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BOOK REVIEWS

IGNEOUS PETROGENESIS: A GLOBAL TECTONIC APPROACH. By M. Wilson. Unwin Hyman, London, 1989. 466 pages. $39.95 (softback).

The book publishing community recently recognized the need for a petrology text that addressed igneous petrogenesis in order to augment classical texts containing phase diagrams and petrographic and field relations. This book is one of several good attempts published in the last two years that aim to fill the petrogenetic gap (see other recent *American Mineralogist* reviews). Wilson's book represents the most radical of the publications in that it departs almost totally from the classical igneous petrology text, with the classification of igneous rocks and phase diagrams occupying only eight pages. The emphasis is shifted to relating igneous activity to global tectonic processes.

The book is split into two principal sections; the first includes an outline of the chemical characteristics of igneous rocks followed by an introduction to the use of trace-element and isotope geochemistry as petrogenetic tools. In subsequent chapters the author discusses the generation of melts in the mantle and their subsequent modification by various magmatic processes. The second part of the book divides magma genesis into three tectonic environments: constructive plate margins, destructive plate margins, and intraplate locations. The tectonic provinces are further subdivided into individual chapters. The crustal structure is outlined in each chapter before the constraints on the degree of partial melting in the mantle and subsequent magma differentiation are discussed, and, finally, detailed petrogenetic models are presented.

The first section of the book covers all aspects of igneous geochemistry. However, this thoroughness means that many subjects are mentioned only briefly. Consequently, students will undoubtedly be required to undertake extensive reading of other texts, or journal articles. This shortcoming is apparently acknowledged by the author in that she makes frequent reference to other recent igneous petrology textbooks, in particular, Cox, Bell, and Pankhurst. References cited are frequently of a general or review nature. Such references will tend to discourage students from reading original texts and assessing data for themselves. Perhaps the area of most notable weakness in the first part of the book is the section on the physical properties of silicate melts. There is little or no introduction to the basic concepts of magma rheology, yet the concepts are widely referred to throughout the book.

Chapters in the second part of the book are written in sections so that less knowledgeable students can omit subjects with which they are unfamiliar, e.g., isotope geochemistry. This structure sometimes makes the text repetitious. In addition, the second part of the book is so dominated by trace and isotope geochemistry that all readers must be very familiar with these aspects of geochemistry to obtain full benefit, perhaps making the segmented format unnecessary.

Wilson should be praised for the wealth of data contained in the second part of the book. The choice and quality of trace-element and isotope diagrams is particularly commendable, ensuring that the text will be widely used for teaching. The petrogenetic sections present a thorough coverage of current views on the subject. Unfortunately, I feel that an opportunity to excite and train new students is lost. Little guidance is given to the reader as to how to evaluate the different models. In addition, the discussion of areas of current debate is not sufficiently focused to suggest future research directions and consequent resolution of current controversies.

The major omission of the book, acknowledged by the author, is the lack of discussion of granite and rhyolite petrogenesis. Perhaps a more appropriate title of the book would refer to only basalt petrogenesis. Wilson has intended the text for the advanced undergraduate and beginning postgraduate student, but the book is definitely more suitable for the graduate student level. However, the book makes a commendable attempt to cover all aspects of basalt petrogenesis and is undoubtedly a valuable addition to the literature on igneous petrology.

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THE CRETACEOUS/TERTIARY BOUNDARY INTERVAL, RATON BASIN, COLORADO AND NEW MEXICO, AND ITS CONTENT OF SHOCK-METAMORPHOSED MINERALS; EVIDENCE RELEVANT TO THE K/T BOUNDARY IMPACT-EXTINCTION THEORY. By Glenn A. Izett. The Geological Society of America, Boulder, Colorado, 1990. v + 100 pages.

Izett provides a detailed discussion of the stratigraphy, mineralogy, petrography (particularly shock metamorphic features) and composition of the Cretaceous-Tertiary (K-T) boundary interval, primarily in the Raton Basin of Colorado and New Mexico. In addition, he compares and contrasts these K-T boundary sites with other sites in western North America (e.g., Wyoming, Montana, and Saskatchewan, Canada) and in Europe (e.g., Stevns Klint, Denmark; Gubbio, Italy; and Caravaca, Spain). Izett points out that at most sites in western North America the K-T boundary interval is marked by a pair of claystone units. He refers to the lower unit as the boundary claystone and the upper unit as the impact layer (earlier referred to as the "magic layer").

The K-T boundary claystone is generally 1–2 cm thick and is composed primarily of kaolinite containing two types of spherules (kaolinite and goyazite). Centimeter-size kaolinite pellets, some of which contain carbonaceous plant material, are also present at some sites. The trace element composition of the boundary claystone is, in general, similar to the trace element composition of tonsteins (kaolinite-rich layers found in coal seams) except for high concentrations of Pt-group elements, including Ir.

The overlying K-T boundary impact layer is commonly 3–8 mm thick and also consists of kaolinite, but with considerably more illite/smectite mixed-layer clay than the boundary claystone. The K-T boundary impact layer does not contain kaolinite or goyazite spherules, but it does contain Fe-rich spherules composed of jarosite and goethite. The impact layer contains up to 2% clastic grains of quartz, quartzite, metaquartzite, chert, feldspar, and rare granite-like rock fragments, some of which show evidence of shock metamorphism. The chemical composition of the impact layer is similar to that of the boundary clay layer, but the impact layer contains more Fe, K, Ba, Cr, Co, Li, V, and Zn, and it has a larger Ir anomaly.

Previous workers have suggested that the boundary claystone and impact layer are composed of primary impact ejecta or vol-

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canic material. Izett argues against the volcanic origin for these units based primarily on the "lack of a coherent assemblage of volcanic crystals." He also argues that the boundary claystone is not composed of altered impact ejecta because it essentially lacks shock-metamorphosed minerals and contains only a minor Ir anomaly. He points out that the boundary claystone contains deformed vitrinite laminae, root-like structures, and plant impressions. The contact between the impact layer and the underlying boundary claystone is generally sharp, and Izett proposes that locally it may be a diastem. Although some authors have suggested that the kaolinite and goyazite spherules may be altered microtektites, Izett argues against such an origin. Although Izett believes that the shock-metamorphosed mineral grains and the Ir anomaly associated with the impact layer are caused by an impact event, he proposes that only a small fraction of the impact layer is composed of altered impact ejecta.

Izett discusses the abundance and size of shock-metamorphosed grains at K-T boundary sites throughout the world and concludes, like other authors, that the K-T impact occurred in North America. He also discusses the evidence for the size of the K-T boundary crater and concludes that it need not be as large as previously suggested. Finally, he concludes that the Manson impact structure in Iowa (36 km in diameter) may be the impact site based on geographic location and petrographic and age data.

One of the arguments that Izett uses to support his conclusion that the source of the K-T boundary impact ejecta was the Manson structure is the lack of thetomorphic glass (shocked glass preserving earlier textures) in the K-T boundary layer and in shocked rock from the Manson structure, which he interprets as indicating only low shock levels. I fail to see how an impact that could produce an impact crater 36 km in diameter and throw impact ejecta around the globe would not produce some thetomorphic glass in quartz- and feldspar-rich target rocks. It seems more reasonable to assume that the thetomorphic glass was not preserved.

The book is profusely illustrated, having 48 figures, 35 with photographs. It contains 12 tables and over 320 references. In general, the text is well organized and well written. However, some material is unnecessarily repeated and some discussions seem out of place. For example, the material in Table 9 is discussed on p. 56 and again on p. 77. The "fern spore spike" above the boundary claystone is discussed in the section entitled "Rocks Directly Underlying the K-T Boundary Claystone."

I am surprised that some of the seemingly numerous negative comments concerning previous work were not edited. Izett often uses words or phrases such as "imagined," "purportedly observed," "claimed to have," and "alleged" when referring to previous work. It would have been very easy to indicate his disagreement with previous authors in other ways.

In spite of the few problems mentioned above, I highly recommend this book for anyone who is interested in the debate concerning the nature of the Cretaceous-Tertiary boundary.

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X-RAY STRUCTURE DETERMINATION, A PRACTICAL GUIDE, Second Edition. By G.H. Stout and L.H. Jensen. John Wiley & Sons, New York, 1989. xv + 453 pages, $49.95.

The first edition of this book, published in 1968, is probably found on the bookshelf of all mineralogists with an interest in crystal structure analysis; this comprehensive treatment of the subject is usually the first purchase of beginning students in crystallography. In the years since the initial publication much has changed in structure analysis, particularly as a result of advancements in computer hardware and software. It is pleasing that the authors have updated their original work and published a revised second edition.

A chapter-by-chapter comparison of the two editions shows that the authors have retained the original organization of the material. As in the first edition, they divide the book into three parts: Part I. Preliminary Stages (Chapters 1–9, 235 p.), Part II. The Phase Problem (Chapters 10–15, 96 p.), and Part III. Refinement and Results (Chapters 16–19, 78 p.).

No prior knowledge of crystal structure analysis is assumed in Part I, which begins with a treatment of X-rays, diffraction, crystals, and symmetry. The theoretical treatment of these topics is followed by a practical discussion of geometric and intensity data collection, data reduction, structure factors, and Fourier syntheses. I have found with the first edition that the advanced graduate student quickly consumes the treatment of these topics, and the same will hold true for the second edition. However, the book is not meant to replace the original, detailed works on these topics, and the new edition gives numerous references to the classic original works. In contrast to the earlier edition, the second edition adds brief discussions of synchrotron radiation, area detectors, fast Fourier transforms and matrix representation of symmetry elements and fortunately deletes much of the discussion of film methods of intensity data collection.

The phase problem is treated in Part II, and the changes from the first edition reflect the emergence of direct methods as the method of choice in crystal-structure solution. The authors note that 80–90% of all small-molecule structures are now solved using direct methods, and they give an expanded treatment of the subject that reflects its widespread applicability. The treatment of heavy atom methods, less germane to mineralogy than to the biological sciences and chemistry, has been reduced from the first edition. The discussion of Patterson methods, included in the chapter on heavy-atom methods in the first edition, has been expanded and treated as a separate topic in the new edition.

Structure refinement, random and systematic errors, derived results, and ambiguities and uncertainties are covered in Part III. The refinement of crystal structures, of primary importance to mineralogists, is given a broad overview. The authors treat most problems that the structure analyst faces in the refinement of routine structures. The lack of detail on certain subjects is understandable in a comprehensive book (for example, only one page is devoted to locating H atoms), but the authors give numerous references on the various subjects and do not pretend that their work should replace them.

The book is generally free from errors, although a few printing errors were noted. Many of the figures will be recognized from the first edition, but reproduction is not as sharp as in the original work. The fact that the authors approach crystal-structure analysis as biological scientists does not detract from the value of the book to mineralogists. Most examples of specific structure solutions or refinements are illustrative of principles, transparent to the actual compound being analyzed. References are updated from the earlier edition and appear to be comprehensive through 1987. Numerous 1988 references and a handful of 1989 references are also cited.

I suspect that the active mineral crystallographer who already owns the first edition will not purchase the updated version. Being in book form, the material is necessarily dated; for example, advancements in crystal-structure analysis already in widespread use, such as the absorption surface method of absorption correction, are mentioned only as promising approaches. The new edition certainly should be purchased by all scientific libraries. The reasonable price and comprehensive nature of the new edition also ensure that Stout and Jensen will continue as a required first purchase for any fledgling mineral-structure analyst.

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CHEMICAL AND DETERMINATIVE TABLES OF MINERALOGY—SILICATES.

By Roland M. Pierrot and Fabien Cesbron. Bureau de Recherches Géologiques et Miniéres, Orléans, France, 1989. 308 pages (hardback).

This book is a compilation of tables of chemical compositions of silicate minerals. It complements the earlier volume of chemical tables of non-silicates published in 1979. The volume contains data for 830 silicate mineral species. Silicides and SiO_2 polymorphs are not included. The book is organized by elements into 29 tables in ascending Z value, from Li to U, and one unclassified table. Thus, all minerals containing substantial amounts of the given element appear in that table. Minerals and their chemical formulas are listed in each table in their order of historical appearance in the mineralogical literature. This is an interesting and unusual approach, which according to the authors allows the tables to be updated without modification of the existing classification. The right side of each page is divided into 41 columns headed by a list of elements. Each column is marked with a bullet if the mineral formula contains that element. Following each elemental section is a descriptive section that gives the chemical formula, crystal system, space group, unit-cell dimensions, Z, and theoretical chemical composition. For minerals described after 1960, the five strongest X-ray diffraction lines and the published chemical analysis also are given. Notably absent are tables for radicals such as CO_3, SO_4, or PO_4.

The authors present an impressive collection of chemical data on silicates. However, the chronological arrangement of the entries in order of historical appearance is awkward to use. Also, the bullet tables are merely a repetition of the chemical formulas and are difficult to read, since no horizontal ruling is provided. Listing the "other elements contained" in order of their historical appearance makes the sequence of elements different for every table. For example, Cu is the first element listed in the section on Al minerals since chrysocolla is chronologically the first mineral in the list. In the Na section Fe is the first element.

The descriptive sections are very abbreviated but include two very useful lists of chemical composition data: (1) recalculated theoretical oxide weight compositions for all the silicates and (2) published chemical analyses for minerals described since 1960. However, the format selected to present this information is poor. The theoretical and the published analyses are run together in paragraph fashion instead of listed in a more legible tabulation.

This reader feels that the reference tables would have been more convenient to use if the minerals in each element section were listed in alphabetical order and the additional elements were arranged by atomic number or at least listed in a consistent manner in each section.

A few minor errors were noted. There is inconsistent use of umlauts for mineral names (e.g., rhönite and örebroite). There are minerals listed in the index that do not appear in the tables. The formula for cesium kupletskite is incorrect (Ca instead of Cs) in the Li table. Esseneite should be $Ca(Fe^{3+})SiAlO_6$ not $Ca(Fe^{3+},Mg)(Si,Al)O_6$. The formula for welinite should be $Mn_6[W,Mg]_2Si_2(O,OH)_{14}$. The formula for olenite is incorrect with six B atoms. It should be $Na_{1-x}Al_3Al_6B_3Si_6O_{27}(O,OH)_4$; $x = 0.4$. No explanation is given for the meaning of the slash in the formula for baghdadite (O_2/Si_2O_7). More serious is the failure to adhere to the IMA guidelines on mineral nomenclature for minerals with essential rare-earth elements. The IMA guidelines requiring a suffix to indicate the dominant rare-earth element apply to all minerals with essential rare-earth elements. This rule has not been followed; e.g., the correct name for minasgeraisite is minasgeraisite-(Y).

In spite of the availability of several computer programs that can rapidly categorize minerals by chemical composition, and even though this reference contains much less information than the recently published *Encyclopedia of Minerals,* this book is a valuable compilation of chemical data. It is the only up-to-date source of oxide chemical analyses for silicates assembled into a single volume. The *Chemical and Determinative Tables of Mineralogy* for silicates will be a very worthwhile resource for researchers who study the chemistry of minerals and especially for those who encounter potentially new silicate mineral species.

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