available in North America. There are two informative chapters which discuss the safety aspects of handling and shooting explosives (Practical Usage of Explosives and Laws Relating to Explosives).

H. Rieke, Morgantown, W.Va.

## CALCULATION OF MINERAL CONTENT

A. Rittmann, 1973. *Stable Mineral Assemblages of Igneous Rocks.* Springer, Berlin, 262 pp., D.M. 76.00.

Rocks can be named, described and compared in terms of their chemical analysis, or in terms of their actual mineral content measured in volume per cent (the "mode"). Both are of course related, although similar chemical compositions may lead to widely varying modes depending on subtle changes of temperature, pressure, fluid pressure of various volatiles, content of rare elements, rate of cooling etc. This book contains interesting examples, e.g. the great influence of oxygen fugacity on the mode (fig.10–12). Its value can be estimated from $Fe^{3+}/Fe$ total, but the meticulous precautions required to get an accurate analysis of $Fe^{3+}$ are not stressed. Conspicuously different modes in chemically almost identical plutonic and volcanic rocks may be due to different $H_2O$ content, governing the absence or presence of minerals as micas and amphiboles (p.15, 71, 72).

Although the book covers both rock groups, the author mainly concentrates on volcanic rocks. He chooses for Streckeisen's classification system based on mineral content, while acknowledging that the groundmass of these rocks is often difficult to determine, or even glassy. In these cases, the mineralogical composition has to be calculated from the chemical analysis (the "norm"). The author thoroughly expounds the erroneous results which may be obtained with the highly standardized American CIPW norm, due to the variations briefly outlined above. Yet, the better approximations made possible by Burri's (1959, 1964) norm calculations are not treated, his book is not even in the references.

Rittmann then devises a quite intricate system of calculations to approach the actual mineral content as closely as possible. This task seems difficult indeed. Some of the modifying conditions cannot be read from the chemical analysis at all. The impressive lists of possible norm compositions of pyroxenes, micas and amphiboles (tables 11-43) clearly raise the problem which compositions we have to choose in each particular case. A more fundamental criticism is that the great majority of the volcanic rocks are unstable mineral assemblages, and thus are not covered by the title of the book. It is very well to state that the mode of a volcanic rock can not be determined correctly from the phenocrysts alone (p.2) The fact is, that these are usually unstable with regard to the groundmass. This is conspicuously so if the phenocrysts are zoned (e.g., fig.38). Not only the composition of the phenocrysts changes, but also the composition of the liquid, and with it the whole crystallizing mineral assemblage. The only method to bring mode and norm of a rock to close agreement would appear to analyze its minerals with the aid of a microprobe.

For a result that may come somewhat closer to reality than Burri's norm, but can hardly be quite correct, Rittmann's method seems to imply a lot of work. The enormous number of symbols or calculation values (table 21 listing 50 of them is not exhaustive) further adds to its opacity. It will receive less acceptance than the CIPW system "mainly because the actual meaning of those symbols remain(s) incomprehensible to an oridinary earth-scientist who is not a specialist in calculating and using such symbols" )p.7).

A.C. Tobi, Utrecht

## REFERENCES

Burri, C., 1959. Petrochemische Berechnungsmethoden auf äquivalente Grundlage. Schweizerbarth, Basel Stuttgart.

Burri, C., 1964. Petrochemical Calculations Based on Equivalents (Methods of Paul Niggli). Israel Program for Scientific Translation, Jerusalem, 304 pp.