proteins and other cytoskeletal elements is left out except for cursory treatment in a few papers. Since this is a subject basic to an understanding of cell locomotion, the book would have benefited by its discussion. Another lapse is that only one paper is devoted to in vivo studies of invasion and metastasis (Tickle), which is somewhat ironic since one of Abercrombie's many exciting contributions to cell biology was the idea that contact behavior might play a role in invasive cell movements. Coverage of invasive mechanisms could have been more thorough, for there are certainly many investigators working in this exciting field (Mareel, Poste, Nicolson, and Folkman, to name only a few).

Despite these shortcomings, the book compiles for the first time since the 1973 publication of the proceedings of a Ciba symposium, *Locomotion of Tissue Cells*, recent research and speculation on cell motility and cell behavior. The topics are loosely arranged in three categories: mechanisms of cell motility in vitro, contact behavior and cell guidance mechanisms in vitro, and control of cell behavior in vivo, including morphogenetic movements and invasive behavior. A few notable papers will be discussed from each category, although the selection is, in some respects, a matter of personal preference, since most of the essays are very good.

The mechanisms of cell motility, though still obscure, have been greatly elucidated recently, and the advent of the interference reflection microscope has been especially useful, since it allows one to follow the formation and disappearance of cell adhesions. Heath's discussion of cell contacts and their relationship to the cytoskeleton is particularly enlightening, as is his analysis of the strengths and shortcomings of the interference reflection microscope. As a result of the tractional forces exerted by the cytoskeleton against these substratum adhesions, the cell is propelled forward, and Harris's paper elegantly demonstrates the presence of this force. The potential consequences of tractional force are at least two. First, cells can deform their substrata as they locomote, which may in turn be responsible for tissue modeling during development and wound closure. Second, the amount of tractional force exerted by a cell may determine whether it is able to translocate in an organism. The latter has tremendous implications for understanding why some cells are motile or invasive in vivo.

A crawling cell can be directed by contact with other cells or by extracellular elements in its environment (as in the case of contact guidance and chemotaxis). Zigmond describes leukocyte response to a chemotactic gradient and presents, in a lucid and unbiased fashion, models for the various mechanisms these cells may use to detect a chemotactic gradient; she provides experimental evidence to support each of these mechanisms. Dunn reviews the historical evidence for contact guidance and presents an original and thoughtful approach to the possible control of contact guidance. He clearly outlines the unanswered questions and the means to investigate these.

Several papers discuss cell movement and cell behavior in vivo. A paper by Steinberg and Poole is particularly intriguing, not so much for the material on liquid behavior of cells, all of which has been published before, as for the report of studies of amphibian pronephric duct movement, which, for the first time, provide compelling evidence that adhesive gradients guide morphogenetic movements. Weston and Trinkaus both contribute informative, well-written papers that are distinguished by a clear presentation of problems that need to be solved and useful hypotheses that can be experimentally tested. Unfortunately, a number of papers under this subheading are rather far afield from the subject at hand, and a few authors, particularly Wolpert, present biased analyses of their research with no reference to published contradictory studies.

Although the book has its weaknesses—some repetitiveness, omissions, and a few substandard papers—its strengths are considerable. It covers in detail many aspects of cell motility and contact behavior. The reviews are, for the most part, thorough and unbiased and are accompanied by extensive bibliographies. The authors were asked to speculate more than is usual in order to foster new kinds of research. Most do to some extent, and some (for example, Harris) present original points of view that are quite exciting. Not surprisingly, a transcript of Abercrombie's Croonian Lecture, delivered in 1978, is particularly noteworthy for its insight and speculation about the many unsolved problems of cell locomotion, even though it is somewhat dated now. In any event, the book will be useful and informative to cell and developmental biologists alike, and it is a fitting tribute to the man who launched this field of investigation.

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Orogenic Andesites

Andesites. Orogenic Andesites and Related Rocks. R. S. THORPE, Ed. Wiley-Interscience, New York, 1982. xiv, 724 pp., illus. $83.95.

Skillful editing of this handsome volume, offered as a "reference text for undergraduate, postgraduate, and research workers" and containing 34 essays by 52 authors, conveys a sense of design and unity more substantial than is in fact the case. The opening 98 pages are devoted to an introduction by the editor, a short paper on the evolution and classification of orogenic volcanic rocks, and a terrifying review (25 pages of text overwhelmed by 27 pages of tables and 107 variation diagrams) of the mineralogy and petrology of Cenozoic orogenic volcanic rocks. The editor's introduction looks at rock genesis through plate tectonic glasses and makes the point, perhaps inadvertently, that, as in pre-plate days, it's a pretty messy ad hoc business. The classification note is concerned more with the evolution of nomenclature than with the evolution of rocks and, despite its title, says almost nothing about formal classification.

The writer of the mineralogy review then mutes the classification issue by arbitrarily attaching names to boxes in a potassium-silicon grid, as do several of the other authors. This, it seems to me, puts an end to serious discussion of relations between bulk-composition and rock type; after all, if andesite is defined as a rock containing 56 to 63 percent silica, it is not very surprising that the average silica content of andesite is usually between 59 and 60 percent, as is shown in a number of places on pp. 88–94. The review compensates somewhat for this implicit circularity of its chemical summaries by a valiant and welcome attempt to characterize the phenocryst assemblages of the orogenic lavas, and one of its results is especially surprising. Despite their high normative q content, nearly a third of the andesites examined by the author contain modal olivine. (Many of the other authors also mention olivine, but only as an "occasional" or "not uncommon" phenocryst, and usually in the less siliceous basaltic andesites rather than the andesites proper.) About the relative incidence of orthorhombic versus monoclinic subcalcic pyroxene, of such central importance in Japanese petrology and discussed elsewhere in the volume, the review says nothing.

The core of the book, sections 3, 4, and 5, is a series of essays on the distri-

bution and character of andesitic volcanism beginning in or extending into the Cenozoic. There are separate papers on the Aleutians, the Cascades province, Mexico, Central America, the Lesser Antilles, the Andes (at last!), Indonesia, Papua and New Guinea, Tonga-Kermadec-New Zealand, Japan, the Mariana and Volcano islands, the Mediterranean arcs, Anatolia and northwest Iran, Sardinia, and Antarctica, all by authors with extensive experience in the areas concerned. There are also papers on Archaean andesites and on those of the British Caledonian, as well as admirable summaries of the physical characteristics of andesite eruptive activity as a whole and of andesite pyroclastic flows. A few of these essays are rather sketchy, with strong emphasis on speculation rather than information. Most, however, are well above average for this difficult form of exposition, and many are very fine indeed. In the nature of the case, most of the information in them is not new—at least three, including what seem to me the two best, are in fact revisions of reviews already published elsewhere—but the material is unusually widely scattered, and it is a major service to gather it together in one place. Unfortunately, the remarkable andesitic and related volcanism of the Kuriles, Kamchatka, and the Carpathian arc (or arcs) is not included in the survey. Perhaps this deficiency can be remedied in a later edition, when Soviet bloc petrologists no longer feel obliged to consider plate tectonics the work of the devil and the rest of us are prepared to admit that it is something less than divine revelation.

The remainder of the book is a potpourri of papers of variable but often slight relevance. An essay about the relation of calcalkaline intrusives to volcanic arcs reads rather like a distended undergraduate lecture on the relation between volcanic and plutonic rocks. In a discussion of mineral deposits associated with calcalkaline rocks the word "andesite" does not appear at all and nearly all the deposits mentioned are associated with plutonic rocks. An engaging discussion of the possible syntectic origin of andesite contains no mention of pre-1971 work on or opinion about this hoary hypothesis. A highly speculative paper on the relation between andesitic volcanism and continental growth concludes that there really isn't much. An interesting review of procedures for estimating the sulfur and chlorine budgets of explosive volcanoes has nothing whatever to say about andesite or andesitic volcanism per se. A remarkable exercise in megathought about pan-African calcalkaline magmatism says very little about andesite. In a pair of essays on trace element and isotope characteristics of "lavas from destructive plate boundaries" all manner of other rocks are discussed but andesites rate only occasional mention. Complex and diffuse contributions by two well-known experimental petrologists are concerned not with andesites but with the nature of the material from which the magma that gives rise to them may perhaps have been formed. For this grandparental role hydrated mafic crust is preferred by one experimentalist, metasomatized mantle by the other.

Nearly all the material in the last 260 pages of the book deserves and repeatedly receives extended discussion in the current periodical literature. Very little of it is yet of sufficient stature to warrant inclusion in a standard reference work or textbook, and most of it is not of sufficient relevance to warrant inclusion in a book bearing the title of this particular "reference text." Omission of undefinitive or irrelevant material would have considerably reduced the size and perhaps also the cost of the book, making its ownership a less unreasonable indulgence for those constrained to read reviews rather than write them.

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Mathematical Physics

Quantum Fields in Curved Space. N. D. BIRRELL and P. C. W. DAVIES. Cambridge University Press, New York, 1982. x, 340 pp. $49.50. Cambridge Monographs on Mathematical Physics.

Constructing a quantum field theory in curved space-time is an enterprise distinct from the much more ambitious one of constructing a quantum field theory of the gravitational field (curvature) itself. Unlike the latter theory, the former has recently passed from confusion into a state where at least the fundamentals are understood and agreed upon. In fact, after decades of gestation, the subject went through a remarkable vogue in the mid-'70's, attracting the attention of "classical" general relativists, "flat" particle and field theorists, and people who had previously worked on quantum gravity proper; recently, many of these have returned to their former pursuits or turned to supergravity, gauge theories, or pure mathematics, and the publication rate has fallen off. We are clearly at the optimal time for the first book on the subject, which will surely become a classic reference.

The authors of this book state their intentions to be "both pedagogical and archival." They have succeeded reasonably well on both counts, although the two goals interfere at times. The authors have chosen to produce a broad review of the literature rather than a systematic presentation from a personal point of view.

The first half of the book has been provided with a unifying theme, "particle detectors." Curved-space quantum field theory is an extrapolation of conventional quantum theory into a regime where experimental verification is, at best, very indirect. Consequently, a basic problem has always been to identify the physical content of the mathematical formalism. The aspect of the subject that has been best developed is the analysis of operators representing local field observables—particularly energy density, energy flux, and pressure—and their expectation values in particular quantum states. The authors have wisely delayed a discussion of this rather technical topic until the second half of the book. Furthermore, there is room for debate over whether these local densities are accessible to experiments, even of the Gedanken variety. In their place W. G. Unruh proposed to study a model detector in which the quantum field is allowed to interact with another field and the resulting excitation probability is calculated by perturbation theory. This analysis provides insight into the physical content of various quantum states that is complementary to that provided by energy-density calculations. Birrell and Davies introduce the idealized detector very early and keep returning to it in various physical contexts, several of which have not previously been analyzed in this way. This feature makes the early chapters more coherent than they otherwise would have been.

The third quarter of the book is a single chapter devoted to calculation of the stress tensor (which comprises the energy density and related quantities mentioned above). Here the attempt to review the entire literature even-handedly does get in the way of clear exposition. At first the chapter concentrates on effective Lagrangians and dimensional regularization, the favorite tools of the Loyal Opposition. Then it turns to the approach developed by Davies and his students (and this reviewer), the direct calculation of the stress tensor from an expansion of the field in normal modes, with the aid of regularization by "point-