

particularly thorough treatment for orthopyroxene. The final chapter on the thermodynamic properties of coexisting phases as a function of temperature and pressure also gives pointers to future research in this field. The book ends with an appendix of computer programmes for calculation of some of the thermodynamic functions discussed in the body of the text.

Each chapter is divided into a number of sections and subsections that are often entities in their own right. Within these, thermodynamic equations are stated, or sometimes derived, and manipulated to deal with the theoretical problem in hand. This approach may be appreciated by the researcher involved with the thermodynamic details of solid solutions but the student requiring an introduction will probably find the style too curt. Where the discussion is developed more freely (as in Chapter VIII, sect. 2, and Chapter XI) the result is good and relevant to a wide range of researchers in geochemistry and mineralogy.

This is a well-produced and advanced text, which should stimulate the application of thermodynamics to problems in mineralogy and geochemistry. It will undoubtedly have a restricted readership of those who are already involved in this subject—for them it will be a valuable text.

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AUGUSTITHIS (S. S.). *Atlas of the textural patterns of granites, gneisses and associated rock types*. Amsterdam (Elsevier Publ. Co.), 1973. xii+378 pp., 687 figs., 24 tables. Price Dfl. 160.00 (\$59.30).

Studies of the textures of granitic rocks are clearly essential to the understanding of the granite problem and this *Atlas* sets out to document the anatomy of such textures with a thoroughness only matched before by the works of Dresden Kaden: in it some 650 microphotographs illustrate nearly 100 pages of text. However, the origin of granitic rocks is not to be finally determined on the basis of just one kind of evidence so that Professor Augustithis invites criticism when he presents the case for granitization largely on the basis of these textural studies—especially when the examples are selected so much at random and largely without detailed reference to the geological environment.

The introductory chapters of this *Atlas* are so general and uninformative that the knowledgeable reader is no further forward. The text becomes more interesting when the author enters into his own research field of crystalloblastic mineral growth in granites. Rightly, such textures are compared with those in metamorphic environments. The central problem is stated in terms of a general preference: that such blastic textures are not simply due to 'deuteric' adjustments during the long cooling history of a magma but represent the process of replacements by which the rock was transformed into granite.

Then follows a rather elementary discussion of the nature of crystalloblastic growth, full of generalities, little related to environment, and almost entirely lacking in the case histories that must surely accompany discussions of the chronology of blastic growth. A chapter on xenoliths, inserted at this point because they are regarded as

relict structures, lacks the understanding derived from field experience: witness the puzzlement expressed over the form of the intrusion illustrated in Figs. 30 and 31— which surely represents a synplutonic dyke. No one would deny that there are metasomatic rocks but the three isolated examples provided do not go very far in proving the more general hypothesis, especially when one involves the decidedly unusual evidence, provided by the Termiers, of relict fossils in granites.

On the blastic growth of feldspars in granite the author is on surer ground, being supported by a great volume of informed opinion and, in the *Atlas*, by some excellent photomicrographs. However, whilst admitting that colloform 'blastoid' textures are rare in granites, an unconvincing thesis is followed based on a possible similarity of such colloform structures and the fine zoning in plagioclases. On the other hand, the profusion of form in mineral intergrowths, including myrmekitic, perthitic, and graphic textures, is very well illustrated and a good case is made for rejecting conventional hypotheses, involving reaction, exsolution, or eutectics, in favour of an infiltration-replacement mechanism: though surely no single mechanism can have exclusive application.

Having so illustrated and commented on the textures of blastic growths the author logically turns to the discussion of diffusion and its significance in granitization but, in the event, the text is disappointingly vague, offering no real contribution to the relative importance of the process. Little reference is made to the abundance of modern geochemical work, which, in fact, suggests a general lack of diffusion in metamorphic processes. At this point the Rapakivi problem is introduced and then follows a most useful discussion on the growth histories of accessory minerals with special reference to the origin of early-generation zircons, and whether these are derived from external sources or not.

An account of the influence of tectonics on the textures of granite rocks is strangely limited and little is said about the origin of foliation and banding. The relation between plastic and brittle deformation, even stress and strain, seems to be confused and the statement that granitic rocks behave as brittle mechanically isotropic bodies is disputed by this reviewer.

A rather low-key account of late-stage metasomatism and alteration is enlivened by a discussion of the growth mechanism of acicular tourmaline, and a note on radioactive minerals of granites includes comments on their abundance and elementary remarks on radioactive haloes.

At this point the author properly enters into a discussion of the intrusive character of granitic rocks and the significance of contact metamorphism and metasomatism. However, the compilation of generalizing quotations culled from the world's literature makes little impact and, beyond agreeing that contact effects are varied and complex, the reviewer is unable to follow much of the argument, never having held the view that enormous quantities of heat are normally released by intrusive granites, or that the latter are necessarily the products of granitization, or that basic fronts are a common association of intrusive stocks.

On the state of the granitic material at the time of intrusion the author has some interesting contributions to make concerning the sequence of blastic growth, the long

time span over which the texture evolved from the original mush or Scropian 'Brei', and the likelihood that some granites might be intruded almost solid and 'ready-made', flowing by plastic deformation of the quartz. But these concepts are never developed in any depth.

In an aside on the relation of metallogensis to granitization we are treated to some simple definitions and some elementary rules of geochemistry are restated. A model is then presented relating the concentration of metals in skarns and veins with the metasomatic processes forming granites.

Concerning the general conclusions it is very likely that the most common textural patterns of granites do develop during a long complex history of recrystallization but this reviewer considers that this holds equally for rocks originating by magmatic as well as metasomatic processes. Cooling of magmatic granites is rarely a single event, especially in syntectonic intrusions. Whilst the author has set out to compare 'textures of more than 500 different granites of world-wide distribution', in the event he has largely failed to relate in any detail the texture to environment and mode of intrusion. That 'the intrusive character of granites is not incompatible with a granitisation origin' is probably true, being a restatement of the hypothesis of Read that some granites, born as a result of anatectic processes in metamorphic environments, become unstuck and intrude upwards, as mushy magmas, into lower energy situations, losing heat as they do so. Nevertheless, only in association with the very earliest members of the Granite Series is the aureole more largely metasomatic than thermal, characterized by basic fronts and reaction skarns. And it is also clear that there are granites of other parentage judged from field, geophysical, and geochemical data. There are still 'granites and granites' despite a common texture and mineralogy.

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RITTMANN (A.). *Stable mineral assemblages of igneous rocks: a method of calculation* (Minerals, Rocks and Inorganic Materials: Monograph Series of Theoretical and Experimental Studies, vol. 7). Berlin, Heidelberg, and New York (Springer-Verlag), 1973. xiv+262 pp., 85 figs. Price DM 76 (\$31.20).

This handbook describes in detail a method for calculating modes from the chemical composition of igneous rocks. The calculation of the *Rittmann norm* is presented as an alternative to calculating the CIPW norm and the new method was developed because of the disagreement of the CIPW with the observed mode, particularly in melanocratic and highly sub-silicic rocks. The calculation of the Rittmann norm is based largely on empirical rules. Thus the average compositions of the main constituents in certain rock groups are estimated on the basis of available analytical data. Largely as a result of this empirical approach the key for the calculation of the new norm is lengthy, extending to over 40 pages of text, including some 25 graphical diagrams. Although, for any given rock, only a small part of the table needs to be referred to, nevertheless the key is dauntingly complex to the newcomer. An attempt has been made to overcome this problem by the provision of a computer program in a dialect of ALGOL. A listing of this program, which the reviewer has not seen, would have been a valuable