it should reveal useful information otherwise unavailable on basic problems of fundamental interest to a broad spectrum of biologists and paleontologists. Writers of invertebrate and general zoology textbooks will also find food for thought here and begin to realize that Bryozoa are not a "minor" or "smaller coelomate" group but merit better treatment with the traditional "major phyla."

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Magma Generation

Terrestrial Heat and the Generation of Magmas. A discussion organized by G. M. Brown, M. J. O'Hara, and E. R. Oxburgh, Jan. 1977. Royal Society, London, 1978. Illus. Paper, £17.65. *Philosophical Transactions of the Royal Society of London*, Series A, vol. 288, pp. 383–646.

The recent attention that has been given to convective heat transfer in the mantle, the recognition that radioactivity decreases exponentially with depth in the crust, and an expanding appreciation of geochemical constraints on melting in the mantle have led to an array of models for magma generation. The 18 papers in this book, predominantly by authors from the United Kingdom, resulted from a discussion of critical aspects of models involving melting in the crust and mantle. Every specialist will find more than enough in the papers to raise his or her adrenaline flow-rate, and the generalist will find strong opposing arguments on many issues.

The authors generally support the views that the diapiric rise of partially depleted mantle leads to pressure-release melting at the mid-oceanic ridges and that melting in the subducted plates is induced either by heat generated by shearing of rocks at the top of subducting plates or through the effect of volatiles released from the plates to lower the temperature of melting of rocks above the subducting plates. Not all the authors are enthusiastic about convective models, and several base their arguments on conductive model geotherms. The grossly unequal volumes of magma presumably extruded on opposite sides of a suture prior to continental breakup are blandly dismissed as "asymmetry" by one supporter of plate-tectonic dogma.

The view of C. Froidevaux and M. Souriau that intraplate magma generation is caused by the heat of viscous dissipation during rapid plate motion is in sharp contrast to the view of I. G. Gass *et al.*, who believe a plate must be nearly at rest for thermal or chemical penetration of the lithosphere. In another confrontation, K. S. Heier concludes that the continents formed at "a reasonably constant rate" through geologic time whereas S. Moorbath is in favor of "episodic" continental growth with subsidiary reworking and recycling.

Most of the papers are written in concise language, and the definitions of some usually vague plate-tectonic terms will be helpful to many readers. Particularly rewarding are the clearcut statements about distinguishing reworked crust from mantle-derived crust (Moorbath), the importance of density differences in driving mantle convection (E. R. Oxburgh and E. M. Parmentier), and the considerable extrapolation necessary to apply experimentally determined geothermometers and geobarometers (S. Howells and M. J. O'Hara); the unique demonstration of crystallization in an upwelling diapir (J. Malpas); the compelling evidence that most oceanic basalts are derived from source regions that have been depleted in large ion lithophile elements (R. K. O'Nions *et al.*); and the evenhanded treatment of the plume hypothesis versus the propagating fracture hypothesis for intraplate volcanism (D. L. Turcotte and E. R. Oxburgh).

There are, nevertheless, some arguments that require clarification. For example, in a paper on the thermodynamics of pyroxene geotherms, the author writes that thermodynamic analysis is the best way of calculating the temperatures and pressures under which the garnet lherzolites are formed because "the methods will be independent of bulk rock composition and of mineralogy" (p. 458). An equilibrium constant, K, is then introduced and is described as "a more or less complicated function of the compositions of the phases and, in general, temperature and pressure." This confusion is reinforced by a statement that "there are no safe assumptions about the dependence of K on composition, temperature and pressure" (p. 459).

Only the paper by Howells and O'Hara presents new experimental data. A paper by Y. Bottinga and C. J. Allègre is essentially a correction and extension of a previously published analysis. These authors present a partial melting model and adopt for starting material a mixture of peridotite and basalt, assemblages that, even though they are incompatible at the high pressures of magma generation, are assumed by the authors to form a simple binary system. The value they use for the enthalpy of the basalt-eclogite transition is three times that found by others, and the enthalpies of the plagioclase-peridotite-spinel-peridotite and the spinel-peridotite-garnet-peridotite transitions are too small by an order of magnitude. After an extensive review of the published values for the enthalpy of melting of the end-member minerals characteristic of basalt, the authors throw up their hands because of the incompleteness and uncertainty of the data and adopt N. L. Bowen's old estimate of 100 calories per gram, without a pressure correction. Their model is unique because it is based on the assumption that melting in the mid-oceanic ridge environment begins just above the spinel-peridotite-garnet-peridotite transition and therefore does not involve garnet in the generation or fractionation of these magmas.

Everyone interested in magma generation will find some new ideas in the volume and many points to ponder. Are regional metamorphic gradients a suitable estimate of "normal" or "abnormal" geotherms? Is the narrow range of temperature deduced from granulites evidence that they are residua from crustal partial melting? Are plates the thermal boundary layers of mantle convection? Is upper mantle heterogeneity the result of trapped undepleted mantle? Can intraplate volcanism be attributed to turbulence within the general convective regime? Do rising magmas scavenge the leachable elements? Is the progressive decay in thermal output of the earth responsible for the changing mode of magma generation?

Use of the book would have been greatly enhanced if a subject index had been included. The discussions that follow most of the contributions are especially pertinent and informative.

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Photochemistry

Inorganic and Organometallic Photochemistry. Papers from a symposium, Chicago, Aug. 1977. MARK S. WRIGHTON, Ed. American Chemical Society, Washington, D.C., 1978. viii, 232 pp., illus. $30.

This small book comprises 12 papers presented at the 174th meeting of the American Chemical Society. The papers are generally of substance and collectively constitute a sufficiently enduring collection that the book is recommended as a useful source of data and of expositions. There is an excellent first chapter on ruthenium(II) and osmium(II) polypyridine complexes, in the usual terse style of N. Sutin and C. Creutz, followed by more specialized chapters by other groups. Similar complexes of chromium(III) are discussed by M. S. Henry and M. Z. Hoffman. There follow several papers on various metal carbonyl and arene complexes, concluding with a stimulating discussion of photogenerated catalysts by Wrighton. Two papers explicitly discuss systems relevant to solar energy; H. B. Gray and co-workers discuss isocyanide complexes and their redox cycles, and C. Kutal examines energy storage through photoinduced endoergic isomerization.

A unifying theme in a collection such as this one should be that photochemistry, as well as photophysical processes such as emission, proceeds from thermally equilibrated excited states. One is repeatedly impressed with the growing knowledge of standard redox potentials of such states, for example. Some distinct name is needed to emphasize that such states constitute a thermodynamic ensemble; they are good chemical species possessing structure and thermodynamic properties such as entropy and free energy. My colleagues and I and other workers have used "thexi state" for "thermally equilibrated excited state." A thexi state is essentially an isomer of the ground state. Some of the discussions in the book are satisfyingly explicit on this point. In others, unfortunately, the word "state" is used sloppily and with no indication of the distinction between a thexi state and Franck-Condon or other nonequilibrium collection of spectroscopic species. For example, band maxima positions are nice to know for purposes of identification, but they usually do not even approximately correspond to thexi state energies. Discussions involving energetics in this book do not always make clear which type of energy (band maximum or thexi state) is being used (and why). Some of the discussions are unconvincing, and there are at least two figures that are closer to modern art than to modern science.

It is a pleasure to see in this book further evidence of the growing maturity of the "second" chemistry, that of thexi states. The papers illustrate both the diversity of the field and the sophistication of experimental and conceptual approaches now in use.

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