have just heard. Examples are: Hoyle, Sandage, and Spinrad on the ages of elliptical galaxies, various theorists on Frank Low's interpretation of his infrared data, and Salpeter and Fowler on Hoyle's new theory of gravitation.

Of course the high level of discussion reflects the style of the conference. Highly selected participation (30 people at Rome compared to 170 at Uppsala) and leisurely discourse (30 papers at Rome compared to 82 at the Uppsala, in a similar time period) encourage high-level discussion. My general impression is that the Pontifical Academy of Sciences is very good at this sort of thing, perhaps because it is not obliged to invite everyone to its deliberations. In this case, the comparison between its style and that of the International Astronomical Union is striking. One might put it this way: The democratic approach (Uppsala) lets many specialists hear low-level discussions, while the elitist approach (Rome) lets even more specialists read high-level discussions.

Of course, that is not to say that there is nothing of value in *External Galaxies*. There are 12 review articles of considerable merit (although half of these are by speakers at the Rome conference, and can be read in *Study Week*). Although most of the research papers have by now appeared in the open literature (in the two years it takes to publish such proceedings), there are a few, such as Angione and Smith's study of the variability of quasars, which are both interesting and not easily available elsewhere.

But I repeat, if you can afford only one book on peculiar galaxies, *Study Week* should be it.

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Intricacies of Nomenclature

Crystal Chemical Classification of Minerals. A. S. POVARENNYKH. Translated from the Russian edition (Kiev, 1966) by J. E. S. Bradley. Two volumes. xvi, 766 pp., illus. $40. Monographs in Geoscience.

This work is a bold and full-scale effort to replace the existing systematics of mineralogy by a new nomenclature and classification based on crystallochemical principles. It is a translation, revised and updated by the author, of a work published in Russia in 1966. In brief, Povarennykh is proposing a system of acronyms conveying chemical and structural information to replace the cumbersome and generally meaningless trivial names that have accumulated in mineralogy since the time of Pliny and before. Although Povarennykh has already published several papers on the subject in the periodical literature (that are touched on in this review), and now a book, it would have been preferable if the general matter had first been discussed before a forum such as the International Mineralogical Association. This still must be done before acceptance can be obtained.

Povarennykh's proposal will undoubtedly seem eminently desirable to many persons, especially those working in the crystallographic aspects of mineralogy. The matter, however, is not so simple. The existing nomenclature is traditional and trivial, but it is a response to inherent characters of minerals that render difficult, and in part preclude, a comprehensive rational nomenclature.

The present proposal and the elaborate and forgotten scheme of H. M. Howe, proposed in 1884, take us back to a major turning point in the nomenclature of chemistry. The nomenclatures of mineralogy and chemistry, earlier both of a trivial nature, parted company in 1787 with the publication of the *Méthode de nomenclature chimique* by Guyton de Morveux, Lavoisier, Berthollet, and Fourcroy. This work conceived chemical nomenclature as a *method* of naming chemical substances, rather than as a rigid system of given names, and was based on the idea that the names of chemical compounds should be related to their constituents. The unit of description in inorganic chemistry is a compound of definite and limited composition, an end composition, that is the result of chemical preparatory operations that, in most instances, are based on natural materials of more general composition.

Minerals, on the other hand, in general are polycomponent solid solutions, often of extremely complex composition that usually varies in different geological environments. For instance, in a natural borosilicate with the formula $XY_3Z_6B_3Si_6O_{27}(OH,F)_4$, each of the separate X, Y, and Z structural sites is shared in varying ratio by two to four or more elements. No specimen of this common mineral has been found in which each site, or any site, is wholly occupied by only one kind of element. Similar complexities occur in many other common minerals. The complexity and variability of the composition of such minerals do not permit a convenient designation in a rational chemical nomenclature. There is no escape. The actual composition must be dealt with, since only this tells us what we have and preserves the genetic information that is carried.

This brings us to the Howe and Povarennykh proposals. In Howe's system, the names utilize arbitrary syllables, consonants, and vowels to indicate the chemical components, the stoichiometry, and the state of oxidation. Thus the mineral braunite, then formulated $Mn^2_4Mn^4 + Mn^4_2SiO_{12}$ was renamed shamnoemniute, in which sha $= 1Si$, mnoe $= 4Mn^2$, mniu $= 3Mn^4$. and te is a formal ending. In Povarennykh's system, as in that of Thomas Thomson in 1802, the names are acronyms based for the most part on the chemical constituents. Short designations are devised for the cations, and the anionic constituents are indicated by suffixes that state the element and are terminated by ite. Structural information, chiefly symbols or abbreviations indicating that the structure involves infinite linkages in one, two, or three dimensions, is also included. For example, the layer structure $CaBi_2(CO_3)_2O$, beyerite, becomes calcbistsitophyllite. A mineral containing Na, Mn, Zr, Ti, Si, O, and F becomes namanzirtiofdisilite. Stoichiometry is indicated by names, as tricuarsulite for Cu_3AsS_4 (enargite) and ar2plum2bis4sulite for $Ag_2Pb_2Bi_4S_9$ (benjaminite); valency is reflected in the name stibstibioxite for $Sb^3Sb^5O_4$. The designations for the cations sometimes conflict. Silver is designated ar, from argentum, and arsenic is ars, causing confusion between arsulite (AsS) and diarsulite (Ag_2S). Tongue and eye twisters such as dimagalsilditilite abound. Rationality easily runs aground on the shoals of practicality!

Aside from questions of euphony. and the change in name required by changing knowledge of the chemical composition—a more serious matter than correcting the formula of a mineral known by a fixed name—mnemonic systems suffer in that one must remember both the name itself and the system of notation as well. They also compound existing difficulties of construction and pronunciation in different languages. Many of these difficulties doubtless could be reduced by adoption of an international mineralogical Esperanto. This could quickly lead to a limited adoption of this type of system, perhaps for newly described minerals. The complete transformation of all existing names into a new system raises the problem of carrying on the meaning of the thousands of old names and synonyms in the past scientific literature.

In the case of Povarennykh's system, there is a further matter that creates an irresolvable difficulty. This concerns his redefinition of the unit of description to which a species name is to be applied. He unknowingly or unwarily returns to the precise definition employed by Franz von Kobell in 1848 in his debate with J. M. Fuchs on the species concept in mineralogy. This particular concept has run out, in the course of a century or so of consideration, into terms such as structure-type and isotype. It has proved useful in a classificatory way but not as a unit of description for species names. It states that the species comprises the entire range of composition within a single type of crystal structure. Povarennykh uses a single species name for this unit, with subspecies, varieties, and subvarieties within the unit being given names derived from the name of the species and formed from it by prefixes. This is superficially attractive, but it can deprive us of a rational name for any end composition present in the broad unit. For example, in the calcite group, the complete solid solution series between Mg-Fe and Mn-Fe results in Povarennykh's abandonment of the familiar designations siderite, magnesite, and rhodochrosite and their replacement by the two names magfercite and manfercite. The pure end compositions $FeCO_3$, $MgCO_3$, and $MnCO_3$, which do or can occur in nature, are indicated by prefixes to the solid solution names, as the subspecies ferromanfercite, magnesiomagfercite, and manganomanfercite. This is irrational because the end compositions contain only one cation and the names indicate two.

Povarennykh's two volumes, in addition to nomenclatural matters, also contain a treatment of relevant aspects of crystal chemistry and of various historical topics. There is also a useful partial description of the x-ray characters of some 1900 minerals; structural drawings and some interatomic distances are included.

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Personal Memoir

Rutherford. Recollections of the Cambridge Days. MARK OLIPHANT. Elsevier, New York, 1972. xvi, 158 pp. + plates. $7.50.

Oliphant's recollections of his decade at the Cavendish Laboratory are a welcomed addition to the genre of what might well be termed highly personal source material. His reminiscences will be of interest to the sociologist and historian of science as well as to a more general public. They provide not only anecdotal glimpses of the striking personalities associated with Ernest Rutherford during the last ten years of his directorship of the Cavendish, but also offer diverse suggestions as to Rutherford's abilities and limitations in the scientific, administrative, and teaching arenas. Thus, although the somewhat standard claim is made that Rutherford was the greatest experimental physicist since Faraday, the most vivid depictions are of a researcher so eager for results (and yet, somehow, incapable of providing more than the bare essentials of equipment) that his collaborators, who were continuously engaged in the experimentation itself, hoped for—and even conspired to assure—his absence during critical moments lest he damage apparatus and spoil incipient results by his enthusiastic, impetuous behavior!

As a book the work suffers severely from two related defects. It may be expected that any set of recollections spanning a decade will be diffuse, but this book is unnecessarily episodic and disorderly in spite of chapter titles and subheadings that give an initial promise of organization. One therefore regrets all the more that it was not deemed worthwhile to prepare a careful, or indeed any, index. Second, while Oliphant has usefully supplemented his own recollections with those (some of them previously unpublished) of several of his Cambridge colleagues, he has curiously enough restricted himself to these same sources when attempting to sketch in background material and to make historical assessments. It is true that in an introductory disclaimer he urges that his work be regarded as but a supplement to the official biography by A. S. Eve (*Rutherford*, Cambridge, 1939). It is also true, however, that in the intervening third of a century a small but significant body of historical scholarship has emerged. In not making use of this scholarship Oliphant has perpetuated a few anachronisms and, much more important, has neglected certain likely underlying themes that could have been used to provide a context for his episodes and thus a cohesiveness for his book. This neglect has also deprived the sociologists and historians of science of the benefit of his reactions to the themes they have suggested. Any comments Oliphant might have made as a physicist personally involved in the work of the period would have been greatly appreciated.

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