FOCUS BOOK

James Rodger Fleming, *Historical Perspectives on Climate Change*

(New York and Oxford: Oxford University Press, 1998)

Editor's note: This new column of *Earth Sciences History* highlights a recent book in the history of the geosciences because of its potential interest and importance to a readership beyond a single discipline. The column includes two essay-reviews, one by a scientist and one by a historian or other humanist, and a reply by the author. Fleming's book, on the timely topic of changing (and in some cases persisting) perceptions and reactions to climate change, fits this bill perfectly. It should be read not only by historians of meteorology and climatology, nor only by meteorologists and climatologists. The public generally, along with politicians and policy makers, could gain a better understanding of the context of the current debate on climate change through these pages. More to the point for *Earth Sciences History,* however, *Historical Perspectives on Climate Change* offers much to our readers who might normally concentrate on histories of other geosciences such as geology, geophysics, or paleontology.

The first essay below is by William Kellogg, who has made fundamental contributions to climate science. Then follow Nico Stehr's essay and James Fleming's response. I hope you enjoy and profit from this new forum and I encourage readers to suggest books for future columns.

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In this book, Jim Fleming, an established historian of science, has wisely avoided writing another chronicle of the current debate about whether or not mankind is changing the climate of the Earth. Instead, he has ably unearthed the many roots of modern thought on this subject.

In the clash of current (and often confusing) arguments about the reality of climate change and its causes, we often forget the fervor of previous generations who sought to understand the Earth's climate, the factors that have shaped it, and its influence on society. Here is an excellent reminder.

Those of us who are active in climate research are generally familiar with the mainstream of thought about climate change, but we often neglect the fascinating tributaries that have occupied so many scientists and others concerned with the role of mankind on our Planet Earth. Fleming has explored some of these tributaries and has discovered that many of the liveliest discussions have taken place there—discussions that have set the stage and contributed to major advances in the mainstream.

During the "age of enlightenment" in the seventeenth and eighteenth centuries, European culture was dominated by the writings of such intellectual leaders as the Abbé Du Bos (1670–1742), the Baron de Montesquieu (1689–1755), and David Hume (1711–1776). The climates of Europe and America were seen as shaping the course of empire and the arts. Furthermore, they believed the climates of Europe and America had been moderated since ancient times by clearing of forests and agriculture, and this had made it more fit for European-type civilization. American colonists such as John Adams (1735–1826), Edward Holyoke (1728–1829), and Thomas Jefferson (1743–1826) used this argument in defending

the desirability of America for settlement. Fleming points out, however, that there were skeptics who disagreed with this rosy picture of the climate and how it was changing.

In the nineteenth century, prompted by such leaders as Matthew Maury (1806–1873), Joseph Henry (1797–1878), and the Smithsonian Institution, systematic observations of the weather and climate were instituted, and this irrevocably altered theoretical climate discourse and established the foundations for the science of climatology. Now it was possible to consult the climate record rather than ancient authorities or the memories of the elderly.

The nineteenth century also witnessed the application of physical experiments and theory to the question of climate change, the role of carbon dioxide, feedbacks between the atmosphere, the oceans, and the land surface, and so forth. This changed forever the approach to climatology. Climatology was transformed from a descriptive subject into one in which the laws of physics and mathematics could be applied. The giants who led this advance were, among others, John Tyndall (1820–1893), Svante Arrhenius (1859–1927), and T. C. Chamberlin (1843–1928). The latter contributed considerations of the role of the solid Earth and the oceans in shaping climate, and he suggested causes for the ice ages.

Somewhat surprisingly, Fleming devotes an entire chapter to the popular and prolific writer Ellsworth Huntington (1876–1947). This man seems to have had a great influence on thinking in the early twentieth century, a rekindling of earlier ideas about "age of enlightenment" environmental determinism. These ideas were certainly evocative, such as the power of climatic changes to cause changes in human occupations, habits, and even character, but they are generally not taken seriously anymore.

Fleming deals rather hastily with the enormous advances in recent years, including the pioneering studies of the increase of atmospheric concentration of carbon dioxide by G. S. Callendar (1897–1964) and Charles David Keeling (b. 1928); the studies of the atmospheric effects of carbon dioxide and other infrared-absorbing trace gases by Gilbert Plass (b. 1920) and Walter Elsasser (1904–1991); and early simplified climate model calculations of greenhouse warming by Suki Manabe (b. 1931) and Richard Wetherald (b. 1936). William Sellers and Michael Budyko (b. 1920), who also developed simplified climate models at about the same time, were unfortunately overlooked here.

It will be recalled that in the 1970s there was the puzzling realization that, contrary to the predictions of the generally accepted greenhouse warming theory, the observed global average temperature had not risen after 1945, and that around 1970 there was even a brief period of cooling. Could this be the result of air pollution (the "human volcano", as suggested by Reid Bryson, b. 1920), or by the development of a new northern ice sheet, according to a theory advanced by Maurice Ewing (1906–1974) and William Donn (1918–1987)? Such concerns even brought together scientists and the CIA to determine the geopolitical consequences of a sudden onset of global cooling. This "scare" was put to rest by the resumption of the warming trend and by (among other things) the announcement by NASA's James Hansen (b. 1941) to Congress and the world in 1988, that "global warming has begun."

It is not surprising that such visions of climate warming (or cooling) evoked schemes for climate control, or "geo-engineering," e.g. damming the Bering Straight or covering the Arctic Ocean with soot. There was quite a flurry of proposals to achieve such control, some of them quite outlandish, and this is covered entertainingly by Fleming. He points out that geo-engineering requires fewer competing actors than the abatement of carbon dioxide emissions by the countries of the world, and some scholars have therefore found it attractive as a

way to mitigate global warming. "If this does not invoke apprehension, I don't know what will," says Fleming.

Fleming chooses to wind up these essays just as the well-known International Geophysical Year (IGY) was getting started in 1957, and as the science of climatology was preparing for a great leap forward. This leap forward involved, among other things, introduction of Earth-observing satellites, better observations of the oceans, and the application of supercomputers to the understanding of the climate system. This is clearly another story, one only touched on briefly by Fleming in the closing chapter.

The omission of a detailed discussion of the fast evolving art of climate modeling can be forgiven because so much is being written about it elsewhere, and because it is the arcane realm of a new kind of computer-wielding theoretician. As one of the deans of climate research, Roger Revelle (1909–1991), remarked shortly before his death, "[This is a] young man's game—not because it's physically demanding, but because it requires a lot of mathematics now."

This little book is delightful for several reasons, particularly for those who wish to understand the current debate about climate change and global warming—and who doesn't? Also, it evokes the ghosts of so many characters of the past whose names are only vaguely familiar but who influenced the thinking of their times, such names as Ferrel, Maury, Montesquieu, Langley, Humboldt, and Arbuthnot.

Finally, it is well written and clear, and represents an extremely well researched study by a competent historian.

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The eighteenth century—which, according to many contemporary historians of social science represents the era in which modern social science discourse originated—was an age in which the educated part of the population in France, Germany, and England spent enormous intellectual energy arguing about the climatic determinants of the civilizational peculiarities of entire nations (relying on such works as *Essais* by Montaigne (1533–1592), *Esprit des Lois* by Montesquieu (1689–1755), and *Remarks on the Influence of Climate* by William Falconer (1744–1824)). As a contemporary observer was prompted to point out, there were an endless number of writers who ascribed supreme efficacy to climate. The extent to which these ideas both resonated with and influenced the understanding of nature and the effects of climate, and the importance assigned to nature and the effects of climate in and on everyday life in different cultures, still need to be examined. Equally unexamined is the impact of common sense understandings on scientific ideas of climate, climate change, and the effects of these processes on individuals and on society.

At the end of the nineteenth century, Émile Durkheim (1858–1917) presented an unmistakable contrast in his classic study *Suicide,* first published in 1897. He put forth the argument, which soon became paradigmatic for modern sociology and anthropology, that apparently completely idiosyncratic individual actions are social phenomena, and that neither their patterns nor their distribution can be explained by invoking physical or even cosmic phenomena. Durkheim did not fail to notice, of course, that many contemporary scientists were convinced that

a causal relationship did in fact exist between air, land, soil, and especially climate or weather, and the number of suicides. Durkheim's judgment was harsh. For explanations that refer to cosmic, biological, or physical phenomena, Durkheim had at best gentle consternation:

> To require such an hypothesis the facts must be in unusual agreement . . . We must therefore seek the cause of the unequal inclination of peoples for suicide, not in the mysterious effects of climate but in the nature of this civilization, in the manner of its distribution among the different countries.[1]

Precisely where environmental determinism ceases, the social sciences commence. Durkheim's epistemological views have had a spectacular career in sociology. Not least with their help, the separation of the social and the natural sciences was cemented and celebrated. But the victory of Durkheim's position was never complete and immediate in all branches of the social sciences. Durkheim's plea to avoid and radically surpass the fallacy of environmental determinism fell itself on deaf ears. The scientific heyday of climate determinism, but also of race science and geopolitics, only reached its peak in the following decades of the twentieth century.

Although the discussion of the impact of climate on societies did not cease abruptly in social science, it was ultimately discredited, and vanished almost without any trace as a largely compromised and widely discredited line of inquiry. It has therefore become more common today, as the French historian Fernand Braudel remarks, to find it "amusing to think that the men of former times would not have been put out by . . . climatic explanation, implicating as it does the heavens."[2]

The disappearance of interest in climate matters among the social sciences, one could hypothesize, was not only a matter of intellectual change in science, but also occurred in response to both the apparent emancipation of modern societies from climatic conditions as the result of technical developments (e.g. air conditioning) and the emergence of other, much more pressing, troublesome political and economic issues.

By the end of the twentieth century, with the scientification of the analysis of climate system and climate change and its global or regional impact in full swing, the effect of air, land, soil, and particularly climate and weather have once again become a major preoccupation of intellectual discussion, scientific research, policy analysis, media coverage, and public debate.

James Rodger Fleming's book *Historical Perspectives on Climate Change* covers this entire period well. In a series of imaginative interrelated essays, he describes and examines historical perspectives on climate and climate change from the Enlightenment to the late twentieth century. Fleming's aim is not merely to record authoritative positions about climate and climate change, but also to trace their origins and development, in order to shed light on contemporary perspectives on climate. Finally—and I will return to this issue later—he asks, what does the intellectual heritage of ideas about climate offer for current and future interdisciplinary work on environmental problems?

The first brief chapter is devoted to the convictions of a few thinkers, representing the overwhelming majority of Enlightenment thinkers in France and England, that climate works independently of local, regional, or national cultural

1. Émile Durkheim, *Le suicide; étude de sociologie* (Paris: F. Alcan, 1897); *Suicide, a study in sociology* (New York: Free Press, 1952), 104.
2. Ferdinand Braudel, *The Structures of Everyday Life*: *The Limits of the Possible,* vol. 1 of *Civilization and Capitalism 15th–18th Century* (Berkeley: University of California Press, 1992 [first published 1979]), 51.

and social conditions; as a matter of fact, climate was seen as responsible for these circumstances. Fleming's exegesis of the history of ideas on climatic change and climatic variability among Enlightenment thinkers could be extended to cover the sometimes sympathetic and sometimes rather skeptical conceptions of climatic influences on society of Johann Gottfried Herder (1744–1803), in his *Ideen zur Philosophie der Geschichte der Menschheit* (1784–1791).[3] The ideas of the Enlightenment found their way to North America in colonial times. Fleming deals with the lively discussion of the interaction between climate and society in colonial and post-colonial North America in his next chapter.

The emergence of modern-day empiricist meteorology in different countries and its critique of more impressionistic views of weather and climate form the core of Fleming's book, and are documented in the following five chapters. From an operational point of view, and given the technical means available at the time, the governing conception of climate now referred to macro-meteorological phenomena that can be *measured* at the *surface* of the Earth. Climate *is* the sum total of quantifiable climatic elements, especially temperature, humidity, precipitation and wind speed, averaged over a certain period of time. In contrast to an indeterminate and merely subjective impression of climate, scientific apprehension of climate requires the numerical expression of climate elements based on empirical information. The heroes of the story are many. The pioneers Fleming discusses in particular are Joseph Fourier (1768–1830), John Tyndall, Svante Arrhenius, and T. C. Chamberlin. He does not refer, however, to one of the most important meteorologists of the time—considered by some to be among the founders of modern meteorology as the science of the physics of the atmosphere; namely Julius Hann (1839–1921). The scientific opinion around which the meteorological community's views began to coalesce is the conclusion that the climate system is permanent and stable rather than changeable.

Fourier's, Tyndall's, and Arrhenius's contributions to the idea of the greenhouse effect are emphasized. Fleming not only stresses the paucity of historical attention to the ideas of these scientists but also the unreliability of the materials and interpretations available so far. It is the special gift of Fleming's fresh and penetrating chapter on Fourier to correct the existing record and show, based on archival research, the early and complex ideas Fourier developed regarding what later became known as the "greenhouse effect." In addition, Fleming stresses that the scientific work of the various pioneers of the greenhouse effect was not yet animated by current concerns about the deleterious impact of global warming caused by excessive emissions and other anthropogenic activities in advanced societies.

The following chapter is devoted to a sympathetic account of the underrecognized ideas of T. C. Chamberlin, who moved from geology to interdisciplinary earth sciences and, finally, to cosmology, combining all of them. Fleming emphasizes Chamberlin's response and contribution to three major conceptual revolutions in his fields of study, especially his carbon cycle theory and efforts to comprehend the Earth's dynamic systems.

The next chapter deals with the ideas and the influence of one of the most famous, though now discredited, geographers of the first part of this century: Ellsworth Huntington. Huntington is the architect of modern scientific climate determinism. Huntington takes in and follows the conception of climate developed by the emerging field of meteorology. He also closely adheres to the methodological principles advanced by scientific meteorology designed to develop a re-

3. Johann Gottfried Herder, *Ideen zur Philosophie der Geschichte der Menschheit,* 4 vols. (Riga, 1784–1791). Transl. by T. O. Churchill as *Outlines of a Philosophy of a History of Man* (London, 1800).

ality-congruent image of climate and weather. Huntington's work is also—as some may choose to call it today—interdisciplinary, a term that was first coined in the late 1920s. He constantly straddles the boundaries of the culture of the natural and the social sciences. The reductionist perspective and metaphors Huntington deploys in order to conceptualize human conduct and society as determinate objects capable of unperturbed observation, precise measurement, and predictability represent an agenda that buys into the governing traditions of at least one of the scientific cultures he desires to serve with his own research. But the question also becomes: in hindsight, can one justifiably invoke the attributes of "a simplistic and wholly unrealistic pseudoscientific theory"[4] in describing central aspects of Huntington's work and agenda?

Unlike the conviction displayed by many classical theories of science, science is incapable of offering cognitive certainty. Scientific discourse cannot generate definitive, or even true, statements (in the sense of proven causal chains). For all intents and purposes, science is able only to advance more or less plausible and often contested assumptions, scenarios, and probabilities. Instead of being the source of reliable trustworthy knowledge, science thus becomes a source of uncertainty. And contrary to what rational scientific theories suggest, this problem cannot be comprehended or remedied by differentiating between "good" or "bad" science (or between pseudo-science and correct, i.e. proper, science).

The key to understanding Huntington's theories *and* their not insignificant public career therefore should not, in my view, be linked primarily to failures to deliver data congruent with reality and/or objective inferences. As a matter of fact, by the standards of his time, his work was judged by many of his peers to be eminently scientific. Fleming stresses the strong opposition that Huntington encountered in his lifetime, which included not only natural scientists, but also many social scientists and fellow geographers. And, as is by no means unusual, the resistance—even hostility—Huntington experienced did not deter him, as far as I can see, from maintaining his ideas. Huntington was quite successful in publishing and promoting them in multiple media, not only in scientific books and journals. Unless psychological accounts are introduced as an appropriate "explanation" for Huntington's stubborn determination to pursue his ideas about the efficacy of climate and weather, one needs to look for answers to the degree to which his world view resonates with similar deterministic, single factor explanations about human conduct found—to this day—among many segments of the public. The appeal and the mundane efficacy of deterministic conceptions in many social contexts are quite evident: witness the persistent appeal of racism and technological determinism. The ideas of the Enlightenment thinkers and lesser climate determinists did not simply vanish; they traveled well, as Fleming convincingly shows in the case of the colonists of North America.

At the present time, the perspective of climate determinism therefore lives, as one might infer, a strange dual existence: On the one side, it is, in some cultures more strongly than in others, a widely accepted view in everyday life based on common-sense traditions and obvious "facts"; and on the other hand, among social scientists, it is considered a long and deservedly discredited intellectual perspective. Although contemporary climate scientists might think they are immune to climate deterministic ideas, Fleming rightly points out that an examination of Huntington's ideas is warranted, if the climate science community is to avoid the kinds of undifferentiated, dramatic, and excessive claims made for weather and climate influences in the current debate about the effects of global anthropogenic climate change. The sustainability of climate determinism may be

4. James Rodger Fleming, *Historical Perspectives on Climate Change* (New York and Oxford: Oxford University Press, 1998), 95.

stronger than the sustainability of the climate system. Fleming's metaphor of apprehension (awareness, understanding, fear, and intervention) applies both to the question of how ideas in science are sustained and nurtured and to the nature of the interaction between scientific perspectives and everyday conceptions of the same set of phenomena.

Fleming designates one of Huntington's preoccupations—namely the excruciatingly detailed empirical analysis of the influence of weather patterns on productivity—most aptly as "meteorological Taylorism." Once again, Huntington's research in this field resonates strongly not only with the scientific management school of thought of Frederick W. Taylor (1853–1929), but also with the social re-organization of work based on the principles developed at the beginning of the century by Henry Ford (1863–1947) and the famous Hawthorne studies by the sociologist Fritz Jules Roethlisberger (1898–1974) on the social context of work, at about the same time.[5]

In the final two chapters of his book, Fleming returns to the issue of the "checkered history" in this century of the notion of global warming and the varied causes (including, of course, anthropogenic influences) that were seen as arresting or accelerating global warming. He pays special attention to the work of an "outsider," the British steam engineer G. S. Callendar. The rising levels of atmospheric CO_2 caused by industrial fuel combustion are called by some the Callendar effect.

Major paradigm shifts in science are not the sole result of internal cognitive developments. Fleming's history of the genealogy of ideas about climate change shows decisively that intellectual shifts are not necessarily as clear-cut, revolutionary, or straightforward as many believe. Rather, they resonate with and respond to social and cultural factors, as Fleming rightly points out. For example, what are the social and cultural factors co-responsible for the emergence of strong research interests in the impact of changes in the CO_2 or water vapor content of the atmosphere and the subsequent decline of interest and concern with climatic change, however it may be caused?

It is in this context that Fleming perhaps fails to sufficiently stress the extent to which the ideas advanced by the thinkers of the Enlightenment, by the early settlers in the United States, and later by the modern-day climate determinists, are implicated in the politics of the day. Since many classical and early modern thinkers speculated that their own societies had attained a summit, it is no accident that the strangers, the enemies, or the barbarians almost always had to endure the worst climatic conditions. An informative case study by Stephen Frenkel of the role of environmental determinism in the development of the Panama Canal Zone establishes, for example, the practical efficacy of climate determinism as an intellectual or ideological weapon.[6] Huntington's views resonated with, and were easily assimilated to, the doctrines of racism and imperialism of his day. Their very success and political utility proved to be a major contributing factor in their obliteration today. And Ellsworth Huntington was rarely satisfied with merely documenting his case: he very much desired to draw practical lessons and apply his conclusions at once. The practical clues came directly from his research.

5. See, for example, Henry A. Landsberger, *Hawthorne revisited. Management and the worker: its critics, and developments in human relations in industry* (Ithaca, N.Y.: Cornell University, 1958); Fritz Jules Roethlisberger, *The elusive phenomena: an autobiographical account of my work in the field of organizational behavior at the Harvard Business School,* ed. George F. F. Lombard (Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1977).

6. Stephen Frenkel, Geography, empire, and environmental determinism, *The Geographical Review,* 1992, 82:143–153.

Huntington wanted us to exploit the benefits of climate: For example, he suggested that the seat of the United Nations should be located in Newport, Rhode Island, because it had the most suitable climate for humans. And his concern for the optimum (indoor) climate even resulted in a close association with the American Society of Heating and Plumbing Engineers.[7]

It is of course important to note, as Fleming does, that the construction of environmental problems as socio-political problems owes its presence on the agenda of political debate and national and transnational policy to modern science. This is not an entirely new phenomenon. Even in the field of climate science and climate policy there is a successful history of scientists who have managed to put the issue of climate change on the political agenda (e.g. Nico Stehr and Hans von Storch, 1999).[8]

But as Fleming correctly points out, the history of the changing nature of ideas developed in the analysis of global change over the last centuries has received little, if any, attention. The fact that global change science is still predominantly a natural science activity may account for some of the systemic disinterest in the genealogy of ideas about climate and climate change.

The transmission of intellectual traditions and the history of ideas and innovation in science are not simply opposing activities. The transfer of past ideas should not be conflated with the notion that the preservation of, and acquaintance with, knowledge of the past equals mere repetition and preservation of these traditions. The transmission of ideas from the past is always a mediation of such ideas in the light of new circumstances, and therefore presents problems and issues. In short, familiarity with past ideas can be instrumental in the construction of new knowledge, rather than an obstacle to scientific discovery, as the practice of science today often appears to imply. I am convinced that Fleming's book will serve this task in climate science rather well.

Author's Reply to Nico Stehr and William Kellogg

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I intended *Historical Perspectives on Climate Change* to be a collection of interrelated essays that would provide historical perspectives on climate and climatic changes from the Enlightenment to the late-twentieth century. I set out to document what people have understood, experienced, and feared about the climate and its changes; how privileged and authoritative positions on climate have been established; and the paths by which we have arrived at our current state of climate knowledge and climate apprehension. I did not attempt to construct a complete survey of climate change history, grand narratives being out of style and fraught

7. Geoffrey J. Martin, *Ellsworth Huntington. His Life and Thought* (Hamden, Connecticut: The Shoe String Press, 1973), xiv.
8. Nico Stehr and Hans von Storch, eds., *Eduard Brückner: The Sources and Consequences of Climate Change and Climate Variability in Historical Times* (New York: Kluwer, 1999).

with problems. In fact, I purposefully constructed a short book that I hope will stimulate additional work on the topic.

I examined the climate apprehensions of scientists, other intellectuals, and the general public from the eighteenth century to the late twentieth century, employing three meanings of the term "apprehension" as an organizational metaphor: (1) awareness or understanding, (2) anticipation or dread, and (3) intervention. The book contains essays on climate and culture in Enlightenment thought, climate debates in early America, the expansion of observing systems, and the development of a scientific mode of climatological discourse. There are also chapters on individual scientists and writers: Joseph Fourier, John Tyndall, Svante Arrhenius, T. C. Chamberlin, and the environmental determinist Ellsworth Huntington. A penultimate chapter on global warming before 1957 examines public awareness of climate issues and the work of individuals such as G. S. Callendar, Gilbert Plass, and Roger Revelle. The epilogue argues for a view of global change and its human dimensions rendered more complete by the study of the intellectual, social, and cultural changes that preceded the current environmental crisis. I conclude that historical studies are essential to the interdisciplinary investigation of environmental problems.

I wish to thank William Kellogg and Nico Stehr for their careful reading of my book and for their kind and insightful comments. They are distinguished representatives of two prototypical readers: the scientist and the humanist—just the cultural range for whom the book was intended. It is also appropriate to thank the editor of this journal, Gregory A. Good, for initiating this **Focus Book** forum which is in the best traditions of "Geo-Clio."

Both reviewers provide cogent remarks on the environmental determinism of Ellsworth Huntington. Although Kellogg registers mild surprise to find an entire chapter on Huntington and notes that such ideas "are generally not taken seriously anymore," this is not strictly true among the general populace, at least in our collective subconscious. Stehr spends considerably more time on the issue and suggests, rightly so, that more work remains to be done on the climatic determinists—whether from the eighteenth, nineteenth or twentieth centuries—and how their ideas are implicated in the politics of the day. Montesquieu's "spirit of laws," Jefferson's "yeoman farmers" and yes, even Al Gore's "Earth in the Balance" share some assumptions, perhaps unwarranted and as yet unexamined, about the inter-relatedness of climate and culture.

Both reviewers suggest additional topics that are worthy of consideration. As Kellogg points out, the work of W. D. Sellers and M. I. Budyko on statistical representations of horizontal heat exchange in climate models deserves more attention.[9] John Kutzbach has recently commented on these models in his chapter, "Steps in the Evolution of Climatology: From Descriptive to Analytic," in a book I edited.[10] According to Kutzbach, the models of Sellers and Budyko, each created independently of the other, stimulated the development of a wide range of coupled-system climate models that include selected processes of the atmosphere, biosphere, cryosphere, hydrosphere, and lithosphere, on time scales ranging from years to millions of years. Stehr's suggestion that the work of Julius von Hann (1839–1921), whose *Handbuch der Klimatologie* is one of the "landmarks of science," is also worthy of note.

9. M. I. Budyko, The effect of solar radiation variations on the climate of the Earth, *Tellus*, 1969, 21:611–619; W. D. Sellers, A global climatic model based on the energy balance of the Earth-atmosphere system, *Journal of Applied Meteorology*, 1969, 8:392–400.

10. J. E. Kutzbach, Steps in the Evolution of Climatology: From Descriptive to Analytic, in *Historical Essays on Meteorology, 1919–1995,* ed. James Rodger Fleming (Boston: American Meteorological Society, 1996), 353–377.

In truth, *Historical Perspectives on Climate Change* might be considered to be a recent contribution, but certainly not the last word on historical climatology. There are a large number of historical issues in weather, climate, and culture yet to be explored. I fully intend to continue such work, I invite others to join the task, and I offer my thanks again to both reviewers for their stimulating essays.

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ANNOUNCEMENTS

PERSONALIA

The American Meteorological Society (AMS) is pleased to announce that Gregory Cushman, a Ph.D. candidate in history at the University of Texas, Austin, has been awarded the inaugural 1999–2000 AMS Graduate Fellowship in the History of Science for his project on the early history of El Niño.

Albert V. Carozzi, Professor Emeritus in the Department of Geology at the Universtiy of Illinois, Urbana-Champaign, was awarded the Prix Wegmann 1999 of the Société Géologique de France. The honor was conferred at the Society's annual meeting in Paris, on June 7, 1999. This recognition was for lifelong contribution to the history of geology.

David Oldroyd received the History of Geology Award at the 1999 meeting of the Geological Society of America. This award is given by the GSA's History of Geology Division to an individual for contributions of fundamental importance to the understandinng of the history of the geological sciences. Dr. Oldroyd's books include *The Highlands Controversy: Constructing Geological Knowledge Through Fieldwork in Nineteenth-Century Britain* (1990), *Thinking About the Earth: A History of Ideas in Geology* (1996), and *Sciences of the Earth: Studies in the History of Mineralogy and Geology* (1998).

FELLOWSHIP ANNOUNCEMENT

American Meteorological Society Graduate Fellowship in the History of Science. The American Meteorological Society (AMS) is pleased to invite applications for a 2000/2001 AMS graduate fellowship in the history of science, to be awarded to a student planning to complete a dissertation on the history of the atmospheric, or related oceanic or hydrologic, sciences. The award carries a $15,000 stipend and will support one year of dissertation research. Fellowships cannot be deferred and must be used for the year awarded, but can be used to support research at a location away from the student's institution provided the plan is approved by the student's thesis advisor. A related goal of the fellowship is to foster close working relations between historians and scientists. An effort will be made to place the student into a mentoring relationship with an AMS member at an appropriate institution.

Candidates wishing to apply must be a graduate student in good standing who proposes to complete a dissertation as described above. To apply, candidates must submit the following:

- a cover letter with vita,
- official transcripts from undergraduate and graduate institutions,
- a detailed description of the dissertation topic and proposed research plan (10 page maximum),
- three letters of recommendation (including one from your dissertation advisor).

Application packages and supporting materials should be sent to:

Stephanie K. Armstrong
Manager of Fellowship and Scholarship Programs
American Meteorological Society
45 Beacon Street
Boston, MA 02108-3693

Deadline for completed applications is 14 February 2000. Notification will

take place by 1 May 2000. Applicants will be informed by mail of application materials received. It is the applicant's responsibility to ensure that all materials (including letters of recommendation) are received at AMS Headquarters by the closing date; applicants are encouraged to check with AMS if they have not received written notification regarding the status of their application package. Any questions regarding the fellowship opportunity may be directed to Stephanie K. Armstrong at the address above, Phone: 617-227-2426 ext. 235, or Email: armstrong@ametsoc.org.

CALLS FOR PAPERS

August 3–5, 2000. Conference On The History Of Geologic Pioneers, Troy, NY, USA.

This meeting will combine theme-oriented and volunteered papers with visits to the favorite geologic exposures of historical figures. The field trip will include ceremonies (memorial plaques will be installed at several sites) at the graves of founders of the Geological Society of America, the American Association for the Advancement of Science, and the American Association of Petroleum Geologists. The meeting is being hosted by the Rensselaer Center of Applied Geology located at 15 Third Street in Troy, New York. This center is named in honor of Jeremias Van Rensselaer (1783–1871), whose book *Lectures on Geology* (1825) popularized the science. Contact: Dr. Gerald M. Friedman, Northeastern Science Foundation, Inc., P.O. Box 746, 15 Third Street, Troy, NY 12181-0746. E-mail: gmfriedman@juno.com. Telephone: 518-273-3247. Fax: 518-273-3249. http://www2.netcom.com/~gmfstf/

May 2001 International Conference—H_2O: Origins And History Of Hydrology, Colloque International OH2: Origines et Histoire de l'hydrologie, Dijon, France.

A colloquium organized by the Comité National Français des Sciences Hydrologiques, and the Comité National Français pour le Programme Hydrologique International. Many works have been published on the history of hydraulics and fluid mechanics, mainly hydraulic developments; however, the history of hydrology, as a science, has so far been the object of very few works. The H_2O international conference, organized jointly by the CNFSH and the CNFPHI, in the framework of the UNESCO International Hydrological Programme, and assisted by the International Union of History and Philosophy of Science, is open to all—hydrologists, hydrogeologists, geographers, engineers, archaeologists, historians, etc.—in order to provide an introduction to the reconstitution of the historical evolution of ideas, concepts, and tools in this field which have developed since Antiquity up to the present day.

Three main lines of reflection are proposed:

– for Antiquity and its great hydraulic works, especially in the field of irrigation and for the Middle Ages and its various uses of water, we wish to lay special emphasis on the knowledge, or lack of knowledge, of the Ancients concerning the cycle of water instead of on the techniques and practices which were used;
– from the fifteenth century, we will focus on the emergence of concepts and tools that made possible and followed the founding acts of hydrology and modern hydrogeology, illustrated by the works of P. Perrault (hydrological assessment) and E. Halley (evaporation);
– finally, since the previous century, hydrology and hydrogeology have progressively structured themselves as autonomous sciences through various schools of

thought, institutions, and scholarly societies, the history of which remains to be written and to be situated in general histories.

The establishment of knowledge and quantification of the cycle of water represents one of the great adventures of human thought. As such, it concerns the whole set of disciplines that are concerned with the relationship between man and nature.

Official languages for the conference are French and English. Contact: www.cilea.it/history/DHS/Oh2.htm; or Dr. J. P. Carbonnel at Université P. et M. Curie, Laboratoire de Géologie Appliquée, Case 123, 4 Place Jussieu, F-75252 Paris, cedex 05, France; e-mail oh2@biogeodis.jussieu.fr

November 5–8, 2001. Geological Society of America, History of Geology Division, Annual Meeting, Boston, Massachusetts.

Paper proposals are requested for a thematic session on the history of "Ophiolites as Problem and Solution." The study of the rocks of ophiolites over more than two hundred years both reflected and advanced the methods and theories of the time. At first there was observation and description, followed closely by study of physical parameters and properties. Mixtures of minerals were fused, and work under pressure began. By the last third of the eighteenth century, chemical analysis, crystallography, and mineralogy were added. Soon after came the thin section, the petrographic microscope, and studies under polarized light. As the nineteenth century advanced mathematical descriptions of heat, its sources and behavior, were clarified, as was the relation of electricity and magnetism. Most common minerals were synthesized during this period. Temperature/pressure/composition studies were pursued with increasing sophistication. Throughout the twentieth century the study of ultramafic rocks has posed an array of problems in the field, in the laboratory, and for theory, that include (but are not restricted to) mineralogy, petrology, magnetism, temperature/pressure/composition relations, plate tectonics, magma differentiation, serpentinization, and ultramafic magmas. Contact: Sally Newcomb, 13120 Two Farm Dr., Silver Spring, MD 20904. E-mail: senewcomb@earthlink.net. Telephone: 301-622-0177.

CONFERENCES AND SPECIAL EVENTS

June 28, 29, 30, 2000. The Geological Society (London), History of Geology Group. The William Smith Millenium Meeting: Celebrating the Age of the Earth, London, United Kingdom.

This special meeting will re-create the atmosphere of interdisciplinary discussion that prevailed at the end of the nineteenth century with invited presentations by geologists, biologists, physicists, chemists, astronomers, and historians of science. Presentations include: a keynote address by Prof. Aubrey Manning, presenter of the television series *Earth Story*; the William Smith Lecture by Prof. Hugh Torrens on "Timeless Order: William Smith and his Search for Raw Materials"; and fifteen others on topics such as eighteenth-century debates, Cuvier and Lyell on time, geology, and fossils, John Phillips, John Joly, and current scientific research. The meeting will close with a presentation by The Astronomer Royal, Prof. Sir Martin Rees, placing the age of the Earth within its modern context in the age of the Universe. Hugh Torrens will also lead a time-related field trip to the Wealden, site of Charles Darwin's famous age estimate. Contact: Cherry Lewis via e-mail at clelewis@aol.com. Registration via Maxine Winter, The Geological Society, via e-mail at winterm@geolsoc.org.uk. On-line registration at http://www.geolsoc.org.uk.

August 6–17, 2000. 31st International Geological Congress, INHIGEO, Session 27-3, Some Major Developments in Twentieth Century Geology, Rio de Janeiro, Brazil.

This is one of the world's oldest scientific conferences, and the premier event of the earth-science calendar, providing the forum for ample debate on all significant advances in the earth sciences. In recognition of the changes occurring around us, the main theme of this Congress is Geology and Sustainable Development—Challenges of the Third Millennium. The aim is to promote discussion on the fundamental role of earth scientists and the industry as a whole in responsible development and the preservation of our environment. The Congress will include a General Symposium on the History of the Geosciences, organized by David Oldroyd and Sylvia Figueirôa. Keynote papers to be presented in this Symposium include:

- Different Perceptions of the Geological Sciences in the Tropics, Manoel Serrano Pinto (Portugal), J.C. Barreto de Santana (Brazil) [INHIGEO]
- Geological Sciences and the End-Millenarism, Hugh Torrens (UK), Maria Margareth Lopes (Brazil) [INHIGEO]
- The Major Developments in Geology in the Twentieth Century, D. Oldroyd (Australia), Sylvia Figueirôa (Brazil) [INHIGEO]
- Geoenvironment and World Mythology, Guy Martini (France), Llias Mariolakos (France) [UNESCO]

The date for the historical symposium is not yet set.

November 13–16, 2000. Geological Society of America Annual Meeting, History of Geology Division Millennium Symposium. Lamont and Plate Tectonics, 1949–1999, Reno, Nevada, USA.

This special session (exact date to be assigned) will include presentations by Jack E. Oliver, Neil O. Opdyke, James R. Heirzler, Lynn S. Sykes, Manik Talwani, Marie Tharp, Heinrich D. Holland, and William Glen on various aspects of the history of plate-tectonic research at Lamont-Doherty Earth Observatory. The relations of seismology, geomagnetism, geochemistry, and other research areas to plate tectonics will be explored. See: www.geosociety.org.

BOOK REVIEWS

Gretchen Luepke, BOOK REVIEW EDITOR

LYELL IN AMERICA. *Leonard G. Wilson. 1998. Johns Hopkins University Press. 429 p. Hardcover. $45.00.*

Leonard Wilson closed his second book on Lyell with Charles and Mary Lyell preparing for their first trip to America. As he is about to leave London, Lyell receives some advice in a letter from his father (Wilson, 1972, p. 516):

> . . . never forget that Mary is a wife of gold and that you could not have found another like her. When rough expeditions are to be encountered do not measure her strength by yours. Her spirits, and anxiety never to be a hinderance to the accomplishment of any wish of yours, will always incline her to run risks which you must not suffer. So take especial care of her if you love me.

Lyell in America justifies Mr. Lyell's opinion of Mary. She went everywhere in America with Charles, traveling rutted country roads, sleeping in cold frontier inns, collecting fossils, wearing out her clothes, serving as Charles's correspondent and deputy on social occasions, and sometimes putting up with the unwanted attentions of the democratic traveling public of the 1840s. For a remarkable tribute to Mary Lyell from an American, see Appendix B to volume II of Katherine Lyell's (1881) *Life.* Wilson cites Mary's letters or Diary in 36% of the 261 footnotes in his first three chapters, and he starts the index to this book with the statement that "Mary Lyell participated so extensively in her husband's activities that separate entries for her would be redundant." Wilson would have a particular sympathy for Mary Lyell in her travels because he and his wife, Adelia, have retraced many of Lyell's journeys in North America, and he dedicates the book to Adelia.

The book under review is Wilson's third on Lyell. In what follows, I refer to this book, *Lyell in America,* as *America,* and otherwise unidentified page numbers refer to this book. Wilson's second book on Lyell, *Charles Lyell, The Years to 1841: The Revolution in Geology,* is Wilson (1972). Wilson's first book on Lyell, *Sir Charles Lyell's Scientific Journals on the Species Question* is Wilson (1970). Charles Lyell means the geologist of Wilson's books, and not his father or grandfather who had the same name. *America* covers a twelve-year period, 1841–1853, during which the Lyells were on their North American travels for slightly less than two and a half years. Lyell described his first trip in two volumes published in 1845, and his second trip in two volumes published in 1849.

America has eleven chapters, of which eight chapters describe the travels of the Lyells in America, and the remaining three chapters depend mostly on their American travels: Chapters 1, 2, and 3 deal with Lyell's first trip to North America (20 July 1841–29 August 1842); Chapter 4 deals with Lyell in England writing up his travels; Chapters 5, 6, 7, and 8 deal with Lyell's second trip to North America (4 September 1845–13 June 1846); Chapters 9 and 10 deal with geological work and social activities in Great Britain and on the Continent; and Chapter 11 deals with Lyell's third and fourth trips to North America (20 August–12 December 1852; 28 May–6 August 1853). The bibliography is 24 pages long. There are 39 illustrations, including eleven maps made for this book that clearly locate the North American itineraries of Charles and Mary Lyell.

Leonard Wilson occupies an isolated position among historians who have

written about Lyell in the last three decades. Wilson is the only one who *appreciates* Lyell, in the dictionary senses of that word: 'to esteem, to recognize and be grateful for, to estimate the quality or worth of, especially favorably'. No one else, since Bailey (1962) authored a short biography, treats Lyell with a command of the subject and with appreciation.

If you read what contemporary historians, including historians whose works I have enjoyed and benefitted from, have written about Lyell, you come away from even accurate descriptions feeling that Lyell is guilty. Of what he is guilty is less clear. Lyell was a master of 19th-century English prose style and of organizing effective and logical arguments. These no longer appear to be desirable attributes. The historical chapters that open the *Principles* in 1830 are judged to be lacking by the standards and knowledge of some late 20th-century historians. Lyell, the pre-Victorian geologist, is guilty of not being such a late 20th-century historian.

After his initial investigations, Lyell had a general working hypothesis that came to be called uniformitarianism. Carrying out further field investigations, he uncovered many phenomena and much geologic data that conformed to the hypothesis, which might then be said to be a theory. Somehow, this development and use of a very fruitful theory is interpreted as devious scheming. In recent decades, Lyell's uniformitarianism has been split into categories, deconstructed, and redefined without regard to its success by the plain English meaning in explaining geologic data. For over forty years, 19th-century geologists and educated public bought the *Principles* through eleven editions, presumably for its benefits. There was not a close competitor.

At their core, the geologic questions of Lyell's time were, in present understanding, elementary to the extreme. What was the steepest angle at which fluid basalt could solidify? Could that stream have cut the valley in which it flows? Could those marks in the Triassic rocks of the Connecticut River valley be bird footprints? Lyell's best answers to these questions were not always the explanations that now are held, but the theory that got to present understanding was his, if it is to be attributed to anyone.

No important scientist can draw a pass when it comes to scrutiny by historians, and Lyell deserves critical analysis. But the analyses that have left Wilson in the minority seem to miss the point of what Lyell did as a geologist.

Much of Lyell's time during the years covered by *America* was devoted to questions involving education, and these questions were inseparable from questions of class and religion. Concerning education, Lyell was a liberal optimist. Given suitable education, Lyell believed in a Lamarckian perfectibility of man—excluding the Irish peasant. Lyell consistently opposed the control exercised by Anglican clergy over instruction at Oxford and Cambridge Universities. In reporting his travels in America, he emphasized the relative independence from religion of state-supported education.

On the evidence from Lyell's travel books and from Wilson's *America,* Charles and Mary Lyell went to church often when in America. They went only to Protestant churches, but sometimes to churches of different Protestant denominations on the same Sunday. They attended Negro (Lyell's term) churches as well as churches with white or mixed congregations. The idea occurs to the reader that Lyell went to church as much to gather data to use back in England, as to share in religious worship.

Lyell met a wide variety of Americans, and it is reasonable to suppose that he had a more realistic view of the United States as a whole than did the majority of individual Americans at the time. He was a loyal supporter of the North and of Union causes at a time when the English were strongly pro-South in their

sympathies. Yet his adherence to the North was tempered by personal friendships with Southerners and by experience in the South.

Lyell did not begin his first travels planning to write the two-volume description that resulted in 1845, but he surely intended to capitalize on the social as well as geologic findings of those travels. Lyell's personal experience with slavery, religion, and education in the U.S. made him a valuable counselor to those promoting reforms in England, and his reputation led to a personal acquaintance with Prince Albert. Lyell was knighted in 1848.

Among many purely geologic results of Charles Lyell's travels in North America were the detailed explanation (with Hall) of Niagara Falls, proof that principles of Tertiary stratigraphy developed in Western Europe applied also in North America, the discovery of reptiles in Carboniferous coal, and an appreciation of the facts (but not the theory) of Appalachian folding developed by Henry Darwin Rogers and William Barton Rogers. In addition to new discoveries, he clarified mistakes in stratigraphy and fraud in vertebrate paleontology. Everywhere, Lyell developed evidence that kept stretching the time scale over which geologic processes had acted, thus pushing back in time the age of Tertiary rocks and lengthening the duration of mountain building. Results obtained in his North American travels extended the *Principles* and *Elements* beyond the geology of Western Europe.

The dramatic incident in this book of travels occurs at home when Mr. Lyell died at Kinnordy in November 1849. Charles, as Mr. Lyell's first-born descendent and a male, expected to inherit the bulk of the father's large estate, according to the custom of that time and that place. However, *America* holds two surprises for the reader when the will was read (p. 313). The father divided his estate equally among his surviving children, and there were eight such children!

The size and composition of the Lyell family was a particular surprise to me, your reviewer, once I had accounted for its members from Wilson (1972). Charles Lyell, the geologist, was the oldest of his parents' ten children, of which eight (three sons, five daughters) were alive at the time of his father's death. By coincidence, I am the oldest in a family whose size and composition has numbers identical in each category to those of the last sentence. With this coincidence as my warrant, here follows a digression into the Lyell family.

There are many footnotes in *America* to people named Lyell, but their relations to Charles and Mary Lyell are usually not clear. One must carefully read Chapter 2 and page 547 of Wilson (1972) to identify the ten children of Mr. Lyell. The existence of such a family would certainly affect Charles's activity, or perhaps, if it did not, that lack might be part of the reason why, as Wilson puts it, he was disinherited. Let us see what the record shows. Lyell's sister, Elizabeth, died on 25 October 1835 of consumption at age 21 (Wilson, 1972, p. 421). His sister, Maria, died on 26 December 1843 after giving birth to her first child at age 35 (p. 136). The first three chapters of *America,* covering 13 months in America, have footnotes identifying about 20 separate letters from Charles and Mary Lyell to Charles's sisters, of which six were from Charles, two were joint letters from Charles and Mary, and 12 were from Mary. During this time, none of the referenced letters are to his brothers, and only two letters are to his father. However, some of the sisters lived with Mr. Lyell, so a letter to them conveyed news to him. The reader will recognize that the absence of additional letters is not proof that there were no others. The letters uncovered by Wilson and other letters printed in Katherine Lyell's *Life* show Charles's relations with his family to be close, considerate, and affectionate. The surviving correspondence indicates that Charles was an integral member of that family.

Based on Katherine Lyell's *Life,* Mr. Lyell never died, for letters in her book do not mention his death. Katherine Lyell was related to Charles Lyell as 'his

sister-in-law, Mrs. Lyell', according to the title pages of her book. In fact, she was doubly Charles's sister-in-law, being wife of his brother, Henry, and sister of Mary. She benefitted from the equipartition of the estate, so perhaps she thought it might be well not to mention it. But she does include letters that show the subject of equipartition had been on the mind of Mr. Lyell for some time.

Mr. Lyell had asked in the summer of 1823 when Charles was in Paris about the effects of the French law on equal inheritance (Bailey, 1962, p. 56). Charles answered, in part, that a major benefit of equipartition is the improved marriage prospects for daughters. (Maria was the only one of Charles Lyell's seven sisters who married.) Charles's discussion is extensive, as reprinted in Katherine Lyell's *Life* (10 Aug 1823), and that *Life* has at least two other letters where Charles discusses the subject, including one to his sister Marianne in 1848, a year before his father's death. Mr. Lyell made the will that disinherited Charles in 1836, the year after Elizabeth died.

There is a frequently quoted letter from Gideon Mantell to Benjamin Silliman that describes Charles Lyell as having "a decided Scottish physiognomy", but the Lyells seem to have been more English than Scottish in Charles's generation. Of Charles Lyell's four grandparents, it appears from Wilson (1972) that only one was born a Scot. Both his parents were Londoners. Charles was born in Scotland, but all nine of his brothers and sisters were born in Hampshire, as far from Scotland as socially important Englishmen lived in those days. The Lyells preferred England; they were more at home there, and so they were more in tune with the society that produced Charles Lyell's friend, Charles Darwin, than that which produced Kelvin.

There are interesting parallels between the Lyell and the Darwin families in timing and in names of the children. Mr. Lyell's ten children were born between 1797 and 1814. Dr. Darwin's six children were born between 1798 and 1810. Dr. Darwin died in 1848 and Mr. Lyell in 1849. The naming of a baby is a complex interplay of tradition and fashion, and both determinants reflect social class. The most famous child in each family was named Charles, and each Charles had a sister named Marianne and Caroline. Caroline is the feminine of Charles. The Mariannes were born in 1801 and 1798, and Marianne is the heroine of Jane Austen's *Sense and Sensibility,* first published in 1811. Jane Austen and the Lyell family were acquainted when both lived in Southampton (Wilson, 1972, p. 21).

This book is a very welcome treatment of Lyell, but it could have been better. Everyone makes choices among the options available to him, and it seems from Wilson's Preface that the appearance of *Lyell in America* occurs at least fifteen years later than it might have been published, given other choices. It seems probable that this delay has impeded scholarship on Lyell and has allowed the present skepticism about Lyell's standing in the history of geology to range more widely than it might have.

The book needs family trees for the Lyells and the Horners, Mary's family. Wilson is meticulous in identifying and locating even minor characters that Lyell meets in his travels, but he fails to properly identify members of the families to which Lyell and Mary belong. For example, the Lyells received in Philadelphia "a box containing the Old World from Frances & Susan". Now who are they? The reader who has read Wilson (1972) and who is in possession of a very good memory will recall that Lyell had a sister Frances, but that reader may also recall that Mary had a sister Frances. And the context here does not guarantee that "Frances & Susan" are sisters.

There is some confusion between granite and basalt. Lyell had a vague idea that, because the same major elements are found in both granite and basalt, granite grades upward into basalt. Wilson says "The chemical composition of modern lavas extruded at the surface was similar to that of granite" (p. 320). As a matter

of petrologic fact, this is not true. The lava equivalent of granite is rhyolite, but the overwhelmingly dominant lava at the Earth's surface is basalt, which is a very different rock. Lyell's vague idea was not falsifiable with the knowledge of the mid-19th century, but the fact that it is false deserves noting.

Lyell was involved in the controversial identification of the Elgin Fossil (pp. 351–355), the fossil of a small land reptile from sandstone in northeast Scotland. The controversy was a late example of a geologic problem whose importance had been recognized by 1851, when Wilson takes it up: correlation by lithology rather than by fossils. The crucial point was whether the fossil was found in Old Red Sandstone (Devonian) or in New Red Sandstone (Triassic). The fossil showed modern characteristics not expected in Devonian rocks by progressionist paleontologists (for the definition of progressionist, see Wilson (1970, p. xxxii)), but the rock type looked Devonian. Wilson notes that Lyell was properly cautious in his 4th edition of the *Manual* (1851) by pointing out the two possible ages, using Murchison and Hugh Miller as authorities for his caution. If that caution is a point in Lyell's favor, then it should be mentioned that three years later, in the 5th edition, Lyell used Murchison and Miller as authorities for a Devonian age, without raising the Triassic possibility, and did not clearly distinguish the different quarries where the Old Red fossils and the Elgin Fossil were found. A modern-looking Devonian reptile would have supported Lyell's ideas on the origin of species.

Lyell in America is a valuable book that should be read by anyone with a serious interest in the history of geology or in the history of the 19th-century United States. *America* shows the firm basis in field work on which Charles Lyell relied to extend his *Principles.* More than most, Lyell stretched the limits of time and place; he went everywhere, looked at everything, talked with everyone, and understood processes with a background that, on the record, none of his contemporaries had. But the value of this book extends beyond geology. It is the record of an intelligent English couple looking at America in the middle of the 19th-century from a critical but appreciative perspective that provides new insight for historians of the 19th-century United States.

A final word on Lyell's prose: Lyell distilled the results of his two and a half years in America through his writing. The observations and findings of those travels appear in detail in 1845 and 1849, and infuse later editions of the *Principles* and *Manual* on old pages that retain unexpected interest today. Lyell's writing skill came of long practice from an early age. His prose holds the reader's interest even when he wrote about intrinsically dull things, as in his first paper (prepared in 1824, published in 1829) on muddy lake bottoms and the remains of algae that grew there. This first paper is clear, well-organized, and far-reaching in the conclusions it yields, as was almost everything Lyell wrote. Contemporary historians have hinted that such skill in writing suggests an intention to deceive. The opposite is true. Writing clear, interesting prose is the result of removing the underbrush that obscures truth. The internal logic of English grammar forces on the writer who takes such pains new aspects of his subject that are only dimly perceived otherwise.

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CHARLES DOOLITTLE WALCOTT, PALEONTOLOGIST. *Ellis L. Yochelson. 1998. Kent State University Press. 510 p. Hardcover, $59.00.*

Charles D. Walcott (1850–1927) was America's most important and powerful science administrator during the last decade of the 19th century and first quarter of the 20th. He was director of the United States Geological Survey and Secretary of the Smithsonian Institution, was involved with the establishment of the Carnegie Institution of Washington and served as president of the Geological Society of America, the National Academy of Sciences, the AAAS, and other scientific organizations. He was also a world authority on the trilobites and other fossils of the Cambrian period. A full biographical study of Walcott is long overdue.

Yochelson, himself a paleontologist and past president of the History of Earth Sciences Society, has been doing research on Walcott for many years (he wrote the National Academy of Sciences *Memoir* on Walcott in 1965, 38 years after Walcott's death). This book is only part of Walcott's life, however; it ends with his leaving the USGS in 1907 to become Secretary of the Smithsonian. Walcott's years at the Smithsonian "constitute another story," says Yochelson. Also not included is any discussion of Walcott's discovery of the Burgess shale fossils in 1909, the interpretation of which is discussed at length in Stephen Jay Gould's *Wonderful Life: the Burgess Shale and the Nature of History* (1968) and which has recently become a source of considerable controversy. (See Stephen Jay Gould and Simon Conway Morris, "Showdown on the Burgess Shale," *Natural History,* Dec. 1998–Jan. 1999, *107* No. 10, pp. 48–51.) This volume is a detailed examination of Walcott as paleontologist and as administrator, and the conflict in his life between his desire to do research and fieldwork and the demands his outstanding executive abilities made on him.

Walcott began the serious collection of fossils as a teenager living and working on the William Rust farm near Trenton Falls, in central New York state. Rust himself had a large collection and taught young Walcott what he knew. Walcott greatly enlarged the collection with trilobites and other specimens from the fossil-rich Trenton limestone, and in 1873 sold the collection to Louis Agassiz for Harvard's Museum of Comparative Zoology for $3500. He corresponded with Professor O. C. Marsh of Yale, James Hall of the New York State Museum, and other eminent paleontologists about his fossil discoveries, and in 1876, Hall invited Walcott to come work for him in Albany.

Yochelson calls the three years Walcott worked as paleontologist for Hall the equivalent of his graduate education, although Walcott never went to college. In Albany he not only worked on the fossils in the museum's huge collections, studying and arranging them for exhibition, he also learned the ways of politicians and spent much time in the legislature observing the arguments over budget bills. It was good preparation for what was to come.

Walcott joined the United States Geological Survey (USGS) in 1879, the year it was organized under Clarence King. He stayed with it through the turbulent Powell years, turning down other offers, and became director in 1894 when Powell resigned, by which time the survey was in disarray from budget cuts and Powell's conflicts with Congress. During his early years with the Survey Walcott was in the field a large part of the time, in the Grand Canyon and other parts of the West, helping to unravel the sequence of the lower Paleozoic strata through his growing knowledge of the Cambrian fossils. His fossil discoveries in western Massachusetts and Vermont helped to solve the long-standing controversy over the age of the Taconic rocks.

As director of the USGS, Walcott accomplished his greatest work, Yochelson

feels, by building the Survey into the best in the world. He explained the Survey's work to congressmen in a way that convinced them of its utility and of the importance of funding it liberally. He was able to increase the staff, and expanded the Survey's role in conservation, hydrography, forestry preservation, topographic mapping and mining. He instituted the publication of the *Water Supply Papers* and *Professional Papers* and published many papers and reports of his own.

During his years as director he also served as secretary of the Executive Committee of the Carnegie Institution of Washington and played a key role in persuading Andrew Carnegie to build the Geophysical Laboratory at a time when geologists were turning more and more to laboratory work for an understanding of igneous rocks. He helped get government support for the development of Samuel P. Langley's flying machine and research in aerodynamics. In 1897, Walcott also became acting assistant secretary of the Smithsonian's National Museum. This in addition to taking on the presidency of various other scientific societies. As a result, he had less and less time for studying his fossil collections, and his research suffered. More than once Walcott suffered a health breakdown from overwork. Yochelson quotes a charming passage from the autobiography of the eminent British geologist Archibald Geikie (whose name Yochelson consistently misspells), who visited Walcott in Washington and discovered that he had a "little sanctum" to which "he retired whenever a few moments could be snatched from the day's work." Geikie praised Walcott as "the highest authority" on Cambrian trilobites and as "director of the work of others" (p. 330).

Yochelson has gathered an enormous amount of material on Walcott over the years and must have found it hard to leave anything out. The narrative, based closely on Walcott's diaries with chapters organized by fiscal or calendar year, seems to include every illness, visit to dentists and doctors, trips home to Utica and elsewhere, details that become tiresome and sometimes distract the reader from the main themes of Walcott's life. Nevertheless, the day-to-day details relating to Walcott's research and involvement with various scientific organizations are a valuable contribution to an understanding of how an eminent scientist administrator used his time and how those organizations were run. The book also provides many insights into how paleontological fieldwork is done, as well as a feeling for the arduous manual labor involved.

One wishes Yochelson had provided more extended analysis of Walcott's personality. A picture emerges of Walcott as a devoted husband and father to his four children, a faithful church-goer, with a a strong sense of loyalty and duty, who couldn't say no to requests to take on yet another executive position. He seems, in fact, to have been the conservative gentleman of science Gould describes in *Wonderful Life,* although Yochelson finds Gould's portrayal inaccurate without saying why.

I look forward to what is hopefully in the works—the second volume covering the last twenty years of Walcott's life, when, as Yochelson promises on the last page, we will be able to read more about the "renowned scientist" in conflict with the "duty-bound administrator."

Peggy Champlin, 2169 Linda Flora Dr., Los Angeles, CA 90077

CULTURES OF NATURAL HISTORY. *N. Jardine, J. A. Secord, and E. C. Spary. (Editors). 1996. Cambridge University Press. 501 p. Softcover, $34.95.*

This book consists of two dozen essays, plus introduction and epilogue, addressing aspects of the history of natural history from the Renaissance to the

end of the nineteenth century. The international group of authors, most of them academic historians of science, approaches the subject as cultural history. They wish to demonstrate the advantages of emphasizing historical perspectives on the varied kinds of human investment in natural history. They also focus on the diverse aims and practices of naturalists, as distinct from a more exclusively conceptual focus on the methodology and scientific results of descriptive and classificatory studies of the mineral, plant, and animal objects of nature.

That is to say, the book's project is to situate treatment of the natural-historical sciences more securely within the newer historiography of science. One thinks of *The Naturalist in Britain: A Social History* (1976), by David Allen (one of the authors for this volume), as having put a cultural-history examination of natural history on the map. Now *Cultures of Natural History* harnesses two further decades of historiographical development, and puts on display the breadth of scope and levels of interpretation these lines of inquiry have achieved.

It may be that, for some readers, any mention of a "new historiography" of science will call forth echoes of the "science wars." Anyone searching through this volume for militant entries in the disputes over science's epistemological status is apt to be disappointed; but no one should be surprised to find that some measure of sympathy with the cultural construction of scientific knowledge is apparent in nearly every essay. With few exceptions this is handled skillfully, without preaching. The editors and the team of authors wisely avoid extended theoretical peroration, trying instead to rest arguments for the merits of a cultural history of natural history largely in the essays' substance. The contributions are intended for readers with broad historical interests concerning science, rather than for specialists, and come with valuable suggestions for further reading. The many illustrations (127 of them) add a great deal, and are generally well integrated with the texts.

Several of the essays are organized mainly around specified kinds of natural history, such as botany, geology, or ethnology. But most follow a thematic pattern. Among the topics treated are the ways natural history practices and conceptions have been linked with book production, court culture, academies, gardens, museum collections, medical arts, travel and exploration, colonialism and imperialism, equipment for field study, and social categories such as gender and class. Recurring interpretive themes include (to name just four examples): 1) consideration of appeals to nature as an authoritative resource in the regulation of human affairs; 2) reflections on naturalists as mediators between nature and society; 3) roles for different notions of spaces—literal and figurative—in the representation of nature; and 4) historically contingent shifts of taste and fashion underlying or reflecting changes of sensibility about nature.

The two contributions most obviously centered on the earth sciences are by Martin Guntau ("The natural history of the earth") and Martin Rudwick ("Minerals, strata and fossils"). Each is a well-crafted, informative essay relating the development of earth-science investigations to patterns of thought and action within natural history at large. Guntau's discussion of heightened interest in the Earth and its mineral products during the eighteenth century emphasizes the attractions of minerals, rocks, and fossils in collections of curiosities assembled by wealthy and powerful connoisseurs, and the influences both of practical concerns (mining and metallurgy) and of religious impulses (physico-theology) in spurring efforts toward systematic comprehension of mineral objects. Rudwick provides an overview of the rapid transformation of a predominantly mineralogical conception of earth science into geology, between the late-eighteenth century and the early decades of the nineteenth. His analysis proceeds though a sketch of naturalists' preoccupations with specimens, fieldwork, and mineral distribution, culminating in emerging recognition of rock formations as fundamental natural units, subject to unprecedented precision of correlation by examination of their characteristic

fossils. The stratigraphic program that ensued quickly yielded the historical centering so familiar in much of nineteenth-century geology, with its attendant historicizing of organic nature.

Guntau's and Rudwick's essays make out strong cases for understanding the practical and theoretical dimensions of early geological science—roughly, from the late seventeenth to the beginning of the nineteenth century—as highly prominent elements of the wider natural-history enterprise in western culture. Each of them meets the editors' intentions of concision and accessibility so well, that the pair of essays could serve quite nicely as high-level introductions to geology's early history for students and other readers without specialized background.

Admirable and important though I judge Guntau's and Rudwick's contributions to be, it does appear to me that they are among the most cognitively-focussed essays of the volume, and in that respect somewhat less representative of recent trends in the cultural history of science than many of the others. I have no wish to suggest that improved historical understanding of scientific conceptualization should not be among the very highest priorities to be served by advances in cultural history. But it would be a pity if readers with historical interests in the earth sciences selectively confine their attention, in this book, to its two most obviously geological components. If they do, they will miss opportunities for stimulating encounters with widened perspectives on how historical inquiry may be conceived across all domains of natural history—animal, vegetable, and mineral.

A final remark: The epilogue by Jim Secord ("The crisis of nature") is the sole exception to this book's chronological exclusion of most of our own century. It is a perceptive discussion of a peculiar asymmetry in natural history's status during our time. On one hand, the current levels of public interest in natural history and acknowledgement of the practical importance of the knowledge it represents are very high. On the other, the prestige of natural history's position within the hierarchy of sciences is quite low. Secord's essay calls for a mobilization of historical perspective—somewhat in the tradition, I think, of the memorable essay on "The historical roots of our ecologic crisis" by Lynn White, Jr. (1967)—to help rectify this asymmetry and deal effectively with current problems.

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MILITARY GEOLOGY IN WAR AND PEACE. *James R. Underwood and Peter L. Guth, editors. 1998. Geological Society of America Reviews in Engineering Geology, v. 13. 245 p. Hardcover, $76.00.*

For the past five years, I have annually been a guest speaker at a seminar in the construction course at the Industrial College of the Armed Forces. Using my book on the construction by the U.S. Army Corps of Engineers of two air bases in the Negev for the Israeli Air Force (*Building Air Bases in the Negev: the U.S. Army Corps of Engineers in Israel, 1979–1982,* published jointly by the U.S. Army Center of Military History and the Office of History, U.S. Army Corps of Engineers, in 1992) as a springboard, I have argued the importance of construction as an instrument of national policy. At the same time, I have urged the student officers to consider the intelligence value of construction records. After all, before roads or buildings go up, engineers take core samples, study ground water, consider the load-bearing capabilities of the site, and assess the availability of aggregate and other construction materials. Because the Corps of Engineers served

as construction agent for projects in so many parts of the world in which the United States has an interest, particularly in South Asia and the Middle East, completion reports and other construction records contain substantial insights into the geological structure of important regions as well as details of the structures built there.

Now comes this valuable collection of essays (which shows better than I ever could in my occasional classroom talks) why geological understanding and documentation are important. The papers make plain that geological knowledge is at the heart of terrain assessment for operations as well as for construction. They also show the direct and central connection between geology and military activities such as tunneling and construction of field fortifications, from the Civil War in the United States to the Western Front of World War I, as well as the infiltration routes excavated by North Korea under the demilitarized zone. Twenty-five essays by a distinguished group of scientists and practitioners illuminate the many ways in which geology plays a vital role in military planning and operations. They concentrate mainly on the American and British experience, but within that framework give a wide-ranging look at geology in military service since the early part of the nineteenth century.

Probably Edward Rose and Michael Rosenbaum, in their "British military geologists through war and peace in the 19th and 20th century" offer the best demonstration of the pervasive importance of the discipline. Their chart, "Production and Home Defense" (p. 36), divides applications into three groups—military and civil engineering, underground water supply, and mineral resources (including fuels). Each category in turn contains numerous entries. Moreover, as their essay and others show, these categories are relevant in peacetime as well as during war.

I have two personal favorites in the collection. The first is Maurice Terman's "Military Geology Unit of the U.S. Geological Survey during World War II." Terman shows a small, dedicated, and extraordinarily industrious group of researchers, brought together from universities and the government, at work. This group provided a prodigious amount of usable data—more than 5,000 maps and other depictions and reports—that was essential to the war effort. The Military Geology Unit also proved conclusively the value of terrain data and led to the establishment of the Engineering Geology Section of the U.S. Geological Survey. Terman tells the story of this remarkable group of only 157 people succinctly and well.

The other favorite essay is C. P. Cameron's "Dearly Bought Ridges," which explains in a geological context the critical importance of the bloody 1951 battles in eastern Korea. The terrain secured in these fights included areas suitable for tunneling and for underground logistical installations—areas, in other words, that would have made it easier for the North Koreans to reprise the surprise attacks of 1950. The ridge lines won in those hard battles also provided lines of sight far to the north, giving control of land not actually held. As Cameron noted in his conclusion, "Appreciation of the geological controls of terrain assists in maximizing their use in military operations. . ." (p. 97).

The editors have put together a very useful package. Each essay is preceded by an abstract and followed by a bibliography. There are also many useful maps, photographs, and diagrams. The prose is generally clear and sometimes quite good. Perhaps only the geological aspects of the numerous western explorations and surveys led by Army Engineers and Topographical Engineers between 1819 and 1879 are missing. Overall this is a fine book. When I make my next scheduled appearance at the Industrial College's construction seminar, I will take my copy with me.

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COLLECTIONS IN CONTEXT. *Charles D. Waterston. 1997. National Museum of Scotland. 213 p. Softcover, £25.*

This book deals with the Museum of the Royal Society of Edinburgh and the inception of a National Museum for Scotland. During its early history the Royal Society of Edinburgh displayed in a museum minerals, rocks, and fossils, as well as other items. Other institutions, including societies and universities, maintained museums which for natural sciences provided information that experimentation did for the physical sciences. As the author states "they allowed philosophers 'to see with their own eyes' the evidence of new discoveries and theories".

Over the long term the fate of museums of the kind which the Royal Society of Edinburgh maintained has been mixed, or worse. As an example, in the early part of the last century the *Transactions* of the Geological Society of London published annually "a list of donations . . . to the museum" of the society. The 1829 *Transactions* note under donation "July 2, 1825: rocks from America. Donor the Hon. von Rensellare" (correct spelling "van Rensselaer"). During his career Stephen van Rensselaer was considered the richest man in the United States (H. Christman, *Tin Horns and Calico: A decisive episode in the emergence of democracy,* 1945) whose generous support promoted the advancement of geology in the first half of the 19th century. For my research I would like to know what kind of collection van Rensselaer donated: the kinds of minerals, rocks, and fossils, and their sites of sampling. I discussed this matter with the curator of the Geological Society of London, John Thackray, who thought that the collection is now housed at the Museum of Natural History in London, where Thackray, likewise holds the office of curator. He introduced me to someone who is more familiar with the dead-storage area of the museum who thought that all trace of the Geological Society collections may have been lost, "although there may be boxes in the sub-basement".

A story for which I cannot vouch relates to an unnamed mineral collector who appeared at the Smithsonian Institution in Washington and asked the curator to assess the value of several minerals. While the visitor was roaming in the galleries, the curator called the police. The minerals which the visitor brought were worth over $10,000, and the curator thought that they may have been stolen. It turned out that one of the colleges in New England needed more space, so the administration discarded the entire museum collection.

The mineral collection of Rensselaer Polytechnic Institute was the work of Henry B. Nason (1831–1895), founder member of the Geological Society of America and his student Washington A. Roebling (1837–1926). This collection was the seed from which the Roebling national collection of the National Museum of the Smithsonian Institution in Washington sprouted. Nason's dedication to Rensselaer is memorialized by his donation of his private collection of 5,300 rocks and minerals which he donated to the institute in 1883. The alumni built a special building, now destroyed, to house the fossil collection of James Hall (1811–1898), America's most influential geologist. This collection is now incorporated in Rensselaer's museum. During the 1998–99 academic year the museum will be closed and current plans are to store the fossil collection in the basement of the New

York State Museum and donate the mineral collection to the local children's museum, where no one understands minerals or geology, and where the collection will probably be dispersed and ultimately lost. The mineral specimens, collected one hundred and more years ago, came from areas that have now been built up, such as New York City, where skyscrapers hide the local rocks and minerals, and from classic mineral localities whose treasures have been exhausted and the mines have been closed.

The history of the museum of the Royal Society of Edinburgh parallels that of other society and university collections. Waterston traces the complex history of the collection. "What event soon after 1750 could have caused the collection to have been so rudely dislodged?" The museum "had to be removed by 1753 when no other suitable accommodation was available to house it". This statement sounds familiar. Later "specimens must remain in their present confusion huddled in Chests and Boxes". "Museum acquisition . . . brought with it problems of accommodation, curation, and policy which the Society was slow to resolve".

In addition to the Royal Society of Edinburgh museum, there was another museum in Edinburgh belonging to the University of Edinburgh. Constant difficulties arose between the Society and the University related to museum policy. In 1862 the Society suggested that any form of museum was unnecessary. Initially tea was served in the museum, and conviviality soon outweighed the Fellows' concern for the collection. Soon the museum became known as the Tea Room. "In 1876 the Library Committee authorized Professor Archibald Geikie to move geological specimens from the Tea Room to make space for books. Soon interest in the Society's museum withered which resulted in the end of the scientific museum of the Royal Society of Edinburgh." A demand arose for a national museum which the government should sponsor.

Last year I was the guest of both the Royal Society of Edinburgh and the University of Edinburgh. Neither organization boasts a geological collection from which the public would benefit. The inception of the National Museum of Scotland made such smaller collections unnecessary. The geological collection of the National Museum of Scotland exceeds 100,000 specimens and geologists are on the staff. This Museum is impressive.

The book in review is a detailed blow-by-blow account of the fights between individuals and organizations and is so detailed that at one reading I fell asleep. A final chapter states that "the men who disposed of the Repository of the Royal Society of London and the collections of the Royal Society of Edinburgh recognized that reference collections for research purposes would be better placed in a national collection"—and that is what happened.

The book concludes with two appendices: (1) a list of specimens donated to the Royal Society of Edinburgh and (2) a catalogue of scientific instruments in the Royal Society of Edinburgh. A biblography and a name index, mostly of the Fellows of the society, complete the book.

I admire the patience of the author who put this work together.

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HISTORY OF SOIL SCIENCE: INTERNATIONAL PERSPECTIVES. *Dan H. Yaalon and S. Berkowicz (Editors). 1997. Advances in Geoecology 29. Catena Verlag GMBH, Reiskirchen, Germany. 438 p. Hardcover, 264 DM, US$176.00.*

This work is a welcome addition to a growing body of literature on the history of soil science. That it is in English will facilitate its dissemination and readership. Until this publication, works in soil science history have had to be translated into English from Russian, French, or Polish. Here we have a collection of 22 papers of contributors representing 14 different countries. The topics considered are eclectic, including discussions of chronology of subject matter, development of a subdiscipline or specialization within soil science, and the life and work of outstanding scientists and practitioners.

The work is divided into five parts. The four papers of Part I consider aspects of soils as an object of study within the broader context of the history of soil science. D. Yaalon (Israel) presents a thumbnail overview of the history of soil science in context and its opportunities for research in this area. The concept of soil humus from the 18th century to the present day is discussed by C. Feller (France). E. M. Bridges (The Netherlands) considers the development of soil horizon designations from the Russian pioneer Dokuchaev's work of the mid-19th century to the present. Part I ends with the paper by I. Szabolcs (Hungary) that describes the First International Conference of Agrogeology held from April 14–24, 1909 in Budapest, Hungary.

Part II contains four papers that consider the classification and mapping of soils. R. W. Simonson (U.S.) considers the evolution of the soil-type and soil-series concepts in the U.S. A treatise on the development of soil-survey and soil-series concepts in the United Kingdom is next presented by J. M. Hollis (England) and B. W. Avery (England). H. E. Stremme (Germany) discusses the preparation of the first soil maps of Europe in 1927 and 1937 under the direction of his father H. Stremme of Danzig (modern Gdansk). The last paper of Part II by D. Helms (U.S.) concerns the evolution of the land capability classification within the U.S. Department of Agriculture.

The papers of Part III address topics within soil physics and soil chemistry. G. H. Bolt (The Netherlands) considers the origin, growth and change of the pH concept. The development of soil mineralogy and micromorphology within the U.S. Department of Agriculture is addressed by J. G. Cady (U.S.) and K. W. Flach (U.S.). M. Kutilek (Czech Republic) and V. Novak (Slovak Republic) consider the impact of Soviet totalitarian ideology on the evolution of soil physics in Russia and eastern Europe.

In Part IV, the papers treat topics and concepts of a broad geographical nature. E. Muckenhausen (Germany) considers the evolvement of soil knowledge to soil science in the 19th-century German lands. The development of Soviet/Russian paleopedology from its beginnings in the 19th century and its relationship to soil science and quaternary geology is considered by A. Tsatskin (Israel). I. P. Abrol (India) and K. K. M. Nambiar (India) discuss the evolution of soil-fertility concepts and studies in India. E. G. Hallsworth (Australia) reveals the history of soil science in Australia, and R. F. Allbrook (New Zealand) does the same for New Zealand.

Part V contains papers about personalities in the history of soil science. B. T. Bunting (Canada) acquaints the reader with the work of the Danish naturalist Erik Pontoppidan (1698–1764) in 18th century Denmark and Norway. N. Florea (Romania) discusses the life and work of the Romanian pioneer pedologist Gheorghe Munteanu-Murgoci (1872–1925). I. J. Smalley and C. D. F. Rogers

(England) consider the work of Lev Semionovich Berg (1876–1950) on loess and the "soil" theory of loess formation. Selman A. Waksman (1888–1973), Nobel Prize-winning soil microbiologist and discoverer of the drug Streptomycin, is the subject of the paper by W. W. Umbreit (U.S.). The contributions to Canadian soil science of J. H. Ellis (1890–1973) of the University of Manitoba are related by G. K. Rutherford (Canada). Lastly, C. G. Olson discusses the contributions of R. V. Ruhe (1919–1993) to soil geomorphology and pedology.

The papers cover a wide variety of historical topics. In addition to the subject matter of the papers, readers will find the extensive bibliographies at the end of each paper very useful for further historical inquiry. This work is a starting point for more detailed research into the history, philosophy, and sociology of soil science. Here we have just a taste of the exciting avenues of exploration into international relationships and interactions that are vitally important in understanding how soil science has developed.

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THE PAPERS OF H. T. DE LA BECHE (1796–1855) IN THE NATIONAL MUSEUM OF WALES. *T. Sharpe and P. J. McCartney, editors. 1998. National Museum of Wales, Geological Series No. 17, Cardiff. 257 p. Softcover, £25.00.*

An important British archive pertaining to the history of geology is that of the founder of the country's Geological Survey, Henry De la Beche. This collection, along with a substantial number of papers of William Buckland, initially put together in the 1930s by F. J. North, first Keeper of Geology at the National Museum of Wales, has long been available to students of the history of geology who have been able to travel to South Wales. It was used by one of the editors of the present bibliography, Paul McCartney, in writing his short biography (*Henry De la Beche: Observations on an Observer,* 1977) and has been further utilised in such publications as Martin Rudwick's *Great Devonian Controversy,* 1985, and James Secord's *Controversy in Victorian Geology,* 1986. The archive will surely find much further employment, which will be greatly facilitated by the publication of this excellent bibliography.

The volume contains a short foreword by Michael Bassett, the present Keeper of Geology, which says something about the size and scope of the collection, its origin, and present circumstances (appropriately housed in purpose-built storage), and carries the good tidings that enquiries about access to the collection may be addressed to the Museum's Department of Geology. An introduction by the editors follows, which gives further information about the origins of the collection and a synopsis of De la Beche's career. We then have a useful synoptic chronology of De la Beche's life (which reminded me that his second daughter was illegitimate), a list of his publications, the catalogue itself (with 2,283 items), and three comprehensive indexes—for personal names, place names, and subjects. Then follow 79 black-and-white illustrations selected from De la Beche's own work and the photographs in the archive, and other items such as interesting sketches to be found in his inward correspondence. Finally, there is what appears to be a complete bibliography of secondary sources pertaining to De la Beche or to the collection. A notable feature of the publication is that a summary is provided of the contents of all the letters. The value of this requires no emphasis.

The publication of this catalogue is much to be welcomed. It is easy to use,

and will probably bring to historians' attention items of specific interest to them that might be overlooked. For example, I was personally most pleased to discover that there is a letter from Sedgwick to De la Beche concerning Lakeland geology, which contains a sketch section that is of great importance to me. On completing this review, I intend to write immediately to Cardiff to enquire further about the item.

I have fond, but rather unusual, memories of the Cardiff Museum. I worked there on the De la Beche collection for a few days back in 1990. That year, nearly all the regular display collections had been placed out of sight and mind, somewhere in the bowels of the building. In their place there was an impressive animated display of dinosaurs, with accompanying noises, somehow recorded and loudly played. The 'noise tape' went round on a loop, so that for several days I repeatedly heard the same roars, moans, groans, and growls as I worked in a room immediately above the display hall. Some children rushed round the display in breathless excitement. Others were reduced to a state of abject terror. (After a few days, I no longer heard the sounds, any more than people in the Middle Ages heard the music of the spheres.)

Anyway, the present Museum publication will assuredly be of more lasting use to scholars than the dinosaur exhibit, and I should suppose that it will bring them more tears of joy than terror. I hope the old collections are now back in place, and that the dinosaurs have gone home!

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LES PLIS DU TEMPS: MYTHE, SCIENCE ET H.-B. SAUSSURE. *Albert V. Carozzi, Bernard Crettaz, and David Ripoll (eds.). 1998. Nouveaux itinéraires a moudruz, no. 5: Collections Payot Amoudruz. Musée d'Ethnographie, Annexe de Conches, Geneva; and Conservatoire d'Art et d'Histoire de Haute-Savoie, Annecy. 367 p. Softcover, 29 French francs.*

Les Plis du Temps [The Folds of Time] was a project initiated jointly by the Conservatory of Art and History of Haute-Savoie, Annecy, and the Museum of Ethnography of the City of Geneva. It was thus a cross-frontier project, since Annecy is in France and Geneva in Switzerland, and intended to underline the complementary character of the collections in those two institutions as illustrating the theme of the "Discovery of the Alps." This book, a byproduct of the project, includes ten papers, five dealing with general themes and five treating, in particular, with the attainments of Horace Bénédict de Saussure (1740–1799). The translations of titles and text herein are my own.

Bernard Crettaz, the Conservator of the Europe Department of Geneva's Museum of Ethnography, entitles his paper "Problématique générale en dix énoncés" [General problem in ten statements]. He examines (and dismisses) the concept of Switzerland as a perfect place and a realized Utopia (p. 13), discussing with variable scorn "the great and small priests of Nature" (p. 16), deprecating the fact that "Under the combined action of science and myth, the Alps have become a great natural Disneyland where high technology, idyllization, and tourist consumption unite" (p. 17). This theme is emphasized in his second paper "Du mythe des Alpes au mythe de la montagne" [From the myth of the Alps to the myth of the mountain], a verbose and (to me) unconvincing polemic against contemporary attitudes to the Alps. Do people really view the Alps in general, and Switzerland in particular, as "a paradise regained" (p. 69)? I doubt it. However,

his point that the Alps, unlike other high mountains, are not important in any mythology (p. 69) is both interesting and curious.

Jean-Claude Pont's treatment of "Le mythe et la science" [Myth and science] stresses how often these two disparate approaches attain a common end (pp. 26–27). He believes that it is not God, but man who is creating the world in his own image (pp. 28, 33) and stresses that, contrary to earlier presumptions, individuality extends down to the level of the atom (p. 36). He quotes with approval the painter Raoul Dufy who wrote "Nature, sir, after all is merely a hypothesis" (pp. 40–41) and not a theme capable of simplistic analysis.

David Ripoll's contribution, "Faire voire, faire croire, faire savoire; images de montagnes et sciences de lat nature au XVIIIe siècle" [To cause to see, to cause to believe, to cause to know; views of mountains and natural sciences in the 18th century], deals with early illustrations of the Alps, presenting selected examples and discussing interpretations of the Alpine landscapes from that period. He contrasts the percipient observations of Jean Senebier (p. 90–91) with those of others, in particular Johann Jakob Scheuchzer, "a model not to be followed" (p. 106). We are properly reminded that, in their time, the cost of illustrations was high and their use inconsistent—illustrations might be published without an accompanying text, or vice versa (p. 93). In such works as Saussure's *Voyage dans les Alpes* (4 vols., 1779–1786), moreover, they might be of high quality (pp. 102–103) whereas others, like the illustration of an avalanche by D. Dürringer (p. 86), were simply grotesque.

Christian Delécraz's account of "Les reliefs de montagne au XVIIIe siècle, entre la science et le mythe" [Relief models of mountains in the 18th century, between science and myth], treats interestingly with that particular method of illustrating the Alps, stressing the attainments of Johann Rudolf Meyer (1739–1813) and his production of an atlas of Switzerland in 16 sheets.

The remaining four papers concentrate on Saussure. The first, "Horace-Bénédict de Saussure, mon aïeul" [Horace-Bénédict de Saussure, my grandfather] is an interesting expression by Yves de Saussure of what it feels like to be the descendent (although in fact not the grandson) of a person of such great attainments. He notes a little wryly that the Swiss 20-franc banknote depicts Saussure, even though he was "very Genevois . . . but never Swiss" (p. 145)—for indeed, Geneva did not enter the Swiss Confederation till fifteen years after Saussure's death. He reminds us that Saussure, though honored as a pioneer Alpinist, was not keen on climbing since he suffered badly from vertigo (p. 146). He discusses his ancestor's involvement in politics and administration, in particular during the Genevois revolution of 1792 (p. 151). He is properly proud that the name "Saussure" is borne by a mineral, some fossils, and a crater of the moon (p. 153) and, endearingly, wishes he had indeed been Saussure's grandson, so that he might have known that great man personally (p. 147).

Saussure's work in supporting "the little Republic of Geneva" is treated more fully by Eric Golay in "Un paratonnerre pour l'arbre et la liberté" [A lightning-rod for tree and liberty]. The scientist's essential pragmatism in approaching political matters is stressed. Françoise Walter, in "Les Préventions d'H.-B. de Saussure au risque de la métaphore" [The preoccupations of H.-B. de Saussure at the hazard of metaphor] considers the problems he encountered in formulating precise descriptions of objects for which no special terminology yet existed. He views Saussure's ascent of Mont Blanc as a voyage of exploration quite comparable to that of James Cook (p. 204) and, discussing William Windham's 'expedition' to Chamonix in 1741, stresses Windham's problems in describing the Alps to countrymen who had never seen high mountains (pp. 206–207).

Danielle Decrouez and Edouard Lanterno treat with "La collection géolo-

gique d'Horace Bénédict de Saussure," the greater part of which—1,274 specimens—is preserved in the Geneva Natural History Museum, only 3 having been lost (p. 213). They mention, in particular, that it includes one of the earliest collections of microfossils.

The volume concludes with Albert V. Carozzi's "Découverte d'une grande découverte: Horace-Bénédict de Saussure et le refoulements horizontaux en sens contraire dans la formation des Alpes" [Discovery of a great discovery: Horace-Bénédict de Saussure and horizontal compressions in opposite directions in the formation of the Alps]. This is, for me, the most interesting paper, a justification in itself for acquiring the volume. It comprises two distinct parts: first, a short autobiography (pp. 225–243) and then, an extended analysis of Saussure's geological concepts.

Though Albert's father, Luigi Carozzi, was Italian, Albert was born in Geneva. His father was a physician with a fine library, who encouraged his son to read and to think. The work that steered Albert into this very different area of science was Pierre Termier's passionate autobiography, *A la gloire de la terre* [To the glory of the Earth]. His father was not at all enthusiastic when his son veered away from medicine into geology: "You will die of hunger," he warned (p. 232). Nevertheless, Albert returned to his birthplace and, after gaining his first degree, undertook distinguished researches on carbonates, becoming a Swiss citizen in 1950. On invitation from U.S. geological visitors to Switzerland, he spent a year at the University of Illinois's Urbana-Champaign campus (p. 238), coming under the influence of Quaternary geologist and historian, George W. White (1903–1985), to whom the present writer is also greatly indebted.

When Albert returned to Switzerland, his attempts at innovation, in a highly conservative geology department, were coolly received. The consequence was that Albert and his wife immigrated to the United States, where he was to spend 23 years (1957–1989) in the service of the University of Illinois, developing his concepts of carbonate microfacies and sedimentary petrography. While Albert was enduring six months in hospital, White lent to him a copy of Werner's (1774) *Von der äusserlichen Kennzeichnen der Fossilien* [On the external characters of minerals], essentially inviting Albert to translate it—which he did, finding this task an aid to recovery (p. 243: the translation was published in 1962). This aroused a wider interest in the history of geology and a particular interest in Saussure, the most distinguished savant of his birth city.

The second section begins with a detailed analysis of Saussure's *Voyages dans les Alpes* (pp. 254–270) and continues with a discussion of the extraordinary abundance of Saussure manuscript material that survives in the Public Library and University of Geneva (pp. 271–273). The difficulties of transcription are wryly reported (p. 275) and emphasized by the reproduction of some pages from Saussure's notes (fig. 7). The picture of Saussure's personality, given by earlier biographies, is supported by the results of Carozzi's study. Saussure's care in note-taking is properly lauded (p. 290). Yet the notes were taken, and the travels done, under circumstances of difficulty hardly imaginable by contemporary travelers in Switzerland:

> In the relatively primitive conditions of the regions traversed in his voyages, numerous problems were presented to him: roads poorly maintained and cut by floods; hazardous crossings of rivers by fords or by primitive ferry boats: poorly informed local guides, false information on routes being given by the ignorant: errors in comprehension between him and his coachmen and postillion: his faithful servants temporarily lost in the landscape or falling asleep at a halting place, or late in rising, dressing and breakfasting: the temporary indisposition of a participant: finally, accidents on the road, such as the breaking of a spring and, in consequence, the complete revision of a planned itinerary.

All these possibilities of delay or mistakes in itinerary represented so many

potential obstacles against accomplishing a rigid program of geological observations of first order, to be done daily at times of favorable light and good weather, and in a number of days that was relatively limited (p. 291). Another perpetual problem was the procuring of daily bread and nightly lodgment for himself, his servant, and such of his family as might be accompanying Saussure on a particular journey. Sometimes the inn was "detestable," offering only one room for them all, and without a fire. Carozzi notes: "The manuscripts often show the exasperation and impatience of Saussure when encountering these unforeseen problems" (p. 301).

Yet Saussure's observations remained careful, his measurements of temperature, et cetera, accurate, and his errors few (p. 297). Confronted with the geological complexity of the Alps, his hypotheses evolved from an original belief in Wernerian Neptunist theories to an eventual belief that horizontal compression from two opposed directions, with a vertical component, combined to produce the structures he was observing—a theory remarkably close to present ideas of tangential tectonics. This mental evolution is meticulously exposed, with ample illustration of outcrops seen by Saussure and diagrams to illustrate his successive concepts (pp. 317–353).

This account deserves to be read with care, not only by all persons interested in the development of dynamic ideas in geology, but also by structural geologists in danger of assuming that current theories are necessarily correct. Can they, like Saussure, claim to have flexible minds and the ability to assess geological data in a fashion unaffected by preconceptions?

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HORACE-BÉNÉDICT DE SAUSSURE: DISCOURS PRÉLIMINAIRE AUX VOYAGES DANS LES ALPES. *Preface by Albert V. Carozzi. 1998. Minizoé, Editions Zoé, Genève, Switzerland. 46 p. Softcover, 5 Swiss francs.*

This is a wonderful little book, and it is little—a mere 15 × 10.5 centimeters. But it should be read by everyone in the Earth sciences, to marvel at the passion and the reason that de Saussure brings to bear as he explains why he has undertaken his explorations—les voyages. It is hard for us to realize, but Saussure was proposing a revolutionary new method of enquiry in what has now become the earth sciences—regional geographical and geological exploration as a basis for understanding the spatial meaning and internal processes of geology. It was not enough to investigate convenient exposures low down in the valleys; all locations and every viewpoint had to be explored and in the process he ascended mountains (including Mont Blanc in 1779) and almost inadvertently invented the sport of mountaineering. He provided James Hutton and John Playfair with an unparalleled series of descriptions from the summits of the Alps—and those who quarry Hutton's "Theory of the Earth" will know the well-acknowledged debt he owed to Saussure. Just as steps are now being taken to rehabilitate Hutton as a field geologist, so we should make equally determined efforts to recognize and laud Saussure's vision as a young man (he began his Alpine explorations at the age of 20, and wrote this discourse, or apologia, when he was 39). Saussure's role in the founding of geology (and Saussure uses this very word in his discourse), and its field methodology, has not been properly recognized by English-speaking historians of the subject (or perhaps by any nationality), as the Preface points out.

Now there is absolutely no excuse. Any budding geologist—of whatever hue—should write a translation of Saussure's discourse for their language requirement.

Consider the sheer topographical immensity and geological complexity of the Alps. Consider that when Saussure began there was no place to stand, no reliable source to start with, least of all adequate maps. Saussure had to invent for himself his subject and his methods, and he took on as his subject the entire natural history of the Alps. For sure he had recourse to chemical methods in the laboratory, but he was at pains to point out the field complexity—that formations with marine fossils could occur at different levels in the same mountain.

The very useful preface by Professor Carozzi, informed by a deep study of Saussure's unpublished manuscripts, traces Saussure's intellectual development, outlines the breadth of his interests and ingenuity of his instrumentation, the nature of his library, and gives an example—the ascent of Mt. Etna—of his notebook prose reworked in this volume into a style more suited to his eighteenth-century public. Most importantly, Professor Carozzi shows that in his unpublished material, never unfortunately completed as an additional volume of the famous *Voyages*, Saussure had in fact worked out that much of what he saw throughout the Alps was due to "refoulements horizontaux en sens contraires"—a truly prophetic vision of our modern tectonic understanding and at which he only hints in the final volumes of the *Voyages*.

"Hats off (ladies and) gentleman, a genius," if I may borrow a quote from the nineteenth century.

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SCIENCE IN THE FIELD. *Henrika Kuklick and Robert E. Kohler, eds. 1996. History of Science Society. OSIRIS (2nd series), vol. 11. 254 p. Hardcover, $39; softcover, $25.*

When the History of Science Society resurrected *OSIRIS,* the companion to the Society's Journal *ISIS,* as an annual thematic volume, historians of science expected great things. *Science in the Field,* the eleventh volume in the new series, gives ample evidence that those expectations were not misplaced. The essays in this volume offer new insights into the nature, challenges, and meanings of scientific work done, in the editors' words, "at least partially out of doors, in uncontrolled settings" (p. 1). These essays not only provide new evidence and new case studies, but more especially ask very interesting questions of the evidence.

The volume works very well as a whole. The editors, Henrika Kuklick and Robert E. Kohler, provide an insightful introduction in which they briefly provide an overview for readers new to the thriving scholarship of field science and clarify the ways in which this volume fits into that broader scholarship. They also identify three themes central to all the essays in this volume: "cultural appropriation, knowledge and power, and identity and gender" (p. 3). While choosing essays that they saw as "rather more provocative work than for full coverage" (p. 3), Kuklick and Kohler have also apparently required that provocative theses be supported with sound scholarship and presented with clarity and style. I can heartily and honestly recommend it as readable, exciting scholarship of the kind that makes one see one's own work in interesting new ways.

It is well beyond the talents of this reviewer to adequately express in linear prose the many ways in which the themes and examples in the individual papers illuminate and reinforce each other. I have chosen, rather, to give a brief idea of

each in the order in which they appear in the volume. The papers are arranged in three groups, both here and in the volume: Life in the Field, Popular Culture, and Material Culture.

LIFE IN THE FIELD

Alex Soojung-Kim Pang's "Gender, Culture, and Astrophysical Fieldwork: Elizabeth Cambell and the Lick Observatory-Crocker Eclipse Expeditions," examines the roles played by astronomers' wives in field expeditions at the turn of the century. Elizabeth Cambell, wife of Lick Observatory Director William W. Cambell, played an essential role in the observatory's expeditions between 1898 and 1922. Pang explores the ways in which both the culture of observatory life and the broader cultural expectations of American wives and women resonated in the essential support role that Elizabeth Cambell played in establishing and maintaining field camp operations and in how she and others understood that role.

Jane R. Camerini's "Wallace in the Field" focuses on fieldwork as "a transformational process" through which an individual becomes a "knowledge maker in natural science" rather than a mere collector (p. 44). Camerini's emphasis is on the *process* rather than the products of fieldwork. Her case study of Alfred Russel Wallace also illuminates the ways in which class and imperialism impacted British field science in the first half of the nineteenth century.

Bruce Hevly's "The Heroic Science of Glacier Motion" examines the ways in which nineteenth century constructions of gender and class underlay the definition of scientific authority in the dispute between James David Forbes and John Tyndall over the nature of the motion of glaciers. In this dispute, "the rhetoric of adventure" and claims to "reliable perception on the basis of authentic, rigorous, manly experience" (p. 68) were exercised by both sides in the controversy over glacier physics. And in the process, the science was defined as one inaccessible, both physically and mentally, to women.

Naomi Oreskes, in a paper that won the 1998 Forum for the History of Science in America Prize, continues the examination of the relationship between heroism and scientific authority. In "Objectivity or Heroism? On the Invisibility of Women in Science," Oreskes examines the life and work of Eleanor Annie Lamson, an astronomer at the U.S. Naval Observatory in the first quarter of the twentieth century. By comparing the nature and content of Lamson's work and the pattern of her career to those of the men around her, Oreskes makes a convincing case for the centrality of field (in this case sea) experience as a legitimating element in scientific authority. Going beyond this however, she examines objectivity and heroism as historically competing visions of science but concludes that objectivity is actually constructed as a subset of heroism. And while objectivity isn't *necessarily* gender-linked, heroism is. And so long as *heroism* is inaccessible to women, so is scientific authority.

POPULAR CULTURE

Greg Mitman's "When Nature *Is* the Zoo: Vision and Power in the Art and Science of Natural History" interweaves a number of related themes as played out in the creation and early history of the Jackson Hole Wildlife Park in the mid-1940s and beyond. Among these themes are the definition of and access to the "wilderness experience," the emergence of a post-war generation of biologists who rejected "wilderness" as an aesthetic and brought a laboratory sensibility to their field studies, and the changing role of technology in field biology. This essay will be especially interesting to any reader who has contemplated the emotional impact of "wilderness," pondered the irony of recreating "wilderness," or wondered about the ways in which photography and telemetry have changed not only the practice but the underlying assumptions of field biology.

Jennifer Tucker presents a fascinating and unexpected study in "Voyages of Discovery on Oceans of Air: Scientific Observation and the Image of Science in an Age of 'Balloonacy.'" Fascinating in the way this case study illuminates the ways in which popular perception and expectation intersect with the scientific community's need to define and control practice and image. Unexpected in the Victorian antipathy to ballooning, rooted in "the balloon's persisting association with vulgar amusement and unruly crowds" (p. 46), an antipathy that sometimes resulted in the violent destruction of balloons by mobs. It proved very difficult to maintain the image of the scientist as the focused, objective observer-hero while he made his (meteorological) observations in an object associated with the decadent, the immoral, and the French.

Stuart McCook's "'It May Be True, But It Is Not Evidence': Paul du Chaillu and the Legitimation of Evidence in the Field Sciences" looks at another, very different, mid-nineteenth-century British case study illuminating questions of authority and validation. In the late 1850s, du Chaillu had spent several years as an explorer and collector in equatorial Africa. In particular, he brought specimens and observations of the gorilla to London at the height of the debates that followed the publication of *Origin of Species.* Du Chaillu represents those "people who were on the social margins of the scientific world but who had privileged access to the field" (p. 196). His treatment at the hands of the British scientific community reflects the community's struggles with such questions as the proper role and status of the natural history collector, the proper relationship between amateur and professional, the definition of "authority" within the community, and what constituted legitimate knowledge—and why. And the ways in which class and race underlie the answers to many of those questions.

MATERIAL CULTURE

Anne Larsen Hollerbach considers the simultaneous rise of popularity for both zoological collecting and the animal rights movement in "Of Sangfroid and Sphinx Moths: Cruelty, Public Relations, and the Growth of Entomology in England, 1800–1840." The zoological investigator in this period killed and collected the object of study, in large numbers if possible. Duplicate specimens were the currency of trade (with other collectors) and commerce (with other collectors or in the popular culture), or might extend one's own collection if slight variations could be observed. The clash of popular and scientific sensibilities becomes quite evident in Hollerbach's story. Conchology, she explains, failed to arouse public outrage because dispatching mollusks looked so much like cookery. And ornithology drew on "established and socially powerful hunting traditions" (p. 203). But collection of entomological specimens was perceived as the wonton destruction of living beings in the pursuit of "knowledge," the scientific legitimacy and possible utility of which was—at best—not apparent to the public at large.

Richard Sorenson's "The Ship as Scientific Instrument in the Eighteenth Century" focuses on the voyages of James Cook and the science of geography. He raises interesting questions about the ways in which scientific instruments, and the ship in particular, "mediated the complex interplay between representation and reality" (p. 236).

Lynette Schumaker's "A Tent with a View: Colonial Officers, Anthropologists, and the Making of the Field in Northern Rhodesia, 1937–1960" examines the growing conflict between the cultures, and sometimes the practices, of the Colonial Service and professional anthropology. Conflicts exacerbated by the frequent interdependence of the two groups as they looked to each other for necessary support and information.

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THE HISTORY OF EARTH SCIENCES IN SURINAME. *Th. E. Wong, D. R. de Vletter, L. Krook, J. I. S. Zonneveld, and A. J. van Loon, eds. 1998. Netherlands Institute of Applied Geosciences, Royal Netherlands Academy of Arts and Science TNO, Amsterdam, The Netherlands. 488 p. Hardcover, NLG 160.00.*

The name "Suriname" (also spelled "Surinam") will, even now, have an unfamiliar ring in the ears of many elder geologists, who remember that land in the extreme northeast of South America as Dutch Guiana. (The fact that all the authors of this volume are from The Netherlands, however, will come as no surprise to them). Though it is a quarter-century since independence was gained (in 1975), Suriname's links with The Netherlands remain strong.

As the "preface" notes, the history of its geological exploration began

> . . .when early travelers and adventurers started traversing the jungle in search of El Dorado, the legendary city of gold. Later on, Dutch merchants visited the so-called 'wild coast' of the Guianas and they went on coming, sometimes colonizing parts of the coastal fringe. In 1667, at the end of the second Anglo-Dutch war, the Dutch traded their North American colony Nieuw Amsterdam [now New York] in for Suriname. (p. VII)

Geological exploration—mostly a continued quest for economic minerals—was done irregularly and on a piecemeal basis until 1943, when the Geological and Mining Service (Geologisch Mijnbouwkundige Dienst; GMD) was brought into being. Even then, progress was slow, since it had only one professional member, the mining engineer H. Schols (who served from 1943 to 1957). The personnel was expanded only in 1949, when systematic reconnaissance mapping became possible. A further expansion came in 1958, with the establishment of the Ministry of Development of Natural Resources and the setting-up of a Soil Survey.

Since that time, progress has been remarkable, in view of the fact that the physical conditions of inland Suriname are so adverse to systematic scientific work. The difficulties encountered are made explicit by D. R. de Vletter's reminiscence (pp. 7–12) of a ten-day journey in 1946 by dugout canoe. In Suriname, especially in the early days, geologists had to be tough! The folding, colored geological map, appended to this volume, well portrays their achievements.

After a historical introduction by four of the editors (pp. 1–5), different aspects of the story of Suriname's geological exploration are treated in nineteen further contributions. Investigations into Suriname's prehistory are treated by A. H. Versteeg (pp. 203–234) and its early reconnaissance and mapping by G. J. J. Aleva and L. Krook (pp. 175–201) and Wong, Krook, and Zonneveld (pp. 73–100). The earliest geological venturings into the interior are described by Zonneveld and Krook (pp. 101–118), and the history of the GMD by de Vletter (pp. 397–416).

Six papers treat with different aspects of the exploration for minerals; among these the searches for gold (by de Vletter and A. L. Hakstege) and diamonds (by de Vletter) are the likeliest to arouse a reader's excitement, though the development of bauxite mining (recounted by Aleva and Wong) has proved of vastly greater economic significance. Among other themes, the study of Suriname's Precambrian deposits (by de Vletter, Aleva, and S. B. Kroonenberg) is of especial importance. Pedologists and hydrogeologists will find much to interest them in papers by D. Noordam and S. Th. Carilho (pp. 119–127) and by J. Groen. Wong's geological bibliography of Suriname (pp. 443–473) will serve as a valuable reference for people concerned with any aspect of that land's geology or mineral wealth.

All in all, this is an admirable volume, illustrated by excellently-reproduced black-and-white photographs. May we hope that there will be similar volumes forthcoming, concerning the history of geology in other former colonies of The Netherlands?

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GLOSSARY OF DERBYSHIRE LEAD MINING TERMS. *James H. Rieuwerts. 1998. Peak District Mines Historical Society, Matlock Bath, Derbyshire, England. 192 pp. (Available from Peak District Mines Historical Society, Peak District Mining Museum, Matlock Bath, Derbyshire, England DE 43 NR). Hardcover, price not stated.*

As one of our leading earth-science historians, Hugh Torrens, has pointed out very forcibly, the origination of geological concepts can very often be traced to the practical men of past times—the men who were engaged in winning the ore and found little time (or had small ability) to set forth their concepts in words. To try to discover the breadth of their understanding of geology, we must first understand the terms that they used. This book is an admirable guide to their technical language; it is useful not only for understanding the surviving texts and records from the millennium-long history of mining in the English Peak District of the southern Pennines, but also for reading early texts from other areas (though Devon and Cornwall, in particular, had an extensive original vocabulary).

Its compiler, James H. Rieuwerts, is well qualified to compile such a compendium, since he has been investigating the history of the Peak mines for over forty years. He was, with the undersigned reviewer, a co-founder of the Peak Mines Historical Society. He is himself an engineering geologist and has served as a juryman for Derbyshire's ancient Great Barmote Court, the legislative body controlling lead mining in most of the Peak.

The terms defined include those applied to the various features of mine construction or methods of mining, those used to name the different types of ore and gangue or to characterize their modes of occurrence, and the (often very local) vocabulary applied to the leasing of properties and to the restrictions on working the ore. This breadth of coverage adds greatly to the value of the *Glossary*. The only supplementation I would suggest for future editions would be to add such mineral names as "copperas" and "erubescite"—names that are now fading from usage, following the international standardization of mineral names, and—albeit not necessarily used by the Peak miners themselves—to be found in earlier accounts of the mines by amateur or professional geologists and historians.

However, that is a suggestion, not a criticism. This is an admirable work, handsomely produced and with an attractive dustjacket. It deserves to be on the shelves of all persons interested in the history of European mining or economic geology.

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SAMPLING THE LAYER CAKE THAT ISN'T: THE STRATIGRAPHY AND PALEONTOLOGY OF THE TYPE-CINCINNATIAN. *R. A. Davis and R. J. Cuffey, editors. 1998. Ohio Geological Survey Guidebook 13. 194 p. Softcover, $16.00 (Available from the Ohio Geological Survey, 4383 Fountain Square Drive, Columbus, Ohio 43324-1362; add $4.00 shipping and handling).*

Although there is no direct history of geology in this volume, it is, in my view, worthy of notice. I had the opportunity to attend the International Ordovician meeting in Great Britain in 1972. This provided an opportunity for many North American geologists to see the type Ordovician. Although there were some fine outcrops, and some exceptions among those viewing the rocks, the general reaction was shock and dismay. What sticks in my mind was a British graduate student, who had been in America, trying to explain the Cincinnatian to one of his colleagues. Finally he recounted that it was like the Jurassic of Great Britain, in the sense of abundant fossils actually falling out of the rocks.

In North America, the Late Ordovician is characterized by this stable, warm-water platform which swarmed with life. As a result of these treasures under foot, the "Cincinnati school" of amateur paleontologists developed, and they contributed significantly to our knowledge of Late Ordovician fossils. Several members of the group, notably E. O. Ulrich and Charles Schuchert, developed into professionals who had a world-wide impact.

Even though the type Cincinnatian is atypical of Late Ordovician rocks in most other parts of the world, it has become the world standard as the Cincinnatian Series. Nearly a century and a half ago, James Hall agreed that this series was superior to the New York Hudson River Series. He then changed his mind and called on the principle of priority. Regardless of that point, the term Cincinnatian has carried the day, and it is known to anyone studying the Ordovician.

As with any sequence of rocks, especially fossiliferous rocks, the more one looks, the more details are revealed. The title is apt and the various papers in this guidebook demonstrate complexity never dreamed of by those who, in the late 19th century, made Cincinnati a household name in geology.

Following a brief introduction to the volume and a summary, thirteen guides to classic localities are discussed in order from bottom to top. Three interpretive papers follow, and there are two appendices, one to type localities and the other an extensive bibliography. The volume is well put together, well printed, and a good buy for the money.

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BEYOND THE BOUNDARIES: LIFE AND LANDSCAPE AT THE LAKE SUPERIOR COPPER MINES, 1840–1875. *Larry Lankton. 1997. Oxford University Press. 288 p. Hardcover, $39.95; softcover $16.95.*

Historians of technology often invoke the metaphor of the net or web, the concept of the technological *system,* to remind us of the interconnected requirements and ramifications extending in all directions from any given technology. In *Beyond the Boundaries,* Larry Lankton provides an outstanding case study of just how manifold such interconnections can be. Lankton considers the ways in which the development of the copper mining industry of Michigan's Keweenaw

Peninsula changed the physical and social landscape of the region. He gives attention to the topography and climate of the region as constraints on development, as well as tracing the effects of human activities on the flora, fauna, and topography.

The book is organized topically, but even the organizational structure encourages the reader to think in new ways about what it takes to make and maintain a community. Every chapter is focused on one aspect of human activity as it played out on the Keweenaw Peninsula. Lankton discusses the problems, possibilities, and adopted solutions that allowed travel, provided housing, and supplied food to the Keweenaw population. He looks at the demands and structure of work, both household work and paid employment, as communities emerged. The provision of essential support functions such as religious services, education, medical care, and recreational opportunities followed as communities grew. Finally, Lankton addresses the institutions that dealt with, to use his chapter title, "shattered hopes and broken prospects" within a community: jails, orphan and insane asylums, and hospitals. At its heart, this is a study of the challenges of importing a complex and infrastructure-dependant existing culture, such as that of the mid-nineteenth century United States, into an isolated and undeveloped area.

One critical issue for the Keweenaw was transportation of both freight and people, and here the reader not already familiar with the voluminous scholarship on the transportation revolutions of the mid-nineteenth century may wish for more contextual information in this volume. But for the most part, Lankton provides ample historical context for the story of the Keweenaw Peninsula, giving the reader a clear sense of how developments there were like—and unlike—contemporaneous developments elsewhere in the United States.

Beyond the Boundaries is explicitly a companion volume to *Cradle to Grave: Life, Work, and Death at the Lake Superior Copper Mines,* in which Lankton focuses on technological and labor history of the Keweenaw. I haven't had access to that volume, but the readability and usefulness of *Beyond the Boundaries* has made finding a copy of *Cradle to Grave* a high priority on my reading list.

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INTERESTING PUBLICATIONS

Gerald M. Friedman, EDITOR

Since the start of this journal, Founding Editor Gerald M. Friedman has prepared this column. Contributors wishing to list recent books and papers of interest to our membership are requested to send them to the Founding Editor Gerald M. Friedman, Department of Geology, Brooklyn College and Graduate School of the City University of New York, % Northeastern Science Foundation, Inc. affiliated with Brooklyn College of the City University of New York, Rensselaer Center of Applied Geology, 15 Third Street, P.O. Box 746, Troy, NY 12181-0746 USA, gmfriedman@juno.com

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$6,942.54	to Allen Press for ESH v. 16(2)
$2,351.77	operating expenses (office, computing, mailings)
$9,294.31	total expenditures in 1998

+$15,541.79 Income in 1998

$13,216.70	membership dues and institutional subscriptions
$ 960.09	interest on checking account
$ 1,365.00	page charges, monetary gifts, sale of back issues
$15,541.79	total income in 1998

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The titles of the sections at the end of your manuscript should be **Archives** and **References.** The Archives section may either list the collections of manuscripts consulted and cited or, if it would allow greater clarity, an author might write a paragraph discussing these collections. Of course, this section should be omitted if no archives have been cited in the article.

The References section follows the Archives section, or if this is omitted, it follows the main text of the article. The Reference section lists *published* materials cited. The main difference between footnotes and items in References is structural. While authors' names appear as Roberta Smith in footnotes, they appear in References with the family name first: Smith, Roberta. Otherwise, citations follow the models below in both footnotes and References. A second difference is that footnotes cite specific locations in a work, while items in the References section list works-as-a-whole. For multiple authors, see the examples below.

Citations should be as specific as the instance requires. That is, a citation to a work-as-a-whole is acceptable only if the reference is actually to the work as a whole. If the reference concerns a particular chapter or page range, these must be specified. All quotations require specific pages. Short comments and original (foreign) language quotations may also be found in the footnotes.

How Citations appear in Footnotes:

Book:

Eduard Suess, *The Face of the Earth,* 5 vols. (Oxford: Clarendon Press, 1904), 1:17.

Arthur H. Robinson, *Early Thematic Mapping in the History of Cartography* (Chicago: University of Chicago Press, 1982), 37–43.

K. E. Bullen and Bruce A. Bolt, *Introduction to the Theory of Seismology,* 4th ed. (Cambridge: Cambridge University Press, 1985), 103–107.

Article in journal:

David R. Oldroyd, The Archaean Controversy in Britain: Part I—The Rocks of St. David's, *Annals of Science,* 1991, 48:407–452, on 434.

Eric L. Mills, The Historian of Science and Oceanography after Twenty Years, *Earth Sciences History,* 1993, 12:5–18.

Article or chapter in book:

Stephen J. Pyne, Certain Allied Problems in Mechanics: Grove Karl Gilbert at the Henry Mountains, in *Two Hundred Years of Geology in America,* ed. Cecil J. Schneer (Hanover, NH: University Press of New England, 1979), 225–238.

Karl Hufbauer, Solar Physics' Evolution into a Subdiscipline (1945–1975), in *New Trends in the History of Science,* eds. R. P. W. Visser, et al. (Amsterdam: Rodopi, 1989), 73–91.

Unpublished thesis or dissertation:

John A. Wolter, The Emerging Discipline of Cartography, Ph.D. Diss., University of Minnesota, 1975, 37–38.

Citing manuscript or archival material and oral history interviews in footnotes:

William Thomson to J. D. Forbes, 30 July 1847, incoming 1847/42, James David Forbes Papers, St. Andrews University Library. (This will vary according to the system at each archive. Subsequent citations may use abbreviations.)

Walter M. Elsasser, Oral History Interview conducted by J. T. Kiehl, 12 March 1986. 1 session, 1 cassette; preliminary transcript. Part of American Institute of Physics/American Meteorological Society project. (Subsequent citations may use abbreviations.)

Archives: Two Alternatives

List format:

Forbes, James David. Papers. St. Andrews University Library. (This will vary according to the system at each archive.)

Elsasser, Walter M. Oral History Interview conducted by J. T. Kiehl, 12 March 1986. 1 session, 1 cassette; preliminary transcript. Part of American Institute of Physics/ American Meteorological Society project.

Paragraph format:

This article is based on research in the James David Forbes Papers, at St. Andrews University Library, in St. Andrew's, United Kingdom. It has also drawn on the Oral History Interview of Walter M. Elsasser, conducted by J. T. Kiehl on 12 March 1986. This interview and a preliminary transcript are part of the American Institute of Physics/American Meteorological Society project and may be consulted at the American Institute of Physics, College Park, MD, USA.

How Citations appear in the References Section:

Book:

Suess, Eduard, *The Face of the Earth,* 5 vols. (Oxford: Clarendon Press, 1904).

Robinson, Arthur H., *Early Thematic Mapping in the History of Cartography* (Chicago: University of Chicago Press, 1982).

Bullen, K. E., and Bruce A. Bolt, *Introduction to the Theory of Seismology,* 4th ed. (Cambridge: Cambridge University Press, 1985).

Article in journal:

Oldroyd, David R., The Archaean Controversy in Britain: Part I—The Rocks of St. David's, *Annals of Science,* 1991, 48:407–452.

Mills, Eric L., The Historian of Science and Oceanography after Twenty Years, *Earth Sciences History,* 1993, 12:5–18.

Article or chapter in book:

Pyne, Stephen J., Certain Allied Problems in Mechanics: Grove Karl Gilbert at the Henry Mountains, in *Two Hundred Years of Geology in America,* ed. Cecil J. Schneer (Hanover, NH: University Press of New England, 1979), 225–238.

Hufbauer, Karl, Solar Physics' Evolution into a Subdiscipline (1945–1975), in *New Trends in the History of Science,* eds. R. P. W. Visser, et al. (Amsterdam: Rodopi, 1989), 73–91.

Unpublished thesis or dissertation:

Wolter, John A., The Emerging Discipline of Cartography, Ph.D. Diss., University of Minnesota, 1975.

Focus Book Guidelines

Earth Sciences History

Each issue of **Earth Sciences History** includes a section called **Focus Book.** These books are chosen for special attention because of their potential broad interest. Two essay reviews—one by a scientist and one by a historian or other humanist—will discuss the book from different perspectives. The book's author will then answer these essays, offer rebuttals perhaps, or refine a point. The **Focus Book** is meant to emphasize that the history of geoscience is a conversation among scholars. It is also intended to generate discussion and interest, and perhaps to define the common ground that will help us transcend our own tightly defined perspectives.

In writing an essay-review of a **Focus Book** for **Earth Sciences History** please remember these few guidelines.

1. Your essay should be between 3,000 and 5,000 words (approximately 10 to 20 typed pages). If you feel the need to write significantly less or more than this, please contact the editor early in the process.
2. The **Focus Book** is chosen because of its potentially broad appeal to both geoscientists and to historians of the geosciences. While your essay-review may be from your professional perspective, try to keep in mind that our readers include a broad range of professionals. Be sure that historians and philosophers, as well as meteorologists, geographers, geologists, oceanographers, and geophysicists, will not be excluded by jargon. Write clearly and engagingly.
3. Although a scientist and a humanist are reviewing each Focus Book, this does not obligate you to stick rigidly to your category. A geologist or a meteorologist might well write a reflective "philosophical" or "historiographical" piece, and a historian might well concentrate on the fieldwork or developments in theory.
4. Do not simply summarize the book. Remember that there is a second essayist writing about the book. Concentrate on what the author is saying about the subject. Write about what makes the book unusual. Discuss the strengths of the author's treatment.
5. Be constructive. If you voice criticism, do not express it simply as an assertion but as the conclusion to an argument. You might point out logical problems in the author's argument or difficulties with the evidence.
6. Suggest new issues or directions raised by the assigned book for future research in history of earth science. This is an especially important part of **Focus Book** essay-reviews.
6. Follow the **Author's Style Sheet and Checklist** and the **Citation Guidelines** for **Earth Sciences History.** These are on accompanying sheets and may also be found on the journal web site.
7. Submit manuscripts (original and two copies) to the Editor: Gregory A. Good, History Department, Room 202a, Woodburn Hall, West Virginia University, Morgantown, West Virginia 26506-6303, U.S.A. Please include an abstract of approximately 150 words. Contributors should retain a copy for reference.
8. A sentence or two should be included for the section **Notes on Contributors**. These should identify the author's or reviewer's professional affiliation, career information, recent research interests, or work in progress.

Manuscript Review Guidelines

In reviewing a manuscript for **Earth Sciences History** please comment in as much detail as your time permits upon the following matters (and of course anything else that comes to mind). Remember that we have an open referee policy. The author will know who has written each referee report.

1. Would you have read this through if you had simply come across it already published in **Earth Sciences History**? If your answer is "No", what might the author(s) do to increase the interest of the piece for you?
2. Is the argument sound, and is its factual basis sufficient and accurate?
3. Are the references to both primary and secondary literatures sufficient, complete, and accurate? Is recent relevant scholarship acknowledged and/or discussed? Can you suggest further materials the author(s) might consult during revision?
4. Is the manuscript clearly written? How might it be reworked for greater clarity?
5. Is the manuscript well organized? What improvements might be made in this area?
6. What is the historical problem the author addresses within the confines of his/her topic? That is to say, if this subject/idea/person is "the answer", what is the "question"?
7. Are the illustrations (if any) pertinent? Sufficient? Of good quality?
8. If this article is revised according to your suggestions, will it be suitable for publication in **Earth Sciences History**?
9. Other comments and suggestions?
10. Make your comments and suggestions constructive! Because articles for the journal typically pass through at least one cycle of revision before being accepted, it will help greatly if you phrase your comments in a manner which can aid the author(s) in the task of revising the manuscript.
11. If you judge that the manuscript ***cannot*** be brought to a publishable standard in anything like its present form, please say so.

Many thanks for this service to **Earth Sciences History** and **The History of the Earth Sciences Society**. Our referees' reviews and commentary are the primary foundation and guarantee of scholarly standards. Please return your comments to me in a timely manner. **In no circumstances take longer than 30 days.**

GUIDELINES FOR BOOK REVIEWERS

Book reviewing is a critical aspect of outreach to both professionals and the general public. Reviews are published for books covering all aspects of the history of the earth sciences. The review editor welcomes volunteers for this task, because it is impossible for one person to be aware of all books worthy of review.

1. Submit book reviews to Book Review Editor: Gretchen Luepke Bynum, 650 Alamo Court, #6, Mountain View CA 94043, U.S.A.

2. Reviews should follow the general Author's Style Sheet and Checklist, printed in the journal and also available on the journal web site, with a few exceptions noted below.

3. The heading should have the following format:

BOOK TITLE. Author(s)/Editor(s). Date. Publisher. City. Number of pages. Hard- or soft-cover, price. (If there are special ordering instructions, these can be put in parentheses at the end of the heading).

4. At the end of the reviews, give your name and affiliation, including your email address. Book reviewers may submit a short item for Notes on Contributors.

5. The length of a review usually runs about 3.5 typewritten pages. For collections of papers in edited volumes, a summary of the work as a whole is preferred to a detailed discussion of each paper.

6. Extensive use of references/citations in a book review is discouraged. Comparisons with other works may be made sparingly, within the text. An example: "As Newton wrote in the *Principia* (1:37-38) in 1687, . . .".

7. If a reviewer feels that a book warrants an extensive, comparative review, it should be submitted specifically as an Essay Review, or the book should be suggested as a Focus Book. The same citation styles should be used in an Essay Review or Focus Book as in regular articles: footnotes plus references. See Citation Guidelines for **Earth Sciences History**.

NOTES ON CONTRIBUTORS

Linda F. Dietz is the Managing Editor of the *Canadian Journal of History* and the Administrative Assistant of the Department of History at the University of Saskatchewan. She has studied at the Universities of Saskatchewan, Toronto, Heidelberg, and Leiden. She has published a variety of papers on topics ranging from the history of geology to local history, detective fiction, and palynology.

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Gerald M. Friedman was the founding Editor of **Earth Sciences History**. He is the current chair of the History Division of the Geological Society of America.

William W. Kellogg (b. 1917) obtained his Ph.D. in meteorology in 1949 at the University of California, Los Angeles. His research interests have ranged from climate change to turbulence in the upper atmosphere. He was the chair of the upper atmosphere working group for the World Meteorological Organization and chair of the meteorological advisory committee for the U.S. Environmental Protection Agency. He is a fellow of the American Meteorological Society and the American Geophysical Union.

Trent A. Mitchell is Dr. Sarjeant's research assistant with the Department of Geological Sciences at the University of Saskatchewan. He has an M.A. in the History of Science and is the recipient of the Society for the History of Technology's IEEE Life Members' Prize in Electrical History for one of his publications on the history of electricity in the eighteenth century.

G. B. Morey is a Professor of Geology in the Department of Geology and Geophysics and Associate Director and Chief Geologist of the Minnesota Geological Survey, both in the N. H. Winchell School of Earth Science, University of Minnesota. He is particulary interested in the activities of Winchell while he was director of the survey.

William A. S. Sarjeant, D.Sc., F.R.S.C., M.Bt. is a geologist, historian, author, and folksinger. His geological specialties are marine paleopalynology, vertebrate paleoichnology, and the history and bibliography of the earth sciences. He is Professor of Geological Sciences at the University of Saskatchewan and is the author or joint author of some 600 scientific and historical publications, in addition to his writings in other fields.

Nico Stehr is Senior Research Associate in the Sustainable Research Development Institute of the University of British Columbia, Vancouver, British Columbia, Canada and during the academic year 99/00 DAAD Professor at the Universität Duisburg, Germany. He is a Fellow of the Royal Society of Canada and editor of the *Canadian Journal of Sociology*. His research interests center on the transformation of modern society into a knowledge society, global change and public policy, the interrelation between climate and society, and the uses of social and natural science knowledge. He has co-edited *Society and Knowledge* (1984), *Knowledge and Politics* (1990) with Volker Meja, and *The Knowledge Society* (1986) with Gernot Böhme. With David Kettler and Volker Meja he is the author of *Political Knowledge* (1994) as well as co-editor of several previously unpublished manuscripts by Karl Mannheim. His current research interests are reflected in *Practical Knowledge* (1992) and *Knowledge Societies: Labour, Property and*

Knowledge (1994) and *The Culture and Power of Knowledge: Inquiries into Contemporary Societies* (with Richard V. Ericson, 1992). His *Klima, Mensch und Gesellschaft* (with Hans von Storch) has just been published. *The Fragility of Modern Societies* and *Knowledge and Economic Conduct: The Foundations of the Modern Economy* are forthcoming.

Davis Young, is a professor of geology at Calvin College in Grand Rapids, Michigan. He has recently published the book *N. L. Bowen and Crystallization-Differentiation: the Evolution of a Theory* with the Mineralogical Society of America in 1998.