

the scheme is reductionist. It describes events at the ecosystem level of integration in terms of events at the organismic level, bypassing events at intermediate levels of community (guild) and population. It assumes that the whole operation runs as the sum of its parts, and so it neglects important system-wide rates governed by complex control mechanisms. Hence Mann sees simulations based on compartmental models as "doomed to failure" as quantitative predictors (although providing "valuable insight") for two reasons: The inherent variability of organisms and their physiologies magnifies statistical confidence limits through the system, and the hierarchical order of the compartments places processes on disparate temporal and spatial scales. Since, for instance, many turnovers of a bacterial population would take but a moment in the life of a higher carnivore, it would be difficult to integrate suitable scales of observation for both.

Herein lurks a potential "catch 22." Mann makes a convincing case that the reductionist approach yields quantitatively unreliable results, yet he does not develop a synthetic approach that would offer a clear alternative. How does one observe a whole ecosystem? Attempts by others to simplify all organisms to particles of different logarithmic size classes or to reduce complete systems to microcosmic analogues have not proved entirely successful. Can one at least observe collective mechanisms and rates of transfer at the population or community level, a step or two up from the organismic level? Mann contends that we need new ecological theory to link cumulative properties of populations with "emergent properties" of the whole.

Perhaps this is why most of the book actually deals with functional groups of species and how they contribute to the workings of various coastal systems: salt marshes, seagrass beds, mangrove swamps, seaweed forests, plankton communities, coral reefs, and benthic communities in sediments. To me, in fact, some of the more interesting accounts were of Mann and his co-workers' own investigations of the demise of kelp forests off Nova Scotia. These had less to do with holistic insight than with relations between species populations: kelps, sea urchins (with alternative food supplies), and their predators. After all, these relations yield a reliable, though qualitative, prediction: Without effective predators, sea urchins can destroy kelp forests. Maybe this kind of forecast is the best we should expect.

A major strength of the book is the recurrence in chapter after chapter of major themes having to do with fundamentally important processes: (i) the existence of alternative pathways of energy flow through ecosystems; (ii) the storage and availability of nitrogen and the need to measure nitrogen as well as carbon fluxes; (iii) the important contribution of detritus (detached plant matter and associated microbes) to the flow; (iv) the conversion of nitrogen-poor detrital food (plants) to nitrogen-rich detrital food (microbes); (v) the recycling of dissolved organic matter produced by plants; (vi) the importance of water movement for plant growth and for transport of nutrients and ecosystem products; (vii) the significance of form and surface-to-volume ratios of plants; and (viii) the overriding influence of weather in shaping ecosystem function. Thus systems ecology complements fisheries biology (p. 259): "Nature cannot be confined to our mathematical representations of recruitment, growth and survival."

Although his references are selective and rarely postdate 1979, Mann covers a broad topic with enthusiasm and verve. He is interested in processes, not species lists, and he offers a rationale for this emphasis at the outset. Professionals and graduate students will benefit greatly from this concrete approach to understanding coastal systems, although parts of the work may be a bit advanced for all but the more enlightened upper-division undergraduate.

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## Andesite Genesis

**Orogenic Andesites and Plate Tectonics.** JAMES B. GILL. Springer-Verlag, New York, 1981. xiv, 392 pp., illus. \$38.50. Minerals and Rocks, 16.

This is an excellent book for earth scientists and students. It is in the same class as *Origin of Granite . . .* by Tuttle and Bowen and *Generation of Basaltic Magma* by Yoder, which deal with the other principal igneous rocks on earth.

It is no accident that a book on andesites should appear later than its counterparts on granites and basalts. Granites make up much of the continental crust. Because they occur in a region of low pressure amenable to both observation and easy experimentation, their origins

in the crust were worked out first. Basalts cover the sea floor. Experimentation and analysis during the '60s and '70s confirmed that most physical and chemical attributes of basalts originate below the crust. Andesites occupy the middle ground. Compositionally they are between basalt and rhyolite (or granite), and ideas about their origins have included aspects of ideas about both the crustal origins of granites and the mantle origins of basalts. Geographically andesites are between land and sea, located at the boundaries of convergent lithospheric plates, and ideas about their origin also postulate an essential role for plate subduction.

Like Tuttle and Bowen's and Yoder's books, Gill's is critical, comprehensive, and systematically organized. In the first chapter, Gill adopts a compositional definition of orogenic andesite that few would argue with: andesites are hypersthene-normative volcanic rocks characterized by 53 to 63 weight percent of SiO<sub>2</sub>, and orogenic andesites are andesites with certain limited concentrations of K<sub>2</sub>O and TiO<sub>2</sub>. The familiar modifiers tholeiitic and calc-alkaline are retained by Gill to further characterize andesites.

The rest of the book comprises three parts: physical features (chapters 2 through 4, pp. 25-96); chemical features (chapters 5 through 7, pp. 97-229, and appendix, pp. 317-336); and evaluation of ideas (chapters 8 through 12, pp. 230-315). In my judgment Gill has chosen the best order and has achieved an excellent balance, one that reflects well the extent of knowledge and agreement. Related subsections are referred to extensively.

I praise in particular the factual summaries, which include numerous original figures compiling such information as distance from volcanoes to plate boundary, height of volcano above the seismic zone, dip of seismic zone, and rate of duration of plate convergence and crustal thickness for 34 volcanic arcs; heat flow and seismic velocity structure; observed and estimated temperatures, densities, and viscosities; elemental and isotopic compositions of rocks and minerals in space and time; and observational and experimental determinations of mineral-melt equilibria. The appendix summarizes the available data on the chemical composition of active volcanoes at convergent plate boundaries and notes 159 references to the sources of data for 317 separate volcanoes, located in 22 figures.

Gill's review of ideas, ancient and modern, is frank, cautious, and skeptical. He concludes that the traditional

ideas that andesite is derived from basalt by crystallization, principally of plagioclase, olivine, augite, and magnetite, still have the most merit and best explain most features of most andesites. Other processes, such as melting of wet mantle peridotite, melting of crustal rocks, contamination by crustal rocks, magma mixing, liquid immiscibility, vapor fractionation, and diffusion, play minor or local roles. The special roles of plate subduction in the generation of orogenic andesites in their typical place is to provide a source of incompatible and radiogenic elements, silica, and water for the fluxing of melting and the production of appropriate parental magmas in the overlying wedge of hot mantle. Gill's book thus concludes that the processes that produce the variable features of orogenic andesites are more complex than those that generate either granites or basalts.

All earth scientists and students interested in the origins of the crust, the significance of volcanism, and the plate tectonic cycle will benefit greatly from this book, whether they read it or not.

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