BOOK REVIEWS

MINERALOGY FOR AMATEURS, John Sinkankas, D. van Nostrand Company Inc., Princeton, N.J. 1964, pp. xiii + 585, 327 illustrations, $12.50 U.S.

Prior to his retirement from the U.S. Navy Captain John Sinkankas had developed an ardent love for minerals and an amazing self-taught knowledge of mineralogy. He had learned also the art of the lapidary and indeed had become known as a lapidarist of great skill. His hobbies led first to the writing of articles for magazines and then to the writing of three books, *Gem Cutting*, *Gemstones of Northern America*, and *Gemstones and Minerals—How and Where to Find Them.* These books quickly established his place in the field of lapidarists and gemmologists. Since his retirement in 1961, he has produced the present book which should establish him in similar manner with amateur mineralogists. He is a perfectionist both in the cutting of a gemstone and the searching out of the detail concerning mineral species. He is no less a perfectionist in his attempt to explain the many facets of mineralogy and to simplify for his reader the difficulties which he remembers all too well from his own experience.

Mineralogy for Amateurs was written to provide a bridge between the extremes of the literature prepared for the beginner and that for the college student. The author worked from personal experience, for having begun as a rock-hound, he soon realized as he says, "... the need for knowledge, if for no other reason than to protect himself against fakes, imitations and the multitude of specimens of indifferent quality...." He makes only one assumption, that the reader wishes to learn mineralogy. From that point, he proceeds with easy style and non-technical language. Often making use of quite refreshing analogies, he shows the relationships between the atoms which force them to combine only in certain ways. The reader is led gently but surely through a discussion of atoms, elements, ions, atomic bonds, crystals, isomorphism, polymorphism and non-crystalline materials.

Succeeding chapters deal with classification, crystal growth, crystallography, physical properties, optical properties, formation and association of minerals, and finally identification procedures and tests. It is impossible to deal here with these chapters in detail but one or two examples can be cited. The chapter on crystal growth is not only well illustrated but contains many fascinating details of crystal growth, and of inclusions and their orientation which are usually glossed over in text books but are of much interest to the professional and amateur. Under "Geometry of

Crystals," he deals with the intricacies of crystallography, pointing out that the amatueur need concern himself only with the essentials. These are then handled with dispatch and with the view that this information all adds up to a better appreciation of crystals and a surer identification of the mineral. After the description of the forms in each class, there is a list of clues to recognition of crystals of that class. Here appears, not only the shape of crystal faces, but variation of lustre on faces, etch marks, striations and others. In the discussion of physical properties, the reader is kept constantly aware of the relationship of these properties to the crystallography and therefore the atomic structure of the species in question. The modern propensity for "Do-It-Yourself" crops up in the discussion of specific gravity. Here the author describes the home manufacture of a beam balance and a Jolly balance. His experience with gem materials compels him to add a fine description of the use of heavy liquids in working with fragments too small to be dealt with by means of either balance.

The second half of the book is devoted to descriptive mineralogy. Nearly three hundred species are described. These were chosen as those most likely to be encountered during personal collecting activities or obtained through exchange or purchase. In keeping with the amateur approach, the major descriptions are given for those species which ordinarily appear in good cabinet specimens. The selection of specific data in the descriptions is also aimed at the amateur and emphasis is put on those characteristics which he can determine in his home laboratory. These include statements of refractive indices. (In the chapter on optics, instruction in the use of the refractometer and the quick preparation of test specimens is given.) Statements concerning size and quality of crystals and matrix specimens are included whenever possible in an effort to make the amateur more discriminating.

Excellent drawings and photographs illustrate the book throughout. The author has done a fine job in this department. All the line drawings are from his pen and with very few exceptions the photographs were made under his direction. Many of the specimens, so illustrated, are from his own collection. In all of the photographs he has given a description of the specimen, its size and its origin. What a delight to the mineral lover!

There are two appendices. The first contains a series of identification tables which, in addition to those usually seen, include a table of refractive indices and one of fluorescent species. The second is a list of more than one hundred books on mineralogy and petrology, localities and deposits, gemmology and lapidary, and a number of magazines and journals which are recommended as references and reading material.

In *Mineralogy for the Amateur*, John Sinkankas has shown that he knows mineralogy and not only knows his minerals but loves them. Once again he has shown himself to be a fine teacher. Having set himself the task of writing an original book on mineralogy, he has done so most successfully, in amazing detail and with the ring of authority. Although written for the amateur, for whom it is a "must," this book should have much appeal for the university student as well.

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ZUR ENTSTEHUNG DER MARIN—SEDIMENTÄREN EISENERZE (A treatise on the genesis of the marine sedimentary iron ores) by H. Braun, Clausthaler Hefte zur Lagerstattenkunde und Geochemie der Mineralogischen Rohstoffe, Heft 2, 1964. Gebr. Borntraeger, Berlin, 133 pages, 15 tables, 12 plates. Price DM 72 (by subscription), DM 80 (purchased individually). In German.

An introduction and presentation of the problems is followed by a detailed discussion of the following main topics:

1. Stratigraphic-paleogeographic relationship in time and space with respect to marine iron ore genesis.
2. Determination of various facies types by means of microscopic investigations.
3. Comparison of the composition as defined by microscopic investigation and by chemical analysis.
4. Relationship between iron and associated principal components of the marine milieu, and the physicochemical conditions.
5. Genesis and diagenesis of the marine sedimentary iron ores.

All these problems and questions are discussed on pages 1-91 and illustrated by 24 figures. Thirty thin sections are described in detail on pages 93 to 120 and 33 corresponding photographs of thin sections (six in excellent colour reproductions) are presented on Plates I to XII.

The chemical and mineralogical composition of 15 different ore types is given on tables I to XV and a very valuable and detailed bibliography pertaining to sedimentary iron ores is found on pages 121 to 130.

History and development of ideas and opinions pertaining to the genesis of the sedimentary iron ores are adequately presented in the introduction.

The author has subdivided the genesis of the well-known and often disputed marine sedimentary iron ores of the minette type into three parts:

1. Origin of the iron, or how has the Fe been dissolved out of hardrocks or sediments of average Fe content.
2. Transportation of the iron and associated components.

3. Reprecipitation of the iron and associated components and formation of the various iron minerals.

Stratigraphically, the marine iron ores have been formed mainly during the Precambrian, Ordovician and Jurassic periods. The sedimentary iron ores have been formed with preference in restricted basins, similar to the recent Black Sea. A facies sequence may be observed with limonite (occasional glauconite), siderite and chamosite and pyritic clay which formed progressively from the coast towards the center of the basin.

The paleogeographic distribution of the deposits is described and illustrated in detail with respect to central Europe only.

The author has subdivided the sedimentary iron ores into 14 facies types, based on a combination of six oölite and eight groundmass types. Each facies type is described in detail, listing mineral components, textures, conditions of formation as well as origin of sample. Out of approximately 300 thin sections examined by the author in order to establish the above subdivision, 30 character-type sections are described in detail, and illustrated by excellent photographs.

On tables I to XV the exact mineralogical-chemical composition of 15 facies types is presented. These valuable tables may be used to determine the chemical analysis from the mineralogical composition or vice versa. A microscopic examination of thin sections may thus be used to avoid expensive and tedious chemical analysis in the economic evaluation of sedimentary iron ores. Possible errors (up to a magnitude of 4%) resulting from the variable mineralogical composition and $CaO—CO_2$ ratio are discussed in detail.

The author discusses the physico-chemical behaviour of iron in sea water. Normally, sea water contains only very minor amounts of Fe (2×10^{-6} gm/l). The solubility of bivalent iron is much greater than that of trivalent iron, and the solubility of iron in general is highest in a medium of low acidity, of CO_2 as in the presence of decomposing organic material, and in the absence of oxygen.

The solubility of aluminum and of silica in media of various pH values is shown on Fig. 19 and table 10. These elements are most soluble in a slightly basic environment. The solubility of aluminum at pH 7.5 to 8.5 explains the incorporation of Al_2O_3 in limonitic silicate ooids. Thus the range of formation of the various iron silicates is a function of the mobilization zone of the iron (weak acid) and that of silica and aluminum (weak basic).

The $O_2—CO_2$ and pH relationship is well demonstrated in several graphs while the $O_2—CO_2$ distribution largely controls the Fe content in the upper zones of the sea basin, the H_2S and NH_3 distribution is of prime importance for the deeper zones of the stagnant Black Sea type basins.

The role of submarine currents in the causation of primary facies changes is discussed in a separate chapter. The major currents known today are rich in oxygen and generally prevent the formation of H_2S and CO_2 zones. Of far greater importance for the genesis of sedimentary iron ores have been the smaller currents and cycles within isolated sea basins, causing changes in smallest paces, i.e. the formation of the oolites proper.

The only iron mineral of importance known to be formed in recent times is glauconite. Its formation is restricted to shelf zones rich in CO_2 believed to originate from substantial amounts of dead organisms. The available oxygen is totally consumed by the decomposition of the dead organisms which leads to the production of CO_2. The iron dissolves from the bottom sediments into the CO_2 rich sea water and reprecipitates in a more basic environment. Glauconite is a mineral formed at lower temperature and in more agitated water than other sedimentary iron minerals. It is postulated that the large iron deposits were formed in ancient basins where a warmer climate prevailed (no ice caps at the poles).

As to the genesis discussed in the last chapter of the book, the author largely concurs with BORCHERT, insofar as the formation of the iron deposits including the mobilization of the components and their precipitation as well as the formation of the minerals has to be considered a marine event.

The climate is considered to be the determining factor in balancing inflow and precipitation against outflow and evaporation in the case of isolated sea basins. Most favourable conditions for the formation of iron deposits are found in regions where the precipitation is greater than the evaporation.

Most animal and floral organisms are found in the upper oxygen rich zones. The sinking, decomposing organisms produce a CO_2 zone (pH 6.5–7.2) and, at greater depth, near the basin bottom, the H_2S and NH_3 zones (pH 7–8.5). The iron is dissolved in the CO_2 zone in the form of bicarbonate out of fresh sediments. Silica and aluminum, in turn, are dissolved mainly in the CO_2 and H_2S zones.

The formation and deposition of the iron minerals has to be considered a combination of chemical precipitation and mechanical sedimentation, with an intermediate colloidal state during which gels are formed.

The interplay of chemical and mechanical processes is largely responsible for the various facies types (combination of groundmass and oölites).

The author considers the diagenesis relatively unimportant since it does not change, as a rule, the material constituents of the ores.

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