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BOOK REVIEWS

Gemstones. By M. O'Donoghue. Chapman and Hall, London and New York, 1988, 372 + xiv pages, 9 color plates. $55 U.S. ($77 CDN).

The last decade has seen major advances in the field of gemology, as evidenced by the appearance of several excellent books on specialized gemological topics. Examples include three books by K. Nassau entitled *Gems Made by Man* (1980), *The Physics and Chemistry of Color* (1983), and *Gemstone Enhancement* (1984), as well as the spectacular *Photoatlas of Inclusions in Gemstones* (1986) by E.J. Gübelin and J.I. Koivula. To these can be added numerous new volumes on specific gems and gem materials (*e.g.*, beryl, garnet, jade, pearls, ivory), as well as updated books on methods of gem identification and dictionaries on gemology. It is not surprising, therefore, that textbooks incorporating the above-mentioned advances will be written. The book under review is the first textbook to appear since *Gems: Their Sources, Description and Identification* (1983, 4th ed., 1006 pp.) by Robert Webster.

The contents of O'Donoghue's book are fairly predictable, as he covers the entire field of gemology in 372 pages; it covers a little of everything in 10 chapters. The chapter headings, which give the scope of the book, are: (*1*; 17 p.) Formation and occurrence of gemstones (based to a large extent on the nature of gemstone inclusions) ; (*2*; 18 p.) The nature of gemstones (primarily crystallography and related topics); (*3*; 23 p.) Gem testing (primarily physical and optical properties such as hardness, specific gravity, index of refraction measured by different methods, dichroism and fluorescence); (*4*; 10 p.) Recent developments in gem testing (*e.g.* , thermal conductivity method to discriminate between diamonds and simulants, measurement of reflectivity and other physical characteristics); (*5*; 38 p.) Color (an important chapter concerned with the physics and chemistry of color, including dispersion, crystal-field theory, color centers, band theory, color filters, the spectroscope, absorption spectra of gemstones, and the alteration of color by means of heat treatment, irradiation, and chemical treatments); (*6*; 10 p.) Fashioning (primarily cutting and polishing of diamond); (*7*, 10 p.) Gemstones in commerce (briefly covers diamond grading based on color, clarity and proportions, as well as suggestions on the purchase of gemstones); (*8*, 146 p.) Descriptive section: inorganic materials (this major chapter is a very predictable, and good, discussion of the optical, physical and chemical properties, and occurrences, of all the major gems, and many minor ones, presented in alphabetical order; where appropriate, the presentations include comments on modern methods of identification, color enhancement, synthesis, and other up-to-date topics); (*9*; 21 p.) Descriptive section: organic materials (comments similar to those about chapter 8 above also apply here); and, (*10*; 41 p.) Synthetic and imitation stones (this chapter is a succinct summary of very important topics which, if nothing else, indicates the breadth of these subjects). The book finishes with three short appendices: *A* (8 p.) Identification tables; *B* (2 p.) Useful sources of information (includes addresses of major journals and gemological societies worldwide of interest to gemologists); and *C* (1 p.) Birthstones. It also has a 5-page Glossary that includes technical terms not explained in the text.

From what can be seen from the contents described above, the author has covered all topics of interest to modern gemologists. Nobody can be expected to be an expert in all subdisciplines; therefore, the author has drawn heavily on the work of others, and these are clearly referenced. He has written his text in a clear and crisp manner, and he has interspersed numerous humorous comments, which I found very welcome. The book gives a significant amount of practical advice on modern procedures of identification. Another very positive aspect is the list of references, many of which were published in the 1980s (up to 1986).

In its price range (*i.e.*, in the $55 range or less), this book can certainly be recommended to those interested in a modern textbook on gemology. I believe that all gemology textbooks bearing publication dates before 1980 are now obsolete in view of the recent advances is synthetic gems, color enhancement, understanding the causes of color, identification techniques, and interpretations, which are now possible from inclusions. However, for those prepared to spend an additional $30, the comprehensive and authoritative book by Webster (1983) referred to above will yield significantly more material (1006 *versus* 372 pages), which many may find to be well worth the increment in expenditure.

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Theory of Earth Science. By Wolf von Engelhardt & Jörg Zimmermann. Translator: Leonore Fischer. Cambridge University Press, 1988 (German ed., 1982), U.S. $75.00.

Wolf von Engelhardt is a geologist and Jörg Zimmermann is a philosopher. Together they have examined the theories in Earth Science and their development through time. This book makes for heavy reading; unless you are willing to give your mind a good workout you better stick to jogging. Any reader will feel that he is skating on thin ice during some of the philosophical discussions, but when you are just about to fall through, you are brought back to solid earth by an example chosen from just about any specialty of geology. It is these wide-ranging case histories that greatly increase the attractiveness of the book. Von Engelhardt acts as a general geologist, drawing his examples from petrology, sedimentology, structural geology, and in particular often referring to the plate tectonic theory and the newly rehabilitated impact theory.

The book contains the following chapters: 1. The Structure of Communications in Earth Science. 2. The Language of Geoscience. 3. The Foundation of Geoscientific Research. 4. Problems at the Empirical Basis. 5. Problems of Inductive Organization of Empirical Data. 6. Problems of Theoretical Knowledge (Laws, Abduction and Deduction, Hypotheses and Theories). 7. The Growth of Geoscientific Knowledge. 8. Regulative Principles of Geoscientific Research.

It is not possible to do justice to such a fundamental text in a short review, and the above list does little to whet one's appetite. The purpose of such a treatise is to provide food for thought, to invite the reader to sit down and re-examine some very basic aspects of his field of interest, and to stimulate some new ideas or bring about the revision of some old dogmas. Thus, I chose to take some selected examples and discuss them in detail in order to provide the flavor of the book. In places it may not always be clear just exactly where the authors have left off and the reviewer has taken over. I make no excuses for this shortcoming, as anything else would make for terribly boring reading. Numbers in brackets refer to pages in the book.

Processes can be classified as stationary, secular, cyclic, *etc.* (90) or as catastrophic, episodic and continuous (125). Such classifications are important to the modern geologist who wishes not only to observe and describe but also to understand. However, the second of the above schemes of classifications can be challenged. The catastrophic process is really only a special type of episodic process. More and more it is recognized that most processes are episodic in nature, and the punctuations of Stephen Gould are gaining acceptance. One must bear in mind that geological observations tend to discriminate systematically against episodicity. For very low frequencies, with periods measured in tens to hundreds of million years, the event is improbable and thus not amenable to conventional scientific research. For high frequencies, with periods less than ten thousand years, the resolution in geological time commonly is insufficient to resolve the series of event and thus records it as continuous change. The sooner we bury the old dogma *"natura non facit saltus"* (nature never jumps), the sooner we shall unravel some of our puzzling observations.

The controversy of catastrophism *versus* gradualism or actualism is extensively discussed (314-325). In my view, we could have saved ourselves as geologists a lot of agony if we had ever properly distinguished between the IMPROBABLE and the IMPOSSIBLE. I postulate the improbable when I claim that a major meteorite is to hit the Atlantic within the next five years. I am not likely to be right, but there is no physical law that would preclude such an event. For the tabloid "News" to declare "Baby Born with Wooden Leg" is to advocate the impossible, since wood is not known to grow in a womb. We have failed in this distinction because of anthropomorphic thinking, a term often used in animal behaviorism but equally applicable in geology. An event with a 95% probability of occurrence in the next 15 Ma is not a major concern to the human race. However, to relegate it into the realm of the impossible is not permissible for those studying the earth's history.

Another useful distinction (not found in this book) separates self-terminating from self-perpetuating processes. Fault motion is self-terminating, since constant stress build-up is required for continued movement along the fault. Both deposition and erosion are self-perpetuating to a degree owing to the accompanying isostatic response.

Popper's concept that a theory may be falsified (Why do philosophers always have to sound worse than lawyers? What's wrong with being refuted, disproved, or even shot down?) or supported but never can be proven (302) figures repeatedly in the text. An error often committed is to label support as proof (274), something we all have been guilty of from time to time. In this context it is also worthwhile to restate a quote from Gilbert (280): "The method of hypotheses, and that method is the method of science, founds its explanations of Nature wholly on observed facts, and its results are ever subject to the limitations imposed by imperfect observation. However grand, however widely accepted, however useful its conclusion, none is so sure that it cannot be called in question by a newly discovered fact. In the domain of the world's knowledge there is no infallibility." This was written by G.K. Gilbert in 1896 and is still very wholesome reading for our younger

generation, who have grown up with instant soup, instant coffee, and instant wisdom, and for whom any publication older than 10 years is obsolete (31).

As to quotes from the book, here is a small sample: . . . "For these reasons scientists have a strong urge to write papers but only a relatively mild one to read them." (Solla Price) (6), "It does not suffice to describe the "face of the earth" or to recount the Earth's natural history" (233), "As long as observational results remain simply verbal lists of descriptions stored in data tables or computer banks, they are dead capital . . ." (265). Amen!

Continental drift and Wegener's fate surface repeatedly (7; 306). It is made quite clear that the true intellectual is a nonconformist (a maverick) and, as a scientist, is driven into isolation as much as any political dissident. [Art Meyerhoff (plate tectonics sceptic) and Thomas Gold (deep gas advocate) are excellent modern examples].

What is called the "directionality of time" is another interesting aspect that is discussed at some length (91). As an example we may look at evolution. It would be wrong to claim that evolution has a goal and in particular that *Homo sapiens* is its sole purpose (Only a very stupid person can believe that mankind is already intelligent enough for its own good: Gaylord Simpson). However, it cannot be denied that evolution progressed from low to high diversity, from low to high complexity, and from a small to a large biomass.

Chapter 1 on Communications in the Earth Sciences contains a few interesting observations. Thus the writers point out that the use of "we" instead of "I" is favored by many authors in order to anticipate consensus (16). Long lists of references are considered prestigious and allow for the inclusion of friends, possible reviewers and other important people (30). In the references one misses any mention of Teilhard de Chardin and Gaylord Simpson.

The above discussion should make it clear that ample intellectual stimulation is to be found in this book. Not many individual geologists may wish to place it on their personal shelves, but it certainly belongs in all university libraries. The translator must be commended for a good job on a difficult text.

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