The notebooks are of interest not only for what they reveal about Darwin's early scientific thinking but also for what they reveal about his ideological predilections. In fact, many of his youthful scientific ideas came packaged in a more or less ideological message. Darwin owed a great deal to his grandfather, Erasmus Darwin, and to the intellectual bugbear of early Victorian naturalists, Jean Baptiste Lamarck. He adopted their Enlightenment deism, their progressive transformism, and their conviction that animal behavior had a lot to do with the process of species change. In particular he followed his grandfather's associationist psychology and his belief in the importance of sex and reproduction. In contrast to these latter-day *philosophes*, Charles Lyell impressed Darwin with doubts about inevitable progress, and the dour Reverend Thomas Malthus instructed him about the negative side of sex: overpopulation and the struggle for existence. In subsequent publications Darwin neglected his debts to Lamarck and his grandfather while emphasizing those to Lyell and Malthus, a tactic that has frequently prejudiced modern historical accounts. However, the notebooks show clearly not only how much he owed to his forebears in both camps but how he struggled to reconcile their sometimes contradictory legacies. Darwin was never fully successful in harmonizing them. All this work was marked by a certain ambiguity and indecision that stemmed from the impossible task he assumed, and all historical interpretations of Darwin have struggled with the problem of identifying his shifting allegiances. However, it is important not to derogate these aspects of his intellectual legacy: tolerance of ambiguity is one of the hallmarks of creative genius, and Darwin derived enormous benefit from his eclectic tendencies. The evidence is right here in the notebooks.

In view of the significant ideological compromise Darwin introduced into the notebooks, their publication together is a noteworthy event. The publisher has provided a handsome format with large type and generous margins. Unfortunately, the editors were not always thinking as generously. Too often they seem to address their notes only to the professional historian of science, indeed only to the professional Darwin scholar. The scrappy character and technical nature of many of Darwin's remarks would have deterred the casual reader in any case, but scholars from related disciplines might have expected more guidance regarding obscure concepts. Still, the quality and thoroughness of the annotation are exemplary. The editors bring us about as close to the pertinent circumstances surrounding Darwin's early thought as scholarship can reasonably get, and their interpretative modesty does assure that the volume will age well. We owe them a substantial debt.

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The Work of Spemann

The Heritage of Experimental Embryology. Hans Spemann and the Organizer. VIKTOR HAMBURGER. Oxford University Press, New York, 1988. xii, 196 pp., illus. $29.95. Monographs on the History and Philosophy of Biology.

Experimental embryology was one of the most exciting fields of research in biology in the early part of this century, when the application of experimental techniques to the embryo promised a rigorous, causal understanding of the processes involved in development. In Europe the leader in this field was Hans Spemann, and of all Spemann's research none had a greater impact than the so-called organizer experiment. Viktor Hamburger has taken this experiment and the work it inspired as the central theme of a book describing what might be called the golden age of experimental embryology.

The organizer experiment was performed by Hilde Proescholdt, who, in 1921, began a series of experiments transplanting the dorsal lip of the blastopore from the gastrulae of *Triturus cristatus* to gastrulae of *T. taeniatus*. The transplanted tissue induced the formation of a second embryonic axis and in the most famous example included neural tube, notochord, intestine, and kidney tubules. There were two remarkable features of this second embryo; it was composed of both donor and host cells and its tissues were appropriately arranged. Spemann argued that the transplanted tissue contained a center that was endowed with the power to induce and organize the formation of an embryonic axis.

Hamburger describes Spemann's experiments in detail, showing how they were designed with great ingenuity and performed with the simplest of tools. He remarks that Spemann's greatest strength was his analytical acumen—his ability to interpret the data from these simple experiments and to design new experiments to explore further his new insights. One of the highlights of Hamburger's writing is his attempt to reconstruct the process of Spemann's thinking, reconstructions that are plausible and illuminating. Hamburger also makes a valiant effort to explicate the increasing number of concepts—"differentiation center," "organization center," "double assurance," "labile determination," "assimilative induction," and so on—that came into use.

But while Spemann and the organizer experiment are central characters in the book, Hamburger describes the work of many others who were entranced by the developing embryo. Hamburger is well placed to do this, as he was himself one of the players, spending almost 10 years with Spemann. Some scientists whose work is described, such as Schotte, Mangold, and Vogt, are well known, but one of the pleasures of this book is that Hamburger gives due credit to minor players in the drama who are usually forgotten. A large part of the book is devoted to Johannes Holtfreter, whose genius and capacity for hard work are evident from his work on the organizer. As Hamburger says, Holtfreter was "simply bolder and more inventive and willing to take risks" than those who remained more closely associated with Spemann. Such inventiveness led to Holtfreter's in vitro experiments and the analysis of heterologous inducers and the regional specificity of induction. Hamburger takes the story of the organizer through to the 1960s and the work of Chuang, Saxen, Toivonen, Yamada, and Tiedemann, and in the last chapter he discusses his views of the organizer phenomenon as a gradient system.

It is strange that Spemann has not received more attention, for he is the only embryologist to have been awarded a Nobel Prize. Spemann wrote an autobiography that has not been translated into English, and it is a pity that Hamburger does not provide more information about Spemann's life outside science. Hamburger's book is strictly a "scientific" biography and does not discuss what influence, if any, Spemann's cultural background had on his approach to science.

But this is a minor point. The story of Spemann's scientific work is fascinating and well worth telling. It is a historically interesting episode, for what began with such high expectations entered a period of what Saxen and Toivonen have called "post-war depression." Hamburger shows how this disillusionment arose as a consequence of the difficulties of applying a reductionist approach (and especially biochemical analysis) to the problem of the organizer. By 1939, Joseph Needham was predicting that at least 50 years would be needed to obtain "certain knowledge about the chemical nature . . . of the substance involved in embryonic induction." Those 50 years have gone, and although there are promising beginnings (J. Gurdon, *Development* **99**, 285–306 [1987]) that goal has not yet been met. Hamburger hopes that his book may en-

courage the present generation to return to these old problems with the new, powerful techniques of modern biological research. But despite Hamburger's efforts to reformulate and clarify the major concepts of experimental embryology, I am left with the impression that the molecular-cellular-developmental biologist will feel that the time is not yet right for an all-out assault on embryonic induction.

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Volcanic Rocks

Mantle Xenoliths. PETER H. NIXON, Ed. Wiley-Interscience, New York, 1987. xviii, 844 pp., illus., + plates. $215.

The mantle comprises most of the earth's volume and mass. It is the source region of almost all the earth's volcanic activity, and its convection provides the driving energy for plate motions on the earth's surface. However, our knowledge of the mantle is limited by its remoteness. Some aspects of mantle composition can be inferred from the chemistry of volcanic rocks formed by partial melting within the mantle, but this does not tell us about the variety of rock types present, their mineralogy, or their interrelationships. The only samples of mantle rock to which we have access are alpine peridotites (fragments of uppermost mantle emplaced in the crust tectonically) and mantle xenoliths (inclusions) brought rapidly to the surface by volcanic eruptions.

Mantle Xenoliths is an ambitious attempt to summarize our current knowledge of mantle petrology and the processes that control its structure and evolution. The book is divided into two main parts. The first presents descriptions of xenolith localities grouped by regions, and the second consists of topical studies related to xenoliths. The latter include reviews of specific suites or occurrences, summaries of particular techniques useful in mantle petrology and the data derived from them, and papers that review what has been learned about mantle processes by the application of these methods to different xenolith assemblages.

Part 1 is the first comprehensive summary of all xenolith localities that have been studied to date. Nixon has brought together 26 papers that summarize existing (and in some cases previously unpublished) data on each major xenolith province. Most of the chapters in this section are well written and informative, although some areas for which extensive data exist (for example, the western United States) are not as well covered as others. Some other areas, such as Greenland and South America, either lack important xenolith localities or have not been studied in detail; these papers (Scott-Smith; Meyer and Svisero) are necessarily brief. The chapters on xenoliths from Italy (Morten), central France (Downes), eastern China (Cao and Zhu), southern Africa (Nixon), India (Ganguly and Bhattacharya), and eastern Australia (O'Reilly and Griffin) stand out as excellent contributions. Also of particular interest to mantle petrologists are the papers that deal with mantle xenoliths from areas underlain by oceanic crust, such as Hawaii (Sen) and the Ontong Java plateau (Nixon and Neal). These chapters provide insight into the differences between suboceanic mantle and that underlying continental crust.

Part 2 is largely a review of previously published ideas. Many of the 24 papers in this section offer useful syntheses of current thinking on topics in mantle petrology such as pressure-temperature calculations on mantle phase assemblages (Finnerty and Boyd), magnetic properties of the mantle (Wasilewski), megacrysts in kimberlites and basalts (Schulze), the redox state of the mantle (Arculus and Delano), and diamonds (Harris; Meyer). Other papers deal with more specific topics, such as textural evidence for the formation of garnet lherzolite from harzburgite by exsolution (Cox, Smith, and Beswetherick), the size and distribution of asthenospheric diapirs beneath central France (Nicolas, Lucazeau, and Bayer), and compositional heterogeneities in a high-temperature lherzolite nodule (Smith and Boyd).

A major theme in part 2 is mantle metasomatism: the enrichment of refractory mantle lithologies in volatile-rich phases and in other components required to form basaltic magmas. This topic is central to current debates about the origin of magma and the evolution of the mantle. Important questions addressed in these papers deal with the scale of metasomatic processes and the timing of enrichments relative to volcanic activity: Is metasomatism regional in extent or confined to magma-saturated wallrock in zones adjacent to volcanic conduits? Does metasomatism precede volcanic activity and provide the additional components necessary to form magma, or does it result from the localized intrusions of magma derived from deeper in the mantle? These questions are addressed by Wyllie ("Metasomatism and fluid generation in mantle xenoliths"), who presents experimental data to show that a separate volatile phase cannot exist at depths between 120 and 260 kilometers because volatiles in this region will be dissolved in a melt phase. Above 120 kilometers, however, regional metasomatism may occur when volatiles exsolve from the crystallizing melts.

Chapters by Dawson on MARID suite xenoliths, Lloyd and others on regional K-metasomatism in east Africa, O'Reilly on volatile-rich xenoliths from east Australia, and Haggerty on metasomatic titanate minerals deal with the question of metasomatism directly by examining xenolith suites that exhibit textural or mineralogical evidence for metasomatic enrichment. These studies reach conflicting conclusions on whether or not the metasomatism is regional or local in extent; this reflects the general lack of agreement by petrologists on this topic. Dawson argues forcefully that the textural characteristics of MARID suite xenoliths require that they form by the crystallization of magma in dikes and veins. Rare composite xenoliths show that these veins intrude peridotite and have metasomatically enriched their wallrock by the infiltration of volatile-rich magma. In contrast, Lloyd and his group suggest that enriched xenoliths from east Africa were formed by metasomatism on a regional scale, based on the presence of relict strained olivines in pyroxene-rich xenoliths. They conclude that this enriched mantle then melted to form the host lavas, which are characterized by extreme LIL (large ion lithophile) and LREE (light rare earth element) enrichments.

These contrasting conclusions can be reconciled, however. O'Reilly compares xenolith suites from alkaline volcanic fields in east Australia with the isotopic composition of the host lavas and finds that lavas enriched in the heavy isotopes of strontium and neodymium are also characterized by modal enrichment of the xenolith suite. She notes that although these xenoliths are heterogeneous on a scale of centimeters, their mantle source region would be homogeneous at the larger scale (kilometers) sampled by melting events. More work of this nature is needed.

This book includes features that will be appreciated by both casual readers and experienced petrologists: a glossary for sorting out esoteric rock names, jargon, and the plethora of "types" and "groups" that plague mantle petrology; a compendium of every known xenolith locality, grouped by region, with data on lithic assemblages, age of emplacement, and host rock types; and, perhaps most useful of all, 72 pages of combined references. In addition, the lavish color plates throughout the volume illustrate clearly minerals and textures that are indistinguishable in black-and-white photographs.

This book is not designed for the reader with a passing interest in earth science. It will appeal most to students who desire a