Through Mr. W. L. Lemcke of Franklin, Pa., the writer has learned that Mr. Andrews was one of the engineers who cooperated to effectively use ultraviolet light at the works of the New Jersey Zinc Company at Franklin, N. J., to control the concentration of willemite.

It is employed to examine the wet waste sand or "tailings" from the jigs in which that part of the ore not picked up by magnetic concentration is separated by gravity into its constituents. The tailings, chiefly calcite, may contain more or less of the valuable ore willemite. By holding the iron-arc over a car of tailings the workman can quickly judge by noting the number of points of light (willemite particles) on the surface whether the jigs are correctly adjusted to make the best possible concentration. It is a very rapid and useful check on the process. From this use the iron-arc soon found its way into the office of the chemist at the sampling laboratory and knowledge of the effect of ultraviolet light in producing fluorescence in minerals has now become widespread. Its use for museum display as exhibited in the mineral collections of the British Museum and of the Philadelphia Academy of Science has been described in recent publications.[3]

It is a satisfaction to be able to make known generally the fact that Mr. Andrews was a pioneer in the development to practical form of this beautiful and very useful instrument of science.

BOOK REVIEWS

LEHRBUCH DER ERZMIKROSKOPIE. HANS SCHNEIDERHÖHN, professor of mineralogy in the University of Freiburg and PAUL RAMDOHR, professor of mineralogy in the Technical High School in Aachen. Gebrüder Borntraeger, *Berlin*, **1931.** Price $17.50 (bound).

This monumental work on the microscopic study of the ore minerals in vertically reflected light is to comprise two volumes and an appendix consisting of determinative tables for ore minerals. At the present writing only volume II and the appendix have come off the press and this review applies only to the former. It contains 714 pages of text with 7 drawings, 235 photomicrographs in black and white and 4 photomicrographs in colors. The "Lehrbuch" can be considered a second edition of Schneiderhöhn's earlier work "Anleitung zur mikroskopischen Bestimmung und Untersuchung von Erzen und Aufbereitungsprodukten, besonders im auffalenden Licht" which appeared in 1921. Volume I of the "Lehrbuch" will consist of the fundamental scientific principles of reflected light, description of the instruments and the methods of investigation. Volume II is a description of ore minerals and their microscopic properties.

[3] *Am. Mineralogist*, **14,** 1929, 33 and 362.

This volume is a systematic descriptive mineralogy of the ore minerals, with some of the more important gangue minerals, such as quartz, the carbonates, augite and hornblende. The sequence of the minerals follows in general that of the tables of Groth-Mieleitner modified in accordance with recent chemical and microscopic observations.

The authors have arranged the data for each mineral in a definite sequence and since in the past no definite system has been followed by the individual investigators, they strongly suggest that in the future others follow the same plan they have used. The scheme is as follows:

I. *General Properties.* The chemical formula, crystallography, crystal lattice, and physical properties are given according to the most reliable data.

II. *Preparation of Polished Section.* No general directions for grinding and polishing all ore minerals can be given; each mineral must be considered by itself. The procedure most suitable for the mineral under discussion is given under this heading.

Two properties of cohesion are referred to which serve as important diagnostic properties, namely, polishing-hardness and polishing-cleavage. Polishing-hardness manifests itself in varying relief of the different minerals on the surface of the section. Polishing-cleavage, as developed by polishing, is at times essentially different from the cleavage observed in the hand specimen. Often well-developed macroscopic cleavage fails to appear after polishing. The authors believe that a smearing of the surface caused by the polishing agent is the cause for this non-appearance.

Precautions are given for avoiding chemical changes in certain minerals caused by imbedding in sulphur-containing plastolin, or during impregnation in Canada balsam.

III. *Power of reflection, color, and reaction to polarized light.* The color of the mineral as seen in the reflecting microscope is described as completely as possible. This has been found to vary widely, in a subjective sense, according to what other mineral or minerals adjoin the mineral in question. For this reason the apparent color is given when the adjacent mineral closely resembles, and is apt to be confused with the mineral in question; also the apparent color is given when in contact with certain standard minerals such as galena, sphalerite, pyrite, chalcopyrite, pyrrhotite, etc.

The absolute reflective power, that is, the proportion of incident light that is reflected, is given both in air and in immersion oil, index 1.505. These values were obtained by means of a photometer ocular designed by M. Berek. Similar relative values were obtained by J. Orcel by means of a specially constructed photo-electric cell. Orcel's values for relative reflection are based on galena as a standard.

The most valuable data on anisotropism are brought out by observation in reflected light with crossed nicols, and must be made with a very strong light source. According to Berek, reliable quantitative data cannot be obtained by this method, which corresponds to the observation of the reviewer. The authors give empirical designations for the anisotropic effect as: very weak, weak, well recognizable, strong, extremely strong. These are, of course, not exact quantities and correspond to the authors' own impressions. The authors also give the colors as seen under crossed nicols, both in air and in immersion oil. (Herein the reviewer differs from the authors and from American scientists, such as Bateman and Farnham, in that he believes that the colors of most minerals observed under crossed nicols are modified largely by the source of light, the optical system and condition of the microscope, and especially by the amount of rotation of the analyzer from the crossed position. For minerals of very strong anisotropism or peculiar polarization colors, such as covellite and arsenopyrite, these colors can be described and duplicated by separate observers; but for the great majority of minerals approximate degrees of variation in intensity are all that can be described with assurance). The authors say almost nothing about the advantage of rotating the upper nicol a few degrees (Sampson's method) which in the reviewer's opinion is vastly superior to the 90° (or exactly crossed) position of the nicols.

IV. *Etch Behavior.* The usual etch tests, which have been made use of by Murdoch and by Davy-Farnham for the determination of ore minerals, are given in this section. Certain drawbacks to this method, such as the electrolytic effects set up when a drop of reagent covers two or more adjacent minerals, are emphasized by the authors. When a single mineral occupies the section the results obtained by different observers check fairly well. The etch-cleavage and blue color produced on chalcocite are specific tests for that mineral; likewise the yellow coating produced on stibnite by KOH. "But in most cases the reactions described as 'tarnishes', 'dissolves', 'gives a precipitate' etc. are so dependent upon unforseen factors that no reliance can be placed upon them. We have, therefore, from the start given up attempts to further this method of obtaining definite properties and warn all against too much dependence on this method of determination."

The present writer takes issue with the authors on this somewhat sweeping statement. With experience in manipulation and observation, surprisingly consistent results are obtained by the systematic etching scheme. The electrolytic effects so emphasized by the authors can be noted for definite mineral associations, but it is the reviewer's belief that these effects are so small with most mineral associations as to be negligible. The platinum loop with which the drop is applied can be made as small as 0.6 mm. diameter and even with complex intergrowths, areas of the unknown mineral can be found with greater diameter. As long as the boundary is not spanned by the drop the electrolytic effect can be neglected entirely.

A different type of etching is strongly favored by the authors, that is, structure etching. It has for its goal the development of an etch fluid for every ore mineral which will bring out the following:

1. The inner nature of the crystal grains (twinning lamellae, zones, deformations). This is termed "internal grain etching."

2. The different degree of attack in different crystallographic directions, since the individual grains in the aggregate are oriented differently. It cannot be sharply separated from 1. This is termed "grain surface etching."

3. The grain boundaries of the individual crystals in the aggregate or "grain boundary etching."

Etch fluids which the authors hope will fulfill these conditions for every mineral are to be described in the forthcoming volume I.

V. *The inner nature of individuals.* The most widely occurring surfaces within a crystal grain are twinning lamellae, which are extraordinarily widespread among ore minerals. The authors differentiate between the different types of twinning as follows: growth twinning, resulting from the formation of the mineral; pressure twinning resulting from the effect of external pressure; and transformation twinning, which results from the change of temperature whereby the mineral passes through an allotropic transformation point.

The authors observe that "Deformations are extremely abundant among ore minerals. . . . They manifest themselves in undulating extinction, warping, translation and glide twinning formations, finally cataclasis in all stages. All these phenomena signify that either the space lattice is under external pressure or that the 'free surface' has become very great." Unmixing phenomena are also considered in this section and the authors have widened our knowledge of these structures very materially. They have been produced experimentally by Lombard, Merwin, Greig, Schwartz and Bateman in this country.

Structures formed by replacement are also discussed and the authors make the following observation which is fully justified. "One must avoid judging as such all forms which at first glance seem to indicate replacement. This has been done too often in the literature."

VI. *Structure and Texture.* The authors do not attempt to describe systematically all the textures and structures that can occur in ore deposits, but they have made all possible observations with the idea of publishing in the future a text book on ore deposits.

Special textures considered are gel-textures which, they state, can form not only at temperatures below 100° but also in molten fluids. Replacement structures are considered in detail and where possible the ascending or descending origin of the replacement is determined.

Intergrowths with other minerals are considered which do not of themselves prove replacement. Such are the widespread "graphic", "eutectic", "myrmekitic" intergrowths, also "mutual boundaries."

VII. *Possibility of confusion with other minerals and recognition.* In this section are given minerals which are apt to be mistaken for the mineral in question, and criteria for distinguishing between them are described.

VIII. *Position in a classification of ore deposits and paragenesis.* The authors have attempted to classify every polished section as far as possible with regard to its position in a systematic classification of ore deposits, especially that set up by Niggli and Schneiderhöhn in 1926. This was only carried out in part in the work under review but they expect to use the abundance of observations already made in a future textbook.

Finally a partial list of localities in which the mineral occurs is cited. The localities chosen are for their value from a genetic rather than an economic standpoint.

IX. *Literature.* References to the literature are collected at the end of the book. The list comprises not less than 618 separate articles. To the reviewer this list constitutes one of the most valuable portions of the book, especially for North American geologists, for many articles are cited which cannot be found in by far the greater number of libraries available to them. There are a surprising number from the geological and mineralogical publications from such countries as Norway, Sweden, Finland, Russia, Austria, Holland, Japan, China and many others. The authors have combed the literature with admirable thoroughness.

* * *

The book is printed on paper of exceptionally good quality, and this permits the reproduction of details in the illustrations with the greatest fidelity. The photomicrographs are carefully selected and are given for nearly every mineral described. They are superior to nearly all those in American scientific magazines not only because of the better quality of the paper but also because of the unusual size of the pictures themselves. The largest of these measures 8×11 cm. and the smallest 5×6 cm.

The amount of space given in the text to each mineral varies with the importance of the mineral and the quantity of data available. Schapbachite, for instance, takes up little less than one page, whereas chalcocite covers 24 pages. The price of the book, $17.50 for a bound volume, places it beyond the reach of the average student.

That the authors are perhaps fully aware of the importance of their own work appears from the following statement: "Beide Verfasser Können wohl ruhig sagen, das sie zusammen mehr erzmikroskopische Beobachtungen gesammelt haben und mehr Anschliffe durchmikroskopiert haben, als es irgendwo sonst der Fall sein wird. Ungerechnet die Schliffreihen aus Einzellagerstatten, die in Spezialarbeiten untersucht wurden, haben beiden Verfassern etwa 6000 systematisch ausgewahlte Anschliffe von den verschiedensten Lagerstatten der Erde zur Untersuchung vorgelegen."

It should be stated, in conclusion, that this book is unquestionably one of outstanding excellence and should at least be on the reference shelf of every institution where economic geology is taught, and thus be available to all students of ore deposits.

M. N. Short

ERZMIKROSKOPISCHEN BESTIMMUNGSTAFELN. Appendix to Lehrbuch der Erzmikroskopie, H. Schneiderhöhn and P. Ramdohr. Gebrüder Borntraeger, *Berlin*, **1931.**

The Determinative Table is an appendix to Volume II but is bound under separate cover. It contains 4 pages of explanatory material and 42 pages in the table proper. Minerals in this table are arranged in accordance with their qualitative and not quantitative characteristics. The only quantitative data used are the relative reflective values for the minerals. As these determinations involve a rather expensive apparatus, they are not used as a basis for main subdivisions but are given in the incidental data. The principal properties on which minerals are arranged are: A—Hardness, B—Behavior toward polarized light, and C—Color. The arrangement according to hardness is as follows:

I. Soft, or minerals softer than galena.
II. Medium, or minerals harder than galena and softer than pyrrhotite.
III. Hard, or minerals harder than pyrrhotite.

These main divisions are in turn divided into subdivisions on the basis of their reactivity toward polarized reflected light as follows:

1. Isotropic.
2. Weakly anisotropic.
3. Strongly anisotropic.

There is no hard and fast line between 2 and 3 but in general if the effect is only apparent with strong illumination and reflection pleochroism is absent, the mineral is considered as weakly anisotropic. If a mineral shows the effect with moderate illumination, and especially if reflection pleochroism is present, the mineral is strongly anisotropic.

The three main divisions, each with three subdivisions comprise nine groups or classes. Each of these is in turn divided into three sub-groups on the basis of their color in reflected light as follows:

(a) Pure white, closely resembling galena.

(b) Slightly colored, "not decidedly colored, but in direct comparison with galena, especially by means of the comparison ocular, clearly different as seen by color-sensitive eyes."

(c) Strongly colored, clearly recognizable as colored, even without the comparative ocular.

The result of the foregoing scheme is 27 "pigeon-holes." The descriptions given for each mineral are necessarily very condensed from those in Volume II. The mineral names are arranged in a column.at the left-hand border of the page and the data are given in compartments successively to the right in the following order: reflective power, color internal reflection, cohesion (cleavage, etc.), elements present, etch tests (according to Murdoch and to Davy-Farnham), special characteristics, and page reference (referring to Volume II where a more detailed description is given).

These data are arranged so effectively that for most minerals three or four horizontal lines suffice to complete the description. The "pigeon holes," as might be expected, vary in the number of minerals which they contain. For instance I. 3.b (Soft—strongly anisotropic—slightly colored), contains 21 minerals, whereas III. 2.c (Hard—weakly anisotropic—decidedly colored), contains only one mineral, ludwigite, $3\ MgO \cdot FeO \cdot Fe_2O_3 \cdot B_2O_3$. The book is of convenient size, 7×10 inches (approx.) and the descriptions are printed only on the right hand pages, giving the user plenty of blank space on which to record additions or corrections.

The scheme is indeed an ingenious one and were it possible to make the distinction required, it would fulfill the purpose for which it was intended. There are, however, some factors which militate against the effectiveness of the scheme as they do against any scheme of pigeon-holing minerals; by far the most important is the large number of minerals which approximate in their characteristics the boundaries between successive pigeon-holes. In the above scheme if a mineral is very soft, it is very difficult to determine whether it is softer or harder than galena. Such a distinction is difficult even with the Talmage hardness instrument. Similarly even the experienced observer will find it difficult to decide whether a mineral is galena-white, or whether it is significantly more colored than galena. By setting up such a criterion the authors have in large measure reverted to the original scheme of Murdoch which relied upon separation of delicate shades of color for subdividing minerals. The authors in part avoid the difficulty by stipulating the use of the comparison ocular. This is expensive in itself and requires an additional metallographic microscope, which constitutes a serious objection in any general determinative scheme. American microscopists, after some years of experience with Murdoch's textbook, were almost unanimous in their opinion that delicate color distinctions should not be made the basis of a determinative scheme for ore minerals.

The appendix is an essential feature of the authors' work and is a valuable reference book for all who are interested in ore minerals.

M. N. SHORT

Correction

The reader is asked to make the following corrections in the article "On the Triclinic Manganiferous Pyroxenes" which appeared in the October and November issues of the Journal. On page 411, fourth line from top, "$MnSiO_3$" should read $MgSiO_3$. Also pages 510 and 511 have been transposed. Page 511 should be numbered 510, and 510 should be 511.