaline Ring Complexes in Africa contains a wealth of information that is not readily available elsewhere. This is a special issue of the Journal of African Earth Sciences, a new Pergamon journal; it represents the proceedings of an international conference held in northern Nigeria in early December, 1983. The meeting attracted most of the active investigators in this field. Many of the papers presented orally are collected in this issue. This is thus a very welcome addition to the literature on anorogenic complexes, both oversaturated and undersaturated with respect to silica. Processes leading to the mineralization in these complexes and the geodynamic significance of intraplate magmatism are two themes emphasized during the conference.

The issue contains three review-type articles, one on structural setting, another on geochemistry, mineralogy and mineralization, and a third on the roles of the various rock-forming minerals during the magmatic stage of evolution in the shallow magma-reservoirs. Both lithosphere and upper mantle play an important role in the generation and localization of the anorogenic complexes; degree of alkalinity and silica saturation are largely controlled by age and thickness of the lithosphere undergoing extension. A very useful comparison is made with other alkaline provinces in the world. The review of mineralogy and geochemistry emphasizes the superposition of magmatic and postmagmatic phenomena.

There follows a series of papers, some also of a review nature, on entire belts of African complexes or on individual plutons. The best studied ring-complexes seem to occur in the host country and are the focus of seven of the seventeen articles in this section. Geophysical and remote-sensing surveys are discussed in two papers at the end of the volume.

In a proceedings volume of this type, the level of treatment is generally very uneven. This volume is no exception; the guest editors and the editor-in-chief, C.A. Kogbe, are to be congratulated for a very polished product that maintains the high standards of the publishing house. The photographs and figures are all very clear, and not reduced to postage-stamp size, as sometimes happens. The collection of papers provides an excellent account of the state of current knowledge concerning African ring-complexes and, by extension, those in other continental blocks as well.

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MICROSCOPIC DETERMINATION OF THE NONOPAQUE MINERALS by Michael Fleischer, Ray E. Wilcox and John J. Matzko (1985). U.S. Geological Survey Bulletin 1627. U.S. Government Printing Office, Washington, D.C. *vii* + 453 pages, 8½ × 11″. Flexible cover. $12(US).

The oldest among us mineralogists still remember, with gratitude, the first two editions of this book (Larsen 1921, Larsen & Berman 1934). For generations it has been the trusted companion of every petrographic microscopist, who soberly appreciated the difference between identification (checking a hunch) and determination (starting from scratch). This 3rd edition, in its new format, neatly typed, one inch thick, is quite impressive. It looks just like what it is — the work of a life time: 34 years collecting the data, 18 of which (while still collecting) putting them into the right tabular format. The deadline for new data to be included was 1983-08-01, half a century after Larsen and Berman stopped *their* collecting. The amount of data in the book under review is truly enormous, and yet its selling price per page comes to 4.1¢ (Can) or 2.6¢ (US) — less than the cost of a xerox copy!

In the Introduction (Ch. I) the authors with nostalgia deplore the fact that, in many colleges, "the time allotted to Optical Crystallography has been reduced". To this observation the Reviewer may add that, probably in the same colleges, all of Crystallography has been cut down to a few lectures given by the mineralogist at the beginning of his course, so that Mineralogy, for which Crystallography is most needed, is itself hurt by the new fad. It is to be hoped that the availability of Larsen's third edition, revised, updated and enlarged, will help remedy this sad situation. The authors themselves stress the need for additional data and emphasize the fact that recent advances now make it feasible to identify extremely tiny samples optically. The large number of persons that deserved acknowledgements (14) testifies to the eagerness with which the profession was awaiting the arrival of the "New Larsen": like the "New Dana' in its days, it has been considered an event of North American Continental magnitude. Now the long wait is over — it has been richly rewarded.

The Preface credits Wilcox for writing the summary of the results of the theory of Crystal Optics and their practical application to Mineralogical Microscopy (methods, equipment, procedures). It is hard to see how anyone, in 25 pages (Ch. II), could have done a better job. Every needed formula is properly stated, and the reader is told where he can find the proof in the literature (104 references cited). Good line-drawings illustrate methods or instruments described, particularly the Wilcox-modified spindle stage of Bloss. The ellipsoids (uni- and biaxial) are given a prominent place, as they deserve (Fig. 3), and so is the nomograph (Fig. 8) to determine $2V$, first roughly from $(\gamma-\beta)/(\gamma-\alpha)$, to be refined by means of a companion graph. A drawing shows differently curved isogyres for four different values of $2V$, in a convergent-light figure of a central optic axis (Fig. 9). The directions for use of every procedure are carefully given, step-by-step, with an occasional warning of a lurking *faux-pas*, thoughtfully dispensed to the neophyte by a seasoned practitioner.

Strict *optical orientation* "would require coordinated optical and X-ray structural investigation of the same crystal fragment" (p.20). Obviously such meticulous work has not routinely been performed. The authors explain that "for many unknowns, much can be inferred from the behavior of interference figures . . ." The tables of biaxial crystals do indeed show a large number of optical orientations. For example, anthophyllite shows (Table 6, p.155): "1.616 *1.628* 1.641 $2V_Z = 79°$ $Y = b$ $Z = c$ el.pos. ORTH(pris. *c*) (210) perf." This is a case where the complete orientation is known to the compiler, but possibly not to the reader.

In the Bragg setting the unit vectors, listed in the order of increasing principal indices of refraction $\alpha\beta\gamma$ [XYZ vibration directions) were along *abc*, which increase in order *cba*, the space group is written *Pnma* (D2h–16) and the gliding mirror is symbolized (210). In "Crystal Data", XYZ are along $b'a'c'$, which increase as $c'a'b'$, the space group is *Pmnb* and the gliding mirror is 120. In the setting advocated by M.J. Buerger, XYZ became $c''b''a''$, increasing as $a''b''c''$, the space group is *Pcmn* and the gliding mirror is (012). (In the above the symbol of the cleavage plane is the same as that of the gliding mirror.) Airing these facts should show the makers of the Tables that some decision will have to be taken for the future. There comes a little brightness in this dark picture: when Larsen began compiling his first edition, there reigned a consensus among mineralogists: no one should modify the original setting, chosen by the mineralogist who described the species. It is my impression that the followers of Larsen have never given up this rule. If so, the task ahead does not loom so large!

A very short section (Ch.III) explains how the data are arranged in the Tables and how to use them to identify minerals. In tabulating data the *use of abbreviations* is, of course, of the essence. Any way of shortening words or symbols is welcome. The dot that usually follows an abbreviation has been systematically omitted. The braces that enclose the Miller indices of a form are likewise gone. One serious omission in the list of abbreviations is "rhomb" for "rhombohedron". The two examples chosen to demonstrate the method of optical determination (here called "identification") definitely can't be beaten: they make it clear that thoroughness and patience will be prerequisites of the art.

Now comes the most voluminous part of the book, the *Determinative Tables* themselves. Essentially the arrangement by optical divisions and choice of criteria taken up by columns remain faithful to the Larsen tradition. A couple of examples show how conscientious the compilers have been in details.

At *Ice*, in the Division of Uniaxial positive, "Melts at O°C" has been added, but that is not the only change! $\epsilon\omega$ is now written $\omega\epsilon$, thus stressing the constant index as the listing number; ω is now 1.309 as in 1934, but ϵ has moved down from 1.313 to 1.312; an added column for birefringence gives $B = 0.003$. Note the right emphasis on the accuracy of birefringence, better than that of an index of refraction.

Now consider *Schairerite*, uniaxial (+), same page 62. Its ω goes up by 0.003, ϵ stays put at 1.445, but the B is given as 0.0012, not as 0.002. A nice feature of this compilation is that the Authors are much against illusory accuracy, but not against valid accuracy. G 2.612 has been trimmed to 2.62, whereas F = easy is now a quantitative F 1.5.

The property of *variability* of indices has received special attention, and the range of variation can now be read quantitatively, between added figures in the left margin. The column heading has been changed to *"Other entries"*.

Among the biaxial minerals, *Alunogen* has seen these alterations: the numerical values of the indices changed to (from) 1.475(1.474), *1.478*(1.476), 1.482(1.483), B 0.010; formula $Al_2(SO_4)_3 \cdot 17\ H_2O$ (from $Al_2O_3 \cdot 3SO_3 \cdot 16H_2O$); $2V$ 75° (near 90°), Opt. orient. unchanged; TCL, tab or fib *c* (MON. Tab. (010), Fib. *c*); cleavages 010 perf, 100, $3\bar{1}3$; White (white); H 1.5–2 (H 1.5); G 1.79 (G 1.64–1.67); Sol. in H_2O, in closed tube, melts in its water of crystn. (Keramohalite. Sol. in H_2O).

Chapter IV collects the special tables for *mineral groups*, the number of which passes from 17 in 1934 to 31 in 1985. There again the formulae have been modernized, the population of each group has increased, the B has been added. Bringing together chemically similar species, disregarding the arbitrariness of the determinative tabulation, is a very worthy tradition that has been endorsed and enlarged. The future of Crystal Optics may be dim in determination, but it is brighter than ever as part of Crystal Chemistry, Solid State Physics, Materials Science, and other sciences that are interested in properties of matter and their relation to its structure. For years professionals in all these disciplines have accaparated most of Crystallography as their own. For some reason they have not been after Crystal Optics yet, but give them time — they'll see the light.

The last part of the book I wish to comment upon is the *list of references* cited. Out of the 104, nine are in German and three in Russian. Unfortunately one that should have appeared on the list was in French, and was missed (Girault 1980). His book covers the same ground as the book under review; the compilation of the literature stopped in 1977, against 1983 for the US work. His alphabetical list of mineral names contains, under A and B only, 23 names that are not in the US index, the latter, for the same two initial letters, has 59 mineral names not found in the Girault index. Girault's book does not include any mineral-group table; they were in the manuscript, but the publisher thought they would make the book too expensive. A new idea is to plot a characteristic index on a line on which the interval labelled 1.49 contains 10 subdivisions from 1.48 to 1.50 (for instance). These lines make vertical columns. Each mineral entry is marked by a horizontal segment showing its range. This scheme does away with the traditional subdivisions Uni(+), Uni(−), *etc.* This reviewer would recommend that both books be used simultaneously, for easy checking. The book is written in French, but that should not deter any one. As Professor Ray Young once said in an A.C.A. meeting: "French is English misspelled". Personally I say: "English is French mispronounced."

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