kaolinites, and montmorillonites. The network silicates are very well treated, although there is the misleading implication that in the zeolite natrolite (and others) the silicate network is not continuous.

Some omissions are surprising: the serpentine group, for example, is represented only by the work on antigorite by Aruja in 1945 and Ito in 1951, and not by Whittaker's detailed work on chrysotile, or that by Kunze on antigorite. It is reasonable to expect, as Wyckoff states, to find only the structures of minerals that exhibit the simpler, somewhat idealized structures, and not all the variants through stacking and other kinds of disorder. However, halloysite is included, so that one would expect chrysotile, which has been so much more fully investigated, to be at least mentioned.

The last chapter of eighty pages gives a concise and useful treatment of basic structural crystallography, in order to enable the less experienced reader to make better use of the data presented throughout the volumes. The subject index and arrangement of references are both well compiled and easy to use.

Those interested in mineralogy and crystallography will certainly find this volume useful, and will be grateful to Dr. Wyckoff for continuing with the almost superhuman task of keeping pace with new structural determinations. J. ZUSSMAN

HAMILTON (E. I.) and FARQUHAR (R. M.), editors. *Radiometric Dating for Geologists.* London and New York (Wiley: Interscience), 1968. viii+506 pp., 88 figs. Price 147*s*.

This book consists of nine articles by various authors on some aspect of radiometric dating. For whom is this book intended? The title suggests that it will be an introduction to age-dating methods for the average geologist; a stratigrapher, a mining geologist perhaps! It certainly is not that. The editors state their intentions for this book as a 'volume in which "case histories" are presented, so that the geologist or geophysicist has access to accounts of methods, results of age studies and related topics concerning the significance of some isotope ratios, in as full a geological and geophysical context as possible'. This certainly explains the inclusion of some of the chapters but the book as a whole falls short of this high ideal.

The opening chapter by P. E. Damon on potassium-argon dating should have formed the model for the whole book. The chapter opens with a clear and concise account of the general principles. Numerical examples are used to great advantage, for example what looks like a sterile academic approach in a deterministic model for K/Ar ages turns out to be fruitful when applied to some work on the Alpine fault zone in New Zealand. The rest of the chapter describes the application of K/Ar methods to the Basin Ranges and ends with some geological philosophy.

The correlation of the disturbance of the age dating system with some petrologically recognizable criteria would be a great help in interpreting radiometric ages. The chapter by S. R. Hart *et al.* is a description of an excellently conceived piece of work towards this goal. The effect of the intrusion of the Eldora stock about 55 m.y. ago into gneisses and schists 1200 m.y. and older was studied. The lowering of the ages

was measured as a function of distance from the contact for most of the dating methods; these effects can be correlated with the cooling history of the intrusion.

The third paper by B. J. Giletti again fits well with the editors' conception of the book. The Belt series might be interesting in suggesting to geologists what can be done with dating a sedimentary sequence, including the use of K/Ar dating on syngenetic glauconite. In the description of the dating of the Laramide events Giletti raises the interesting possibility of seeing the details, for example is it possible to measure the time it took to emplace the Boulder Batholith? Unfortunately the answer is that the errors in the method are still too large.

The chapter on the interpretation of lead isotopes by E. R. Kanasewich is confusing, which is disappointing because it is a comprehensive survey of the subject especially on the anomalous ore leads. The author doubts the existence of single stage or ordinary leads that fit the Holmes–Houtermans hypothesis, but he finds that some of the data support the Collins, Russell, and Farquhar hypothesis of a single growth curve. This approach leads to circular reasoning. We find that the author's criteria for recognizing ordinary leads is that the $^{206}Pb/^{204}Pb$ ratio should be characteristic of a source region with a $^{238}U/^{204}Pb$ ratio of $8{\cdot}99 \pm 0{\cdot}07$. We cannot use the data to show that the mantle is uniform and then use this uniformity as a criterion to recognize ordinary leads: especially, it is not possible to conclude that this means that the $^{238}U/^{204}Pb$ of the mantle appears to be constant within 0·75 %. Leads extracted from oceanic volcanic rocks, which are probably derived from the mantle, are definitely multistage, showing that variations of the $^{238}U/^{204}Pb$ have existed in the mantle for considerable lengths of time. Kanasewich recognizes this and at one point suggests that a different model must be used for oceanic and continental leads.

The response of the U/Pb system in accessory zircons to metamorphism is complex. The discordant age pattern that is usually found in this mineral is attributed to lead loss. A metamorphism that completely resets the K/Ar system may cause only partial lead loss from the zircon. The chapter by E. Catanzaro describes the hypotheses currently used to explain this loss (continuous diffusion and episodic lead loss) and how they can be used to interpret the lead loss pattern to give the original time of crystallization. In this way zircon has turned up some very old ages, an interesting example of which is Catanzaro's own work in southwestern Minnesota on three 3550-m.y.-old samples which suffered lead loss 1850 m.y. ago. A weakness of the chapter would seem to be a lack of discussion of some of L. T. Silver's important work, especially on the analysis of samples that have been separated into several fractions.

The otherwise admirable paper by S. Moorbath, K. Bell, B. E. Leake, and W. S. McKerrow on 'Geochronological studies in Connemara and Murrisk, western Ireland' seems out of place in a book and surely belongs in a journal.

The chapter by T. N. Clifford is a comprehensive survey of radiometric dating and the pre-Silurian geology of Africa and quite predictably is the longest chapter in the book. Because it is crammed with fact and figures it is very hard to review except to say that it must be recommended to any student of African Geology.

Geologists will find it interesting to read the short chapter by R. L. Fleischer, P. B. Price, and R. M. Walker on fission tracks found in natural materials. It would appear

that the study of geological materials has been overshadowed by the development of the technique in meteorites and it seems too early to see whether this will prove a cheap age-dating technique.

A general chapter on Rb/Sr dating of the calibre of Damon's chapter on K/Ar dating would have been very welcome but the editors must have decided not to duplicate too much material with previous books. The chapter by Hamilton describes the use of strontium isotopes in the elucidation of the origin of basalts and carbonatites. There are also some minor errors for example, the statement 'In any strontium rich, rubidium poor, mineral the ratio Sr^{87}/Sr^{86} ratio is $0{\cdot}710 \pm 0{\cdot}007$' is false because, during metamorphism, redistribution of strontium may result in radiogenic strontium entering such a mineral.

On a preliminary examination this appears to be an attractive book and indeed there are some very worthwhile chapters but the geologist who feels inclined to buy it should look at it carefully to see how well it lives up to what he expects from it.

I. G. SWAINBANK

PHINNEY (R. A.), editor. *The History of the Earth's Crust: A Symposium.* Princeton (Princeton University Press), 1968. viii+244 pp., 97 figs., 2 coloured pls. Price £6. 10*s*.

The hypothesis of continental drift has long had its enthusiastic adherents and its sceptics. Recently, however, evidence has been obtained from research into oceanic magnetic anomalies, deep-sea magnetic stratigraphy, and earthquake mechanisms that continental-sized blocks of ocean floor and continent are moving at rates of 1–5 cm per year. This evidence of the spreading of the sea floor was presented at a conference at the Goddard Institute for Space Studies, New York, in November 1966, which happened to come at a critical period when the evidence was becoming available but had not been published. This volume contains the contributions to that conference by those who made the significant advances. It includes papers that identify and discuss certain chemical and physical parameters that place significant restrictions on the way the mantle and crust of the Earth can have evolved. The evidence from the oceanic basins is reported in detail, and papers on palaeomagnetism, basement age dating, and the structure of mountain belts give a comprehensive view of the evidence available on the continents. Full details of contributors and titles of individual papers are given in *Mineralogical Abstracts,* vol. 20.

R. A. H.