

ulation of the unimolecular rate with respect to phase space in both classical and quantum-mechanical formats; pertinent degrees of freedom are thoroughly discussed, due attention being drawn to the necessary restrictions implied by conservation theorems. As might be anticipated, a lengthy and excellent chapter on energy-level densities is included and should enable the reader to utilise the various approaches in actual calculations.

Part 2 divides itself naturally, through the average energy of the excited species, into a discussion of thermal reactions, chemical activation systems (including photoactivation) and, most welcome, a detailed consideration of the fragmentation of highly excited molecules and ions. These make excellent reading indeed, and the detailed analysis of rotational effects, where appropriate, is certainly worthy of comment.

References are given at the end of each chapter and are both extensive and up to date; a glossary of the symbols used, together with their clear definitions (always welcome in this field), is given as well as an author and subject index.

The author rightly appeals in an appendix, for the more extensive use of the results of the steepest descents method of calculating energy-level densities. A simple basic programme is given as further encouragement.

I found my task of reviewing this book both rewarding and enjoyable, and even at a price in excess of twelve pounds, no one with any pretensions to interest in this field can afford to be without a copy.

W. J. ORVILLE-THOMAS

Arctic circle

Arctic Geology. (Proceedings of the Second International Symposium on Arctic Geology, held February 1-4, 1971 at San Francisco.) Edited by Max G. Pitcher. Pp. xvii+747. (American Association of Petroleum Geologists: Tulsa, Oklahoma, 1973.) \$30.

THERE is a certain scale of geological phenomenon that may suddenly come into focus when the appropriate mixture of specialists come together at a symposium. The formula works particularly well when the solution of a geological problem requires knowledge of the geology of a number of countries. This book contains some seventy papers read at a symposium on Arctic geology held early in 1971. To my mind the result is particularly rewarding in two ways. The specialist will find discussions of the geology of Alaska, of Arctic Canada and the Soviet Union, of the Arctic ocean, the North Atlantic and the North-

ern arc of the circum-Pacific fold belts together with first class reviews of various stages in their geological history.

But above this and of more importance to the science as a whole the symposium succeeded in illuminating the geology and the economic potential of the succession of sedimentary basins which overlie the Precambrian blocks clustered around the Arctic Ocean. By the end of the century a quarter of the world's production of hydrocarbons may come from the Arctic. The ring of Precambrian blocks which underlie Canada, Greenland, Northern Europe, north-west and north-east Siberia have separated and come together in a complicated fashion during the past 500 million years. The mountains of Scotland and Scandinavia, the Appalachians, the Urals, the island arcs and the mountain chains around the northern Pacific and the North Atlantic itself are direct results of these movements. Their history is traced out in this book, as is the history of the sedimentary basins which are so important as potential or actual sources of petroleum. This book can be recommended as providing an excellent synthesis of a region likely to become of ever increasing importance in the remainder of this century.

JOHN SUTTON

Impurities have virtues

Deep Impurities in Semiconductors. By A. G. Milnes. Pp. xviii+526. (Wiley-Interscience: New York and London, 1973.) n.p.

STUDIES of the electrical properties of semiconductor crystals containing impurities fall into at least two distinct categories. The first is concerned with the determination of the position and nature of localised electronic states due to specific impurities, and perhaps the accounting for these properties in terms of theoretical models. The second category relates to the electrical behaviour of such material under non-equilibrium conditions and to the properties of junction structures. It is important to recognise that work in these two areas is in general carried out by different groups of research workers and consequently the bridge between them is often quite tenuous.

The present volume aims to be complete in this context, although analyses of defects produced by irradiation damage are explicitly omitted. The theory of localised energy levels is discussed briefly in chapter 1, which is followed by reviews of data for silicon, germanium, gallium arsenide, gallium phosphide and other III-V compound crystals in chapters 2 and 3. The latter chapters read very much as a catalogue,

but are nevertheless valuable because of the large number of references cited. There is then a marked change in style in chapters 4, 5 and 6, which deal with theories of steady state statistics of deep impurities, trapping and recombination. Apart from a few examples, of which gold doped silicon is prominent, the deep levels are not considered in relation to particular systems. The emphasis becomes more practical in the following chapters with discussions of photoconductivity, recombination and trapping in junctions, thermally stimulated currents and techniques for measuring lifetimes.

The contents of the remaining four chapters are of considerably more interest. It is shown in some detail how the presence of deep impurities can lead to a negative differential resistance, and oscillatory effects are discussed at length. The relevance of the final chapter on conductivity by hopping processes to deep impurities is not too clear, as is pointed out by the author in the very final paragraph.

An overall impression gained from this book is that the difficulties referred to in the opening paragraph of this review have not yet been overcome, although of course this in no way reflects adversely on the text. A second impression is that the author has given prominence to the beneficial aspects of deep impurities, citing the value of infrared detectors and possible future uses of oscillatory phenomena. Adverse effects such as the quenching of luminescence, reduction in carrier mobilities and lifetimes would be regarded by many as being equally if not more important. Finally it should be noted that the very large bibliography containing nearly 1,900 items should be invaluable to workers in this field.

R. C. NEWMAN

Ancient climates studied

Climatic Fluctuations of the Ice Age. By Burkhard Frenzel. Translated from the German by A. E. M. Nairn. Pp. xxiv+306. (Case Western Reserve University: Cleveland and London, November 1973.) \$22.50.

THE world's climate is not only changing, but changing on a timescale rapid enough to affect present day economic planning. Interest is growing in the problems of climatic change in general, and in such spectacular examples as ice ages in particular. So the arrival of this translation of Frenzel's 1967 German language study of the most recent ice age is particularly well timed.

The book concentrates upon facts, rather than hypotheses to explain the factual variations, and thus provides a useful reference for anyone wishing to