ESSAY REVIEW

Vic Baker, Book Review Editor

FRANK SPRINGER AND NEW MEXICO, FROM THE COLFAX COUNTY WAR TO THE EMERGENCE OF MODERN SANTA FE. *David Caffey. 2006. Texas A&M University Press, College Station, 261 p. Hardcover, US$ 34.95.*

As a paleontologist, I know Frank Springer (1848 – 1927) (Figure 1) as the dominant student of fossil crinoids during the latter nineteenth and early twentieth centuries and was surprised to learn that his scientific contributions were a sideline to his real profession as a lawyer in the nascent New Mexico Territory. Alternatively, David Caffey, a historian of New Mexico, found "To discover that this same man had carried on a parallel career as a paleontologist, amassing collections, conducting research, and publishing his finding in the leading scientific institutions, was somewhat astounding."[1] *Frank Springer and New Mexico* is a welcome biography of Frank Springer, a "many-sided man"—a man of great accomplishments.

This book is not for the Earth scientist who wants to learn about the history of ideas in the productive collaboration of Frank Springer and Charles Wachsmuth or in the scientific debates between Frank Springer and Francis Bather (British Museum, Natural History, London). That history has yet to be written. Instead, *Frank Springer and New Mexico* is a complete biography of Frank Springer, emphasizing his contributions to the development of the New Mexico Territory, his profession, and placing his many other accomplishments within this primary context.

Frank Springer was born on June 17, 1848, in Wapello, Iowa. At the age of 14, Springer enrolled at the State University of Iowa at Iowa City, graduating in 1867 with a bachelor of philosophy degree. A pivotal juncture in his life occurred early during his studies at Iowa City, when he attended a lecture by the eminent Harvard University Professor, Louis Agassiz. Agassiz lectured on "The Coral Reefs of Iowa City," and Springer was captivated by the geological history of Iowa and by geological data and their logical interpretations. Thereafter, he was " ... torn between a passion for science and more pragmatic considerations." [2] In the end, more pragmatic considerations prevailed, and after graduation he moved to Burlington, Iowa, to read law with Henry Strong, a prominent attorney largely engaged in railroad affairs. This decision was not made to the exclusion of paleontology. Instead, the plan was to earn a sufficient living so that he could also, later, pursue a career in paleontology.

Springer did not stay in Burlington long; he departed for New Mexico in January of 1873, where he anticipated greater opportunities to establish financial independence. However, his time in Burlington was a crucial beginning. Springer advanced quickly in

[1] Caffey, 2006, p. xii.
[2] Caffey, 2006, p. 9.

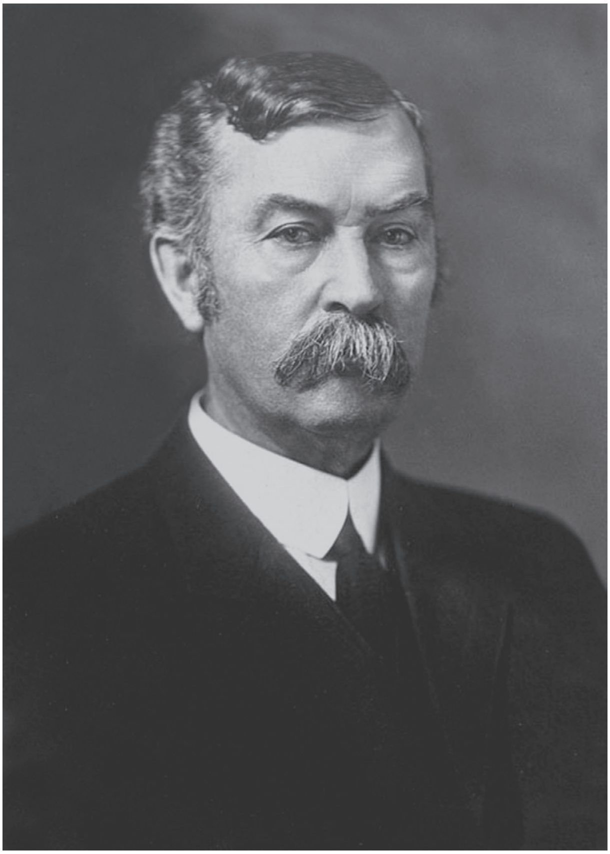

Figure 1. Frank Springer. Photograph from the personal papers of A.H. Clark and used with permission of David L. Pawson and the Smithsonian Institution.

law, gaining valuable litigation experience and becoming a partner in Strong's firm. His interests in geology and paleontology were cemented by meeting and joining into collaboration with Charles Wachsmuth. Wachsmuth was a Burlington businessman who, taking advice from his doctor, began taking long walks along the bluffs of the Mississippi River. Here he began finding fossil crinoids, the scientific study of which became his life's work. Springer shared Wachsmuth's fascination with crinoids, and from these early beginnings on the Burlington Limestone above the Mississippi River, a most productive scientific collaboration was forged.

On February 6, 1873, Frank Springer arrived in Cimarron in the New Mexico Territory with the prospect of assuming much of the legal business associated with the Maxwell Company, and he would also assume joint management and editorial duties for the *Cimarron News*. The Maxwell Company in its various forms (i.e., Maxwell Land Grant Company) was a product of early land grants, the legality of which took decades to settle in court. Springer's first task for the company was to prepare lawsuits for the eviction of settlers on land regarded by the Maxwell Company as theirs. Attending to various legal needs associated with the Maxwell Company occupied a large portion of Springer's legal work in New Mexico. His work, principally in civil law, was often contentious and sometimes violent, involving property boundaries, mineral rights, the plight of Native Americans, political intrigue, and arguing concessions in the railroad wars that helped bring the railroad into New Mexico, among others. Some of this work led directly to New Mexico becoming the forty-seventh state of the United States. Springer was an excellent litigator. He argued cases at all levels from Colfax County, New Mexico, to the United States Supreme Court. He argued eight cases with the U.S. Supreme court, winning all but one. Along the way, Frank Springer also invested in cattle ranching with his brother in a company that would eventually be called the Charles Springer Cattle Company; he was instrumental in coal mine development and in building the Eagle Nest Dam; a new railroad town was named Springer (today on I-25 in Colfax County); he helped establish the New Mexico Normal University, the School of American Archaeology, and the Museum of New Mexico; he was a strong promoter of the Arts in Santa Fe; and he was an accomplished flutist. In 1916, the *Albuquerque Morning Journal* referred to Frank Springer as "New Mexico's Foremost Citizen."[3]

Asked about the keys to his success in law, Springer noted two guiding principles:

> 1) Thorough study and perfect preparation for the trial. Leave nothing to chance that foresight can provide against. A program for the case is put into systematic notes and assembled in logical order and with mathematical precision.
>
> 2) The ability, acquired by experience, to discriminate between the essential and the non-essential. Don't waste energy on immaterial points, unless for some strategic reason. In almost every lawsuit there is some one crucial point or proposition of fact or law upon which the decision must ultimately depend."[4]

These two guiding principles were also key to his success as a scientist. Throughout his time in New Mexico, Springer maintained an active correspondence with his friend and collaborator, Charles Wachsmuth. This was sometimes a stormy collaboration because Springer could not devote his full efforts to crinoid studies. However, in the end it was most fruitful. Wachsmuth and Springer collaborated on fifteen publications. Some were descriptive paleontology, in which crinoids from the Burlington Limestone and elsewhere were described. However, Wachsmuth and Springer concentrated much of their efforts on syntheses, defining the fundamentals for organization and classification of the Crinoidea, culminating with *Revision of the Palaeocrinoidea*, a 692-page work published from 1880 to 1886 and the *Crinoidea Camerata* a beautifully produced monograph published in 1897. Their work was international in scope, and led to active engagement with paleontologists around the world.

In accordance with his plan, Springer amassing a considerable fortune, and paleontology became his primary concern. He remained active in the affairs of the Maxwell Land Grant Company for most of his life, but after his move to Washington, D.C. in 1911, his legal work and other projects were secondary to paleontological research. With the second Wachsmuth crinoid collection (the first acquired by Harvard University), Springer amassed what today is the core of the premier collection of fossil crinoids anywhere. It is housed in the U.S. National Museum of Natural History, Smithsonian Institution. The significance of Springer's work and of this collection was recognized by the museum director, Charles D. Walcott, who secured the collection for

3 "Santa Fe Society Notes: The Secret of Keeping Young," *Albuquerque Morning Journal*, October 8, 1916. Caffey, 2006, p. 176.

4 Typewritten note on stationery of CS Cattle Company. This is also quoted in Twitchell, Notes and Memoranda. Caffey, 2006, p. 113.

the Smithsonian. Frank Springer was appointed an Associate in Paleontology of the U.S. National Museum. In this second phase of his paleontology career, Springer concentrated on the publication of monographs, chief among them Uintacrinus*: Its Structure and Relations* (1900), *On the Crinoid Genus* Scyphocrinites *and Its Bulbous Root* Camarocrinus (1917), *The Crinoidea Flexibilia* (1920), *Unusual Forms of Fossil Crinoids* (1926), and *American Silurian Crinoids* (1926). The works of Wachsmuth and Springer and of Springer remain the foundation of current understanding of the morphology, taxonomy, and classification of the Crinoidea.

In today's reductionist world, Frank Springer's lifework, as a "many-sided man" was most extraordinary. For any generation, Frank Springer would be a man of great accomplishment. In 1923, Springer suffered a significant heart attack, and upon hearing of this Charles Lummis wrote "of all men in the world, he is one of those I value most highly. And he is one of those who could least be spared in the world – they don't make his kind any more."[5] David Caffey presents a balanced view of the entire life of this most incredible man. This is an important biography for understanding the men who fought the legal and business battles that formed the West. Furthermore, this biography elucidates the influences, motivations, and factors that shaped Springer's life and outlines the framework for a most unlikely and highly successful scientific collaboration that has had a lasting impact on paleontology. Among Frank Springer's final scientific works was *American Silurian Crinoids*. It was reviewed by Charles Schuchert (Yale University), who stated "a beautiful and monumental work, ...Would that the human world had more men like Frank Springer!"[6]

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5 Caffey, 2006, p. 198.

6 Charles Schuchert, review of *American Silurian Crinoids* by Frank Springer, *Science* 65:1681 (April 29, 1927) 424–426. Caffey, 2006, p. 204.

BOOK REVIEWS

Vic Baker, Book Review Editor

THE LAST GIANT OF BERINGIA: THE MYSTERY OF THE BERING LAND BRIDGE. *Dan O'Neill, 2004. Basic Books, New York. 231p. Softcover, $15.00.*

The "giant" of the title is geologist David Hopkins (1921–2001), who was called thus by his Russian friend and colleague, Andrei Sher, in a tribute at his memorial service. Reasons why his colleagues regarded him as a "giant" are ably demonstrated in this highly readable book, written by Fairbanks-based journalist and popular history writer Dan O'Neill. The book is essentially an account of Hopkins' life and career, which was spent mainly with the U.S. Geological Survey (USGS), working in Alaska. But his true vocation, the task that absorbed him, and for which he is best known, was to understand the geological and biological history of Beringia.

In O'Neill's account, Hopkins' career is a good demonstration of contingency, or being in the right place at the right time. His initial arrival in Alaska was almost by accident, following a recruitment search by the USGS in 1942. Born and brought up in New Hampshire, Hopkins completed an undergraduate degree in geology and went on to Harvard to begin graduate studies. Shortly thereafter, he accepted a placement in Alaska to look for strategic minerals for the war effort, partly, O'Neill suggests, so as to delay being drafted in WWII. This initial experience set the pattern for most of the rest of his life: summers in the field in Alaska, winters in the office, mostly in Menlo Park, California, analysing data and writing reports. Hopkins' fascination with the landscapes of Alaska was immediate and lasting. O'Neill's descriptions make it clear that this work was no sinecure, but was demanding both physically and mentally; Hopkins endured field conditions that would be unimaginable to most professionals today. He undertook fieldwork in remote parts of Alaska, a state that is itself considered remote by most people, and encountered difficult living conditions, made more challenging by foul weather, arduous travel, and the assaults of mosquitoes.

If this were all, Hopkins would probably not be famous, but would simply be one of the myriad geologists who have worked unsung to add to our knowledge of the earth. However, soon after he began working in Alaska, Hopkins became fascinated by the question of the Bering Land Bridge, whether and when it had existed, what it might have been like, and its role in biogeography and archaeology. At the same time, he was encountering and working with other professionals, notably Bob Sigafoos, a botanist, and Louis Giddings, an archaeologist, who were also interested in linkages between northeast Asia and northwest North America. Giddings, in particular, already had an established reputation and abundant northern experience. Hopkins had personal qualities and a curiosity that drew him to interdisciplinary work. O'Neill attributes this to formative experiences as a child, being encouraged in natural history studies by his mother, and by the influence of Kirk Bryan at Harvard. When Hopkins was a graduate student, Bryan was already an eminent professor, a strong personality who sought explanation from areas beyond geology and encouraged students to question and follow research leads. This was a lesson Hopkins clearly absorbed and applied in his career. Evidently, Hopkins also had an ability to get people of widely different backgrounds and viewpoints talking to each other. This knack resulted in two landmark, edited volumes, *The Bering Land Bridge* (1967) and *Paleoecology of Beringia* (1982), works that are still widely cited and for which he is best known.

Hopkins was also unusual in his desire to reach out to colleagues in Russia during the 1960s and highlight their research. It is perhaps hard now for us to appreciate how difficult it was to communicate with colleagues in Russia during the Cold War, when they were cut off by the state-control of communication channels and the language barrier. Nevertheless, Hopkins was able to secure several papers from them for inclusion in The Bering Land Bridge. O'Neill recounts Hopkins' apprehension when eventually he had the opportunity to travel to Russia in 1969. He was concerned that the Russians might be annoyed with him for the extensive editing he had done on their papers to turn them into readable English. Instead, he found that the Russians were happy that their research had been made accessible to readers beyond their borders. As O'Neill points out, the relationships with Russian colleagues remained an important part of Hopkins' professional life.

As part of this Beringia research story, O'Neill provides an adequate, if brief, summary of the two major controversies for which Hopkins was a catalyst. Arguably, these are the pivotal research questions of his career. The first is the so-called "Productivity Paradox", the seeming incongruity between the apparent abundance and variety of mammals, as inferred from subfossil faunal remains, and the differing reconstructions of vegetation cover, as inferred from pollen records. The second is the positional importance of Beringia in the peopling of the New World, especially the debate over routeways, with advocates supporting either an interior route, from eastern Siberia through interior Alaska and southwards along the eastern slopes of the Rockies, or a coastal route from Siberia, "island-hopping" along the Aleutian chain and the southern Alaska coast and southwards along the British Columbia coast. Both controversies draw on inferences about the extent and chronology of Beringia itself and the nature of now-drowned landscapes.

Many other researchers became drawn into discussions around these controversies, which polarised, and in many ways continue to polarise, the research community. To some extent, the discussions were exacerbated by differing interpretations of evidence by researchers from different disciplines or, in some cases, disagreement over what constituted evidence. But the debates also highlight some more fundamental issues in what one could term the "anthropology of science." O'Neill does not take up the challenge of this deeper and more difficult examination. He does not explore in any detail the various theoretical perspectives, underpinned by strongly held beliefs about what the past ought to look like, that in part led to this polarisation and made the debates sometimes heated and fractious. The story is told primarily from Hopkins' point of view, and in O'Neill's account Hopkins remained somewhat aloof from these debates. Even today, however, after decades more research, neither debate is resolved.

O'Neill had the benefit of interviews with Hopkins and his colleagues and students in the preparation of this book, as well as access to archival material on file at the University of Alaska-Fairbanks. The anecdotes and quotes give the book immediacy and a vibrancy that bring the story alive. The text is interspersed with photographs of people, often other researchers or Hopkins in the field, and field sites. I never had the opportunity to meet Hopkins, but I have colleagues who knew him and worked with him. The sense of Hopkins' basic decency and likeableness portrayed by O'Neill certainly meshes well with what I have heard of him from other people. Probably Hopkins' most enduring legacy, however, will be his academic lineage through the ideas that he formulated and the students that he helped train. Through O'Neill's fine book, with its accessible approach and fluid writing style, Hopkins' life and ideas should become better known beyond the geoscience community.

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RANDOM HARVEST: BIOGRAPHICAL SKETCHES. *B. P. Radhakrishna. 2005. Geological Society of India Memoir 60. Geological Society of India, Post Box 1922 Gavipuram, Bangalore 560019. ISBN 81-85867-65-8. 291p. Softcover, US$25. (Distribution in North America: GeoPlanet Resources Co., P. O. Box 526239, Salt Lake City, UT 84152-6239*

What are scientific biographies for, anyway? Why should we care about the life, work and publications of dead scientists? Well, I can think of at least four reasons. First, scientific biography provides the raw materials for historiography of science. After all, science progresses because we have found ways to accumulate and analyze the knowledge of our predecessors. Second, professional successes and life lessons of pioneer scientists encourage the younger generations. Nearly all of us who have become scientists have had role models and heroes who fascinated and drew us to science. Third, scientific biography is essential for creating a scientific community. Science cannot contribute to human culture without having its communities and connections; this is a vital lesson science has to learn from religion which has shaped culture long before science because of its congregations and bridges to the public. Fourth, an appreciation of the life, services and accomplishments of our peer scientists is simply a good etiquette and a humanistic act. That scientific biography is at times a questionable endeavor explains why scientific biography has not become a well-developed genre of literature especially in the earth sciences and especially in the developing countries.

With this background we can better appreciate the significance of Dr B. P. Radhakrishna's book, *Random Harvest: Biographic Sketches*. Radhakrishna has led the Geological Society of India and its monthly Journal with untiring commitment and far-reaching vision for decades. Being a prolific author, he has written interesting editorials in the GSI Journal. In 2003, to commemorate his eighty-fifth birth anniversary, the GSI published a selection of his editorials in a Memoir entitled, *Random Harvest: An Anthology of Editorials* (GSI Memoir 51). *Random Harvest: Biographical Sketches* is a worthy sequel to that publication.

The 45 biographies collected in this volume can be categorized into five groups, as follows:

(1) Indian geoscientists who have mainly worked in universities or research institutions: D.N. Wadia (1883-1969), S. Narayanswami (1917-1978), C. V. Raman (1888-1970), Charles S. Pichamuthu (1900-1990), Birbal Sahni (1891-1949), A.P. Subramaniam (1921-1973), M.N. Viswanathiah (1921-1986), C. Radhakrishnamurty (1933-2001), L. Rama Rao (1896-1974), P. Nath Bose (1855-1934), M.S. Krishnan

(1898-1970), K.K. Mathur (1893-1936), P.R. Pisharoty (1909-2002).

(2) Indian geoscientists and servicemen in the mining industry and mining geology: Nallari P. Rao (1901-1952), N. Jayaraman (1911-1971), B. N. Raghunatha Rao (1908-1975), T. B. Sundara (1928-1976), B. V. Murthy (1917-1978), P. S. Narayana (1906-1981), P. N. V. Raghavan (1916-1987), Bellur Rama Rao (1890-1970).

(3) Indian environmentalists and social activists: Y. M. Settaru (1815-1887), A. Saheb Nazare, Salumarada ("tree-lover') Thimmakka, S. Bahuguna, M. A. Sreenivasan (1897-1998), Anil Agarwal (1947-2002), Nani Palkhiwala (1920-2002), Kalpana Chawla (1961-2003), M. Vittal Kamath, C. Rajagopalachari (1878-1972), Raj Ramana (1925-2004).

(4) Foreign scientists or servicemen who have worked in India: George Everest (1790-1866), J.B. Haldane (1892-1964), William Jones (1736-1794), William D. West (1901-1994), W. F. Smeeth (1865-1951), John B. Auden (1903-1991).

(5) Foreign scientists who have played a leading role in development of geoscience: Preston Cloud (1912-1991), Charles Thies (1900-1987), Arthur Holmes (1890-1965), William Smith (1769-1839), S. Warren Carey (1991-2002), James Hutton (1726-1797), F.J. Pettijohn (1904-1999).

Given this wide coverage, the book has something to offer to every reader. It has educational value for teachers and students; it is also a useful reference and research source for journalists and science historians. Obviously, the selection of these biographies heavily depends on Radhakrishna's life experiences, but this should not be viewed as a limiting factor. This book is not meant to be a biographical dictionary of earth scientists or Indian scientists. Given that Radhakrishan is a living history of Indian geology, the biographical sketches he has prepared of his colleagues, friends and peers is an informative source of information. Young readers from India will find many simulating stories of life in the pages of this book. And geoscience historians from the Western countries will find raw materials on the life and works of prominent Indian geologists and those who have contributed to Indian geology.

I personally enjoyed reading these biographical sketches. Some of the men profiled here have been my own heroes as well, notably D.N. Wadia and John Auden who contributed so much to our understanding of Himalayan and Indian geology. The most moving piece I read in this volume was the life story of Nallari Pandurang Rao, a less known mining geologist who came from a poor family in Karnataka, southern India. His selfless devotion to work and to use geologic science and resources for the betterment of people's life, and his kindness in daily life to fellow humans despite hardships in his own career are all marks of a noble and admirable personality. Thomas Carlyle has said that history is made by heroes. If this is true, we should also add that the majority of heroes are little known individuals among us who illuminate our vision by their great spirit and build our society by their labor of love. N.P. Rao was among these heroes.

We should be grateful to Radhakrishna for sharing these stories. It would have been equally important and fascinating if Radhakrishna had also included a biographical sketch of himself in the volume. I am glad to inform readers that I am currently editing a book entitled "Tales of Earth Science," and B.P. Radhakrishna kindly accepted my request to contribute his autobiography to that upcoming volume.

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CHINESE FOSSIL VERTEBRATES. *Spencer G. Lucas, 2001. Columbia University Press, New York, 375p. Hardcover, $86.50; Paper $50.*00

Vertebrate fossils were documented in China as far back as 133 B.C., when dragon bones were discovered during the digging of a canal. Yet, scientific research on Chinese fossil vertebrates did not begin until western visitors began buying "dragon bones" in drug stores, and publishing on their finds, beginning with A.L. Adams in 1868. It was nearly another half century before Chinese workers began to play a significant role in their own scientific paleontology. The record now includes rich deposits of many periods, of which the most ancient agnathans (Cambrian), Peking man, dinosaurs, and the Liaoning birds are among the most interesting or famous internationally.

Spencer Lucas first went to China in 1980, and he made four subsequent visits. He has, he tells us, a little Chinese. He has published extensively on Chinese vertebrates from amphibians to mammals, and has studied material from China in New York and Sweden. His book *Chinese Fossil Vertebrates* summarizes work on this complex vertebrate record to about the end of the 20th century. He adopts a politically realistic boundary, including fossils from Tibet and Inner Mongolia, but not from Taiwan. After an introductory chapter and a historical survey, the bulk of the text is presented stratigraphically, from Cambrian-Silurian to Pleistocene. A brief summary chapter rounds out the book, with 46 pages of references and an index. A few typos were noted.

Illustrations are abundant, but not striking. Many maps illustrate the distribution of different formations in China, as well as individual regions and paleogeographical restorations. Those of the whole country (on a half page) are so small as to be diagrammatic—which works only when they are not carrying much data. Diagrams include numerous stratigraphical and range tables and cladograms. Photographs (often poorly reproduced) along with drawings illustrate fossils, sites, museum exhibits and restorations. A few portraits show European workers, but only one shows a Chinese researcher, C.C. Young.

For a number of reasons, this book will be of interest to many who work on vertebrate fossils elsewhere in the world. Firstly, much of the work has been started or continued by researchers from other countries (at first in the absence of local expertise, and later in collaboration with Chinese paleontologists). Many of the fossil groups show their best representation on the world stage in Chinese deposits, and some topics discussed are of international importance. Examples of these include the pioneering fossil egg stratigraphy used in the Cretaceous, the apparent extinction of dinosaurs 200-300 thousand years before dinosaur extinction elsewhere, and Lucas's previously proposed biochrons—each an interval of geological time that corresponds to the duration of a single taxon—which are tested on this rich fauna. Lucas does more than merely report; he discusses paleogeography and evolution, and he offers opinions on stratigraphic and taxonomic problems.

Readers of *Earth Sciences History* will be particularly interested in the historical survey. A 22-page chapter provides one of the best short, English-language overviews of the history of Chinese vertebrate paleontology. Lucas opens with a summary of Basalla's 1967 model for the diffusion of western science into a non-European nation, and shows how it fits the Chinese history. Early finds were documented by Chinese sages within a mythological context, usually that of the dragon. When Europeans arrived they found a thriving industry in the excavation of fossil mammal bones for medicine. These unsourced specimens were the major scientific resource until the beginning of the 20th century. Basalla's second phase, colonial science, begins in China with the Swedish geologist J. Gunnar Andersson, who became a mining advisor to the Chinese government in 1914, and excavated a mammal locality in 1916. The transfer of knowledge began when Andersson's Chinese assistants were given some independence in 1919. Lucas does not name these Chinese pioneers, but Andersson names Yao and Chang, perhaps the first trained Chinese to collect fossils for scientific purposes (Andersson, J. G., 1973, *Children of the Yellow Earth*. MIT Press, p. 80). Lucas gives a good discussion of the complex politics of the Swedish involvement in paleontology, with particular reference to the work of Austrian Otto Zdansky, of whom he has made a special study. Lucas also makes reference to the American Museum expeditions through China to Mongolia, and the initial work on the Peking Man site at Zhoukoudian, briefly discussing the later work of Canadian Davidson Black and Frenchman Teilhard de Chardin.

Lucas dates the third phase, completing the transplantation of the science, to 1949 and the founding of the People's Republic of China. A Chinese vertebrate paleontologist, C.C. Young (Yang Zhungjian) had already been trained in Munich, and then had 20 years with the Chinese Geological Survey before the birth of the new republic. Yang was responsible for training and mentoring the next generation of Chinese vertebrate paleontologists, of whom Minchen Chow (Zhou Mingzhun),—who studied in the U.S.A., and to whom the book is dedicated—succeeded him as dean of Chinese vertebrate paleontologists.

Following the Chinese Cultural Revolution (1966–1976) Lucas recognises "a true renaissance" in which "Western and Chinese paleontologists [have] collaborated extensively." However, he only discusses this period briefly, rightly recognizing the importance of the Sino-Canadian Dinosaur Project but not discussing other work, which remains for future historians to discuss.

The ancient imagery of the dragon is still very much part of Chinese culture. When a slab containing nine dicynodont skeletons was uncovered in the seventies, the paleontologists recognized its similarity to the powerful image of nine dragons (representing the eight directions with the sun in the centre). It was christened the "nine-dragon wall."

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THE PUBLIC FOUNTAINS OF THE CITY OF DIJON. *Henry Darcy, 1856. (English translation by Patricia Bobeck) Kendall/Hunt Publishing Company, Dubuque, Iowa, 506 p. Hardcover, $100.*

Henry Philibert Gaspar Darcy was born in Dijon, France, on June 10, 1803. He died of pneumonia on January 3, 1858. His accomplishments during this relatively brief life were numerous and important. Darcy was an engineer who completed several critical experiments that described the flow of water through pipes, open channels, and sand columns. The result of his experiments with the flow of water through sand has been generalized as the flow of any liquid through porous material. Stated briefly, Darcy found that the flux of liquid through porous media is directly proportional to the energy available as a driving force. This relationship is called Darcy's law, a law mathematically parallel to Ohm's law for the flow of electricity, Fourier's law for the conduction of heat, and other linear relationships in mechanical and physical systems.

Few, if any, experiments related to the Earth sciences have been cited more often in the technical literature than Henry Darcy's experiments with water flowing through sand columns. However, few, if any, of these citations have been based on an actual reading of Darcy's original publication. The citations made have been simply copied from earlier citations made by still earlier individuals. This failure to return to the original publication, for American researchers, has been doubtless due to a language barrier. In addition, the original publication containing more than 500 pages, all in French, is simply not available in most libraries in the Untied States. We are fortunate indeed that these shortcomings have been overcome by the dedicated work of Ms. Patricia Bobeck, who has faithfully translated Darcy's entire massive volume into English. The importance of her accomplishment to the understanding of the origins of quantitative hydrogeology, petroleum engineering, soil physics, and related fields is impossible to overstate.

The title of Darcy's book that is reviewed here, "The Public Fountains of the City of Dijon," is a bit deceptive because it is much more than just a detailed record of the construction of a single water-supply system. The book describes work completed at different times as well as experiments of wide importance but not directly related to the city of Dijon. In some ways, the book resembles a mixture of an engineering report, a bit of engineering economics and law, and a textbook on hydrology. Darcy's stated goal in writing the book was to provide a guide for engineers charged with constructing municipal water-supply systems. He easily achieved his goal.

Darcy's book has several primary parts in addition to an appendix. Part 1 is a historical summary of the water-supply situation in the City of Dijon. Part 2 covers the construction of the aqueduct and distribution system provided for Dijon. Part 3 records experiments conducted on the aqueduct and distribution systems. Part 4 presents the appropriation of springs that at one time belonged to a nearby village. Part 5 is an appendix that includes a variety of subtopics including the famous Appendix D that records, for the first time, Darcy's law of flow through porous media. Finally, Part 6 is an atlas giving detailed drawings of the various elements of the water-supply system for Dijon.

To Earth scientists, Appendix D is by all measures the most important part of the book. This appendix presents the results of extensive experiments by Darcy and his assistant, Charles Ritter, who ran water through a column of sand. They found that, for a given column of sand, the flux of water through the sand was directly proportional to the head loss and inversely proportional to the length of the flow path. As already noted, this linear relationship is now known as Darcy's law, and it is the foundation of the mathematical treatment of fluid transport utilized by a number of disciplines.

There is some question about the extent to which Darcy realized the wide applicability of his discovery. Certainly he recognized that he had discovered something entirely new, for he wrote, "...to my knowledge at least, no one has experimentally demonstrated the laws of water flow through sand." (Darcy, p. XXV, 1856) On the other hand, in certain places in the book, Darcy is concerned with the flow of ground water in supposed natural subsurface fractures and large cavities. These cavities and fractures were thought to transmit water to artesian wells in a different manner than subsurface layers of sand that follow Darcy's newly discovered law.

Owing to the overriding theoretical importance of the column experiments described in Appendix D, general discussion of Darcy's book commonly skips over the fact that much more space in the book is devoted to artesian wells than to sand-filter problems. One reason for an extended discussion of artesian wells may be the fact that Darcy rejected artesian wells as a primary source for the water supply at Dijon. Instead, he selected a large spring some distance from Dijon. At the time, artesian wells enjoyed wide support from the influential Francisco Arago. This fact, together with the fact that the artesian well in Paris at Grenelle was a spectacular success, meant that extreme care was needed if the popular artesian wells were to be disqualified.

A number of interesting sidelights appear in Darcy's book. At the start of the book, Darcy quotes Arago at length, the gist of which was a plea for a reduced cost of water in order to make water available to people of limited means. Arago further summarizes the use of water for fire suppression, personal hygiene, cleaning public roads, flushing sewer systems, and requirements of hospitals.

Abundant data are given for water-use in major cities in England and France. Some of the per capita uses more than 150 years ago were almost as high as present values for use in the United States, that is, roughly 100 gallons per capita per day. In one estimate of municipal water needs, about 20% of the total supply was allocated to washing down the streets, which was thought to be needed three times per day for one hour for each washing. At first glance, this seems quite excessive until the waste production of horses on a busy city street is taken into account.

Water quality is discussed in several parts of Darcy's book. Chemical analyses are presented of the spring water that was developed for the city of Dijon. The analyses show that the spring water was of excellent chemical purity. This is in contrast with shallow well water in Dijon and vicinity. Evidently, near-surface aquifers were widely polluted and were rejected by Darcy as sources of municipal water. He thought that the pollution was caused by water percolating through thick surficial soil. The probable effects of shallow cesspools and other sources of urban waste were also identified.

In connection with his discussion of health issues, Darcy summarized Gaspard Adolph Chatin's research that showed the importance of iodine in potable water supplies. In what may have been the world's first scientific study of the health effects of natural trace constituents in water, Chatin demonstrated that very small amounts of iodine in water were beneficial in preventing the development of goiters in humans. This conclusion was based on analyses of about 300 samples of water from various parts of western Europe.

The present review of Darcy's book is of necessity only a brief sampling of its rich historical content. For those interested in a well-rounded picture of Henry Darcy and his life together with comments on his history-making experiments, a good starting point would be an excellent essay by R. A. Freeze. (Freeze, R. A., 1994, Henry Darcy and the fountains of Dijon: *Ground Water*, v. 32, no. 1, p. 23-30) Like all famous persons of science and engineering, there is no limit to the benefits of revisiting the life work of Darcy. We should thank Ms. Bobeck for a vastly improved look at the work of Henry Darcy, one of the great men of the 19th century.

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HISTORY OF PALAEOBOTANY: SELECTED ESSAYS. *A. J. Bowden, C. V. Burek and R. Wilding, eds, 2003. Geological Society of London, Special Publication 241, 312p. Hardcover, $144*

The title is accurate and from it one might assume that these essays should be of interest only to an incredibly small group. This assumption would be quite wrong, for these essays illuminate the scientists, technicians and artists who developed a science; it is human interest at its best. Along the way one glimpses some of the major discoveries of British paleontology, especially among the Paleozoic strata, but the essays aim for the individuals, and almost all are right on target. If a generalization is to be made, it is that, despite the difference in spelling, developments in the United States are comparable to those in Great Britain, as those who studied dead plants were almost invariably denizens of departments of botany, rather than directly associated with geology. Still, the importance of coal in Britain fostered an early interest in the fossil plants that formed the mineral. The study of plants in concretions ("coal balls") was well developed before the first American coal ball was sawn open.

The sixteen essays of the book are arranged in four groupings, with a fifth grouping "From other continents" of two short papers on Argentina and China respectively. Several of the papers in two of the groupings touch on the same personages, but in different contexts, and each provides new facets of career or personality. The rise and fall of paleobotany in Glasgow and Manchester provide valuable insights for those who examine the successes and failures of institutional structure. Particularly intriguing are the efforts of those lesser figures that attempted to keep a group energized after a leading personality departed.

For those who prefer the history of great men and great women to that of institutions, there are those who labored hard to harvest long-dead vegetation (this may be a poor way to describe the raw material of paleobotany, but I work with shells, not twigs and leaves). "Great women" is not a misprint, for two—Emily Dix and Marie Stopes—warrant their own chapters.

The predecessors of the golden age of paleobotany in Great Britain are not neglected. Hugh Miller, a man of many parts, made some noteworthy plant collections. The first Paleozoic paleobotanical paper published in the United States was based on British specimens brought over by a Moravian minister. Those even earlier naturalists who dabbled in many fields, such as Robert Plot and Edward Lhynd, are noted for their contributions to paleobotany.

Interwoven among the scientists is the development of techniques. Thin-sectioning began in Edinburgh, Scotland, and silicified wood may have been the first fossil, if not the first rock to be studied by this dramatically new method. Later, a group of paleobotanists (sorry-palaeobotanists) helped support commercial development of sectioning, but were upset when the one-man company distributed slices of the same fossil to a variety of places; it is a cautionary tale for those who want technology and technicians on the cheap.

A fine chapter on illustrators and illustrating techniques from 1800 to 1840 contains information applicable to classical paleontological publications in other fields of paleontology. In several places, botanical nomenclature, as applied to fossil plants, is mentioned, and that too is an interesting study. Another interesting story is the more detailed investigation of early attempts to conserve key collecting sites.

As one might expect of a Geological Society of London publication, the editing is excellent, and the numerous illustrations are crisp. The text is clear and equally crisp. The book certainly does not cover all aspects of British paleobotany, but it is a fine collection of essays. Regardless of what field of history of geology might be of particular interest, these essays show how what could have been a disjointed assemblage of papers can be woven into a good story. Whether one is paleontologist or petrologist, these essays will reward your reading of them.

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A ROMANCE IN NATURAL HISTORY; THE LIVES AND WORKS OF AMADEUS GRABAU AND MARY ANTIN. *Allan Mazur, 2004. Garret, Syracuse, NY, USA, 484 p Order from author,* <amazur@syr.edu>

Amadeus Grabau, one of the most influential and controversial American geologists during the first half of the twentieth century, remains today almost totally unknown. His wife, Mary Antin, a precocious writer and activist celebrity, was a major figure in the literature and politics of immigration during the same period, but similarly faded into obscurity. Sociologist Allan Mazur, Professor of Public Affairs in the Maxwell School of Syracuse University, became interested in Antin when he used her book, *The Promised Land* in his course, "America's Ethnic Groups." Grabau was Mazur's wife's great uncle and provided another personal contact with the subjects of his biographical work.

Mazur's is the first comprehensive biography of Grabau. Antin's, *From Plotzk to Boston* (1889) and *The Promised Land* (1912) describe her early life as a Russian Jewish immigrant and, later, as a Columbia University faculty wife. Although there are many memorials and short accounts of both Grabau and Antin, Mazur's book is the first in depth analysis of their personal relationship and joint role in American scientific and intellectual history.

Grabau's career from childhood through his appointment at Columbia University is a phenomenal record of intense academic effort. At Columbia he neglected interpersonal relationships with his distinguished, but less energetic colleagues and was soon regarded as an "outsider." His marriage to an eighteen-year-old Jewish immigrant celebrity writer, further exacerbated Grabau's estrangement from his colleagues. In addition, his outspoken respect for German scholarship and culture cast doubt on his patriotism as the United States entered the First World War. This partially explains Grabau's eviction from the University, the separation from his wife and subsequent flight to China. Although Mazur has gathered much previously unavailable information, his account of Grabau's departure from Columbia and the United States fails to resolve all controversy. Unfortunately, Geology Department and University files at Columbia were purged some time between the First and Second World Wars, making it impossible to evaluate the exact causes of Grabau's expulsion. A recent e-mail exchange with Robert Dott at the University of Wisconsin concerning preservation of embarrassing archival records at the University of Illinois yielded a volunteer statement that Marshall Kay, and a group of other Columbia professors, removed files relating to Grabau because they were "dirty." Presumably those files related to widespread gossip about possible sexual misconduct; gossip that is discounted by Mazur.

In Peking, Grabau joined a cosmopolitan group of expatriates helping a handful of distinguished Chinese create a modern scientific and academic establishment. Mazur details Grabau's leading part in recruiting and training geologists and in organizing academic and governmental geological institutions. Grabau and his colleagues initiated a continuing program of geologic mapping, outlined the stratigraphy of China and integrated Chinese geology and stratigraphy within a global synthesis. The Peking group also began describing and cataloguing Chinese fossils, including the famous work on "Peking Man." Finally, Grabau and his Chinese, European and American associates advanced innovative theoretical work on a global basis, presaging modern concepts of tectonic cyclicity, continental drift, plate tectonics and global paleoecology. Along with his own colossal scientific work, 18,927 pages of scholarly publication, he made himself the social and intellectual center of the Peking Circle, a unique group of Chinese and foreigners, the originators of modern Chinese science.

Grabau returned to the United States only once, for the 1933 International Geological Congress, to which he was brought by a group of his former American associates and rivals. Although he never divorced, he never reestablished his family life with Mary and their daughter Josephine.

When she married in 1901, Mary Antin was already a famous literary prodigy, the author of *From Plotzk to Boston.* Publication of the enormously successful, *The Promised Land* elevated her to celebrity status. Ultimately, she became a confidant of Theodore Roosevelt, Louis Brandies and many other well-known public personages. Her reputation far transcended that of her husband. She continued public life, writing and speaking on immigration issues, but wrote only one more book, the less successful *They Who Knock at our Door* (1914), and, as restrictive attitudes towards immigration came to dominate public opinion, she and her works gradually faded from public view.

Mazur thoroughly reviews Antin's transformation from a child in Russian shtetl, through the slums of Boston, to acclaimed author. He also describes her difficulties as a young Jewish women married at age 18 to a 31-year-old professor in a prestigious University. In addition, he also discusses the adjustments she and her father made in transforming themselves from strictly observant ultra-conservative Jews to life in mainstream America.

Mary and Amadeus' marriage more than likely failed under the strains of Grabau's workaholic life-style, his conflicts with his peers in the Geology Department, and their commitment to opposing sides in the First World War. Antin allied herself with Wilsonian interventionists while Amadeus remained steadfast in his respect for German science, scholarship and culture. Mazur also explores Antin's developing enthusiasm for the Zionist cause. After their separation, Antin saw the cessation of writing, progressive withdrawal from social contacts, and a decline into obscurity.

Mazur describes Antin's decline and life-long attempts to cope with life. First came repeated bouts of psychological counseling, followed by her taking refuge at Gould Farm, an idealistic rural commune organized by Agnes and Will Gould. Later she became a disciple of pantheistic prophet, Meher Baba, and, thereafter, Rudolph Steiner's Anthroposophy, a mystical version of Christianity, to which she remained loosely affiliated until her death in 1949. Through all of this, however, Mary never gave up her Jewish identity and progressively allied herself with Zionism.

Mazur's treatment of Antin is founded on their common Jewish immigrant background and by his scholarly interest in her as a Professor of Public Affairs. His account of Grabau, however, rests entirely on scholarly research; though a fossil collector, the author is not a geologist or a physical scientist. Thus, he brings no preconceptions to his account of Grabau and is somewhat limited in his grasp of the attitudes of geologic research. However, as a geologist sharing in Grabau's research interests, I find Mazur's treatment of Grabau thorough, perceptive and free of significant error. Mazur's Antin story, on the other hand, is almost entirely outside of my own experience and, furthermore, is entirely new to me. It is founded on the extensive study of published works, letters, and documents and I detected no flaws. It is certainly relevant to America's current social condition, as indicated by the 1977 and 2001 reprints of, *The Promised Land.*

Well written and edited, this book reports on a wide-ranging and exhaustive investigation of an important topic. Even the casual reader will find it rewarding. There are many references to unpublished archival records as well as to the literature. Librarians and scholars concerned with the history of geology and the history if immigration studies need this book. Do not be "put off" by the fact that it was privately published and is unconventionally marketed.

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AFRICAN DINOSAURS UNEARTHED. THE TENDAGURU EXPEDITIONS.
Gerhard Maier, 2003. *Indiana University Press*. 380pp. *Hardcover*, $49.95

Only a few dinosaur sites continue to capture the imagination of scientists and the public after many decades. The Flaming Cliffs recur through Andrews' books about the Gobi Desert, and have been visited, revisited, and written about year after year, while Dinosaur National Monument in Utah and Dinosaur Provincial Park in Alberta have both been studied for much of the last century, and interpreted for at least 50 years. Africa has just one site of such vintage and prominence, yet it is a site less well known than many which have only attracted a single expedition or produced a single significant find.

First discovered in 1906, Tendaguru has a story of discovery that is longer, more international, and more complex than most. An abundance of scientific papers in German, and a few travel accounts in German and English record much of its history, but there has been no single source in one language for the story of this remarkable site. This book is the first comprehensive account of Tendaguru, its history and importance to science.

When bones were first discovered there, Tendaguru was in German East Africa, and scientists from Germany were the first to be attracted to its riches. Major contributions were to be made particularly by Werner Janensch (1878–1969) and Edwin Hennig (1882–1977).

A series of expeditions funded by major industrial corporations tackled this most difficult location. Some 60 km from the nearest port, Tendaguru was a hill in thorny forest, with open spaces covered by grass, which hid bones in the rainy season, and produced devastating bush fires in the dry season. It was far from roads and railways, so it could not be approached by mechanized transport. Lions occasionally disrupted work, but a much more serious problem was provided by small game — tsetse flies which made it impossible for beasts of burden to be used, and mosquitoes that carried diseases that incapacitated — and in one case killed — visiting scientists. The native population could be trained to find, excavate and transport fossils, but recent unrest had left ill feeling, and the area barely produced enough food for its own needs. In the midst of a forest, there was no suitable wood for making packing cases, and crates from Scandinavian forests had to be reused half a dozen times, traveling to Berlin and back to Africa. It is remarkable that anything worthwhile was collected, let alone that the region was the subject of the world's biggest dinosaur excavations, in terms of the number of people involved (several hundred at a time), the amount of bone material recovered (over 200 tonnes), and the spectacular nature of some of the remains.

European and colonial authorities provided concessionary fares and subsidized transport costs; the scientists were eager; and a series of pits soon produced many bones, some so large that, for instance, it could take eight men to carry two vertebrae. Manhandled to the coast by teams of bearers, then repacked and shipped by steamer, the bones were carried to Germany year after year until the First World War broke out. Then scientists who had worked at Tendaguru fought with the armed forces in Africa and Europe, and when the dust settled Tendaguru was part of the Tanganyika Protectorate, now managed by Britain.

The British Museum had been watching events with interest, and by 1924 had a party in the field. The first site director, Anglo-Canadian William Cutler (1878-1925), died of fever, and the site was subsequently managed by Frederick Migeod (1872-1952) and John Parkinson (1872-1947) among a succession of others of various qualifications — at one point the site was babysat by a couple of big game hunters. Meanwhile, through the chaos of post-war Germany and the rise of the Nazi regime, the German workers continued the slow process of preparation, scientific description and exhibition of the material they had collected.

By the opening of World War Two, there were many tons of bones in Berlin and other German centers, and many more in London. When the two nations set out to pulverize each other from the air, museums in both countries suffered, but most of the Tendaguru material survived. As the war progressed, Berlin mounted what became the world's biggest exhibited dinosaur skeleton, using material from 40 different quarries to assemble a complete *Brachiosaurus*. Bombing soon led to it being dismantled again, and when it was reconstructed the museum was in Soviet East Berlin, where the museum was soon separated from western science — and indeed some of its own curators — by the Iron Curtain. Shortage of funds during post-war reconstruction prevented both countries from undertaking more than token research; independence came to African colonies; and Tendaguru slumbered undisturbed for a few decades.

Interest revived in the 1970s, when projected Canadian involvement led by Dale Russell (b. 1937) of the Canadian National Museums had to be abandoned after Idi Amin invaded Tanzania. (Russell contributes a useful foreword to this volume). Subsequently American, British and German scientists have led the way in reevaluating the site, bringing new techniques and information to understanding the riches of Tendaguru.

As the centenary of the first discovery approached, an ideal historian at last appeared. Gerhard Maier has been fascinated by the story for many years. For a decade he was a technician with the dinosaur program at the Provincial Museum of Alberta and the Tyrrell Museum of Palaeontology, so he knows of what he writes. Bilingual in German and English, he was able to read all the pertinent materials. He has traveled to Britain, Germany and Africa to fill the gaps in his first-hand experience. And lastly, he has proved to be a careful researcher and capable writer, shaping this complex story into a readable and informative account.

Maier presents a fascinating account of this enthralling enterprise. He not only documents the explorations — dates, excavations, tonnage of fossils, even rates of pay — but also uses the published travel accounts, diaries and letters of the participants to good effect, bringing their joys and tragedies to life. He generally follows a chronological approach, switching between Africa, Germany and England as appropriate. We follow the struggles of the German scientists to wrestle bones from this difficult site, and scientific interpretations from partial skeletons and bone beds. Maier is good with the British leaders too, and recognizes the skills as well as the defects of Cutler and Migeod, who were collectors rather than paleontologists, and Parkinson who was a geologist. He is a master of telling detail, and it is fascinating to hear of the champagne toasts on Tendaguri hill, and the swastikas on the wall at the unveiling of the Brachiosaurus, or to contrast the Prince of Wales's token donation of ten pounds to the British Museum fund with the huge amounts raised from German industry.

With his technical background, Maier also gives good coverage of the few dedicated preparators in Germany, describing how they triumphed in their many challenges, particularly mounting the great brachiosaur. Nor are the native workers neglected; as far as data is available their aptitude for the work is described, as well as the complex squabbles over pay and food and the colonial attitudes to discipline. An unexpected hero emerges in Africa, for the Arab/native supervisor hired by the Germans in 1909, Boheti bin Amrani, served successive English expeditions as well. We last see him meeting Hennig again in 1934, and his subsequent history seems to be unknown.

Subsidiary stories appropriately find a place, as Tendaguru leads workers to other dinosaur sites, and one-time Tendaguru workers Hans Reck (1886-1937) and Louis Leakey (1903-1972) find human and then pre-human remains at Olduvai, now a much more famous African fossil site. Background is lightly sketched in throughout without disturbing the flow of the main narrative, so we are never in doubt about the state of colonial administration or the progress of the current war. A final chapter, summarizing a mass of information, surveys the impact of Tendaguru research on many aspects of dinosaurian and other paleontology, and the wider geological context.

Generally, Maier largely lets the story tell itself, using the words of his many players when available and pertinent, but the author's own voice is available when needed; analyzing, comparing, pointing out inconsistencies and speculating about alternative strategies.

Seven maps and 50 photographs (appropriately emphasizing the German story) provide good visual backup; unfortunately the only two color illustrations are paintings reproduced on the cover. The volume is completed with 22 pages of notes, an 11-page bibliography, and an index.

Maier's splendid work sheds light on the lives of many significant Earth scientists, the history of two great and many other institutions, and on the colonial and post-colonial era in East Africa. It will serve the historian and paleontologist, and (since the language is generally accessible), it also provides a good account of the site for the general reader who is doesn't mind skipping a few of the more detailed sections or is prepared to keep a glossary of geological terms at his elbow. As a thorough and lucid account of a complex series of events, rich in splendid detail, it also provides a model approach to paleontological history.

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THE EVOLUTION OF CLASTIC SEDIMENTOLOGY. *Hakuyu Okada with Alec Kenyon-Smith, 2005. Dunedin Academic Press, Edinburgh, 251p. Hardcover, £45.*

Hakuyu Okada is a sedimentologist with an exceptionally wide range of experience in clastic sedimentology. His first papers on sedimentary petrology appeared in the 1960s, and at that time he also spent a year as a research fellowship at the University of Reading, where he became familiar with European studies. Since then, Okada has traveled widely, has been active in the International Association of Sedimentologists (IAS); from 1994 to 1996, he was President of the Geological Society of Japan. This book was first published in Japanese in 2002 and has been revised, enlarged, and translated with assistance from Alec Kenyon-Smith (University of London). It is the first book-length history of a major part of sedimentology, ranging from the "pre-sedimentological" studies of William Smith, Georges Cuvier and Charles Lyell to modern times.

The authors begin with the following definition of sedimentology: "...a discipline of the earth sciences that studies the nature of sediments and sedimentary rocks and the processes of their formation in order to determine the earth's past environments." (p.1). Two aspects of this definition are relevant to the scope of the book. First, by this definition, sedimentology is a branch of the earth sciences, so this book does not attempt to cover studies of sediment transport made in other disciplines (e.g., civil engineering – even Gilbert's and Bagnold's studies receive only passing recognition). Second, the authors stress sedimentology's environmental aspects (facies, paleogeography, sequence stratigraphy), and pay less attention to the considerable advances that have also been made in studies of diagenesis, including those that are important to basin analysis and the origin, maturation, and trapping of petroleum. Like many other modern geologists (the present writer is a stubborn exception), the authors include many aspects of stratigraphy within sedimentology, except for those aspects of stratigraphy concerned mainly with dating sediments.

The second chapter reviews the early development of geology and stratigraphy, including geosynclinal theory before plate tectonics. Following this, the authors begin their systematic review of the history of sedimentology, which they argue (in Chapter 3) begins with Sorby (rather than with Lyell, whose main interest in sediments was as evidence for uniformitarianism). Each chapter is devoted to the development of a particular theme in sedimentology: "observations of strata" (Chapter 3; mainly structures and sequence stratigraphy); classic sedimentary petrology (Chapter 4); lithology (i.e., facies, Chapter 5); professionalization (Chapter 6); and marine geological studies (Chapter 7). The final two chapters are devoted to the history of sedimentology in Japan; and to some speculations about the future role of sedimentology in the twenty-first century. The authors take note of the on-going unification of sedimentology and stratigraphy, the development of extra-terrestrial sedimentology (studies of the Moon, Mars and Venus – but surprisingly, they give little attention to "impact sedimentology" on Earth); and "social sedimentology" (the study of environmental changes produced by man, rather than nature). A result of this organization is that there is necessarily some repetition, and it is hard to see the development of sedimentology as a whole. Even the "evolution" of some specific topics is not always clear. For example, granulometry (size analysis) is treated briefly in Chapter 4, but without mentioning the pioneering work of Udden, or giving the reasons why this technique was once so popular and is now regarded by many simply as a descriptive aspect of the sediment, from which little can be deduced about its history. The work of Udden and Wentworth does reappear later in the book, in Chapter 6, where it is mentioned as one of the characteristics of the American school of sedimentology.

Chapter 6 is of special interest, because it makes a distinction between three main "schools"of sedimentology: the European, influenced by Sorby, characterized mainly by studies using the petrographic microscope (including both thin sections and heavy mineral techniques); the Russian, influenced by Walther, with emphasis on "lithology," i.e. facies of sedimentary rocks; and the American, influenced by the petroleum industry, and concerned mainly with textures. Okada is well qualified to make this distinction, as he is independent of all three schools. The authors maintain that, although this distinction can be made up to 1950, after that date all three aspects of sediments are studied by the modern synthetic science now generally described as sedimentology, without much distinction between different national schools. The authors then give a rather complete history of IAS, the first Congress of which was held in Belgium in1946. In contrast, the history of SEPM, beginning in 1926, is given much briefer treatment.

Chapter 7, devoted to marine geological studies, briefly discusses the Challenger expedition, skips on rapidly to the Deep Sea Drilling project (mainly in the Pacific and Mediterranean), then returns to the description of deep-sea currents in the Atlantic and seas adjacent to Japan, and ends with a discussion of oceanic anoxic events. This chapter seems to be more of a review of selected topics of interest to the authors, rather than a balanced history of the contributions of marine geology to sedimentology.

Most of the history of sedimentology in Japan, given in Chapter 8, will be entirely new, and probably surprising, to many readers. Geology was introduced into Japan in 1867 by three invited foreign experts: Coignet, from France; Lyman, from the USA; and Naumann, from Germany. The Tokyo Imperial University was founded in 1877, and immediately appointed its first professor of geology. The Geological Survey of Japan was founded in 1878, and the Geological Society of Tokyo in 1893 (it became the Geological Society of Japan in 1934). The first use of the Japanese name for sedimentology ("taiseki-gaku") was by Yagi in 1929 (so before Wadell proposed the name in English), though the name was not widely used for the next 20 years, just as "sedimentology" was not widely used in English until the 1950s. The first textbook, entitled "Chiso-gaku" (equivalent to Walther's term lithology) was published in 1931. Though geological studies started late in Japan, the development of sedimentology was almost contemporaneous with its growth in America, Europe and Russia.

I hope that this book will be widely read, both by those interested in the history of geology, and by English-speaking sedimentologists. It provides them, not only with an interesting overview of their discipline, but also with a perspective that they may not have met before. The book is very well illustrated, not only with maps and diagrams taken from the literature, many already familiar to most sedimentologists, but also with photographs and drawings of 45 prominent students of clastic sediments. Alas, the text does not also provide thumbnail biographies (as found, for example in Zittel's classic History of Geology and Paleontology), and indeed some of the few biographic remarks are erroneous (Alexandre Brongniart was not a paleobotanist, that was his son Adolphe;

Sorby was never a Professor at the University of Sheffield, though he helped in its foundation; and Potter was not a student of Pettijohn, unless you count a Guggenheim fellow as a “student”). Other factual errors are rare, and the translation, with only rare exceptions, is well done and idiomatic.

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GOETHE IM GESPRÄCH MIT DER ERDE: LANDSCHAFT, GESTEINE, MINERALIEN UND ERDGESCHICHTE IN SEINEM LEBEN UND WERK.
Wolf von Engelhardt. 2003. Hermann Böhlaus Nachfolger. 375 pages. Hardcover €69.95

Johann Wolfgang von Goethe’s fascination with the mineral kingdom has never received anything like the attention lavished upon his other scientific studies. This is no reflection on Goethe, who wrote dozens of essays on geognostic and mineralogical topics, kept up a correspondence that bristles with observations of the Earth’s crust, was a devoted collector of rocks and minerals, was instrumental in establishing the natural historical museums of Jena University, and had administrative responsibility for reopening and running a copper and silver mine in the Duchy of Saxe-Weimar, among other things. And yes, his literary work matters a great deal for coming to grips with how he thought about the Earth. Wolf von Engelhardt, a senior German mineralogist and Goethe scholar, is keenly aware of all this, for he recently completed many years of work editing the geological and mineralogical volumes of the magisterial Leopoldina edition of Goethe’s scientific works. The Leopoldina is a historical-critical edition with full textual apparatus, commentary, and a vast body of supplementary materials (von Engelhardt’s contribution amounts to about 2500 quarto pages). It is unlikely that it will ever be superseded.[1] Now von Engelhardt has gone beyond the boundaries of an edition and offers a rounded interpretation of Goethe’s interactions with landscapes, rocks, minerals, the Earth and its history.

The course taken by the book under review is revealed in its lovely title ‘Goethe in Conversation with the Earth,’ for here we see Goethe as a geognost and as a profound poet with a philosophical understanding of nature. Von Engelhardt traces this ‘conversation’ through Goethe’s adult life, beginning with the emotive experience of landscape depicted in *The Sorrows of Young Werther*[o] (1774) and the 1775 journey to Switzerland. The subsequent move to Weimar and travels in Thuringia and the Harz Mountains gave him

[1] Goethe, *Die Schriften zur Naturwissenschaft*, is published under the auspices of the Deutsche Akademie der Naturforscher, Leopoldina. It currently counts over twenty volumes and is now nearing completion. Part I of this edition consists of Goethe’s scientific texts, part II of commentary volumes. Geohistorians should be warned to ignore the first two volumes of part I, as these are now obsolete. Goethe’s geological texts are best consulted in Part I, vols. 8 and 11. The corresponding commentary volumes, all edited by Wolf von Engelhardt with the assistance of Dorothea Kuhn, are: part II, vol. 7, *Zur Geologie und Mineralogie: von den Anfängen bis 1805* (Weimar: Hermann Böhlaus Nacholger, 1989); part II, vol. 8A, *Zur Geologie und Mineralogie: von 1806 bis 1820* (Weimar: Hermann Böhlaus Nacholger, 1997); part II, vol 8B, *Zur Geologie und Mineralogie: von 1820 bis 1832* (Weimar: Hermann Böhlaus Nachfolger, 1999).

a much deeper understanding of nature, as revealed in his early studies of granite and in his Italian journey. Goethe's encounter with Kant and Jena Idealism in the 1790s is given careful consideration, as are the landscapes of *The Elective Affinities* (1809) and *Wilhelm Meister's Wandering Years* (more or less completed by 1810), the travels in Bohemia, and along the Main and Rhine, and *Faust I* and *II*.

This is an admirable book that gives expression to the broad scope and the depth of Goethe's study of the Earth. More than that, it unifies an often ungainly body of sources, and that through a very simple thesis encapsulated in its title. Goethe's conversation with the Earth began haltingly in his early years at Weimar. In late 1780, overflowing with enthusiasm for the new way of observing the Earth's crust he had learned from Freiberg, via the geognost Johann Carl Wilhelm Voigt, Goethe rejected sweeping theories of the Earth's origin. All the same, he felt tied to the Earth by an 'obscure' thread (76). By 1785, in what is arguably his most memorable scientific essay, 'On Granite II,' Goethe wrote of Nature 'speaking softly.' Von Engelhardt argues convincingly that Nature in this essay is nothing other than Spinoza's 'natura naturans,' a kind of infinite substance or God-Nature. Goethe read widely in geognosy and natural history in the 1780s, but it was his reading of Spinoza's *Ethics* that offered him a unifying picture of nature.

Goethe's most intense engagement with philosophy began in 1789, with the revolutionary philosophy of Immanuel Kant's *Critique of Pure Reason*. He then turned to the *Critique of Judgement*, which was to be of even greater moment for his thought. Kantian concepts left their mark, but he could not accept them in their entirety. The gulf between the empirical, sensible world and the noumenal world accessible only by the intellect, not the senses, ran against his sense of unity with nature. The philosophy of Johann Gottlob Fichte and Johann Friedrich Wilhelm Schelling, both of whom taught at Jena University, offered a way of overcoming this Kantian dualism. Based on a close reading of Goethe's annotated copy of one of Fichte's published lecture, von Engelhardt shows that Fichte's idea of an 'I' that was essentially linked to the 'not-I' (i.e. nature, or the world) held great appeal for Goethe, as did Schelling's notion of a transcendent identity of the subject and object. While he was not engaged specifically with geognostic or mineralogical problems in the 1790s, Goethe did pursue his morphological studies and, despite some uncertainty on the question, he eventually concluded that his notion of morphology applied only to the living world. This was also the time of Goethe's closest work with Schiller, yet for all the renown of this famous partnership, it did not really help Goethe frame a poetic account of his engagement with nature (261).

Von Engelhardt explicitly refrains from discussing the secondary literature on Goethe's geology. For the most part this is a wise choice, but a little more might have been done to place Goethe against the backdrop of some of the insights offered by historians of geology. For example, the idea of Werner's 'neptunist theory of Earth history' (67) or 'neptunist geognosy' (288) might have come under a little more scrutiny. It is indisputable that Werner was in some sense a 'neptunist,' as was Goethe, but so was just about everyone studying rock formations in the 1780s, including the so called vulcanists, such as his student Voigt. Most rocks were thought to be of some aqueous or fluid origin; the dispute about neptunism involved the classification of only a few kinds of rock. Practically everyone in the late eighteenth-century who thought about it was a neptunist when it came to most of the rocks that make up the Earth's crust. It is not always a helpful label. For example, in Italy Goethe observed the now famous 'Serapis Temple' of Pozzuoli and offered a creative interpretation of how very local phenomena might explain the puzzling boreholes in the three columns still standing to this day. Von Engelhardt says this was a case of Goethe seeking 'to rescue his neptunist conviction' (152) of a gradually receding ocean. Rescue it from what? This looks like reading history backwards from Lyell, since the very idea of local fluctuations of the Earth's crust was not on the table in the 1780s. Along related lines, this book downplays a little too much the significance of Goethe's involvement with mining. It is true that most of Goethe's texts do not specifically address problems of finding ore and getting it out of the ground, but almost all of the geognostic community had some sort of connection to the Freiberg Mining Academy. It is unlikely that mining was insignificant for the ways in which many of Goethe's correspondents and friends thought about the Earth.

Von Engelhardt observes that by the standards of our science practically all of Goethe's insights have been eclipsed, and that we do better to judge Goethe by the 'intentions' of his studies rather than their 'results.' (2-3) True enough, though arguably the same could be said of most geologists of Goethe's era. It would be worth knowing more about how science was changing in his lifetime, not just in terms of the major conceptual innovations and discoveries, but how its social structure was changing. The book under review claims Goethe put himself on a geological 'special path' (*Sonderweg*) (300) in 1820 when he claimed the neptunist origin of basalt was an irreducible 'Urphenomenon' (the only time, in fact, that Goethe applied this word to the mineral kingdom). To this one could add that Goethe was increasingly becoming an outsider because he lacked the formal credentials and institutional recognition that were already becoming the hallmark of the German-speaking scientific community, but that is a story for a social history of geology, a different kind of history than the one under review.

Here we have a richly textured portrait of Goethe engaging with the Earth as geognost, traveller, and above all poet and philosopher. This book is a splendid capstone on von Engelhardt's long and profound study of Goethe's geological writings, and it also brims with insights into Goethe's life and literature. Above all, this is a book that is written for readers who love Goethe. Almost every page is graced with Goethe quotations and we readers are the beneficiaries. Von Engelhardt has allowed us to hear some of the beauty of Goethe's conversation with the Earth.

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THE WEB OF SCIENCE: THE SCIENTIFIC CORRESPONDENCE OF THE REV. W.B. CLARKE, AUSTRALIA'S PIONEER GEOLOGIST. *Selected, Edited and footnoted by Ann Moyal, with technical assistance by Angus Rea, editorial assistance by Diane Carlyle, documentary and editorial assistance by Stephen Martin, 2003. Australian Scholarly publishing, Melbourne, 2 volumes, 1340p. Hardcover, A$200.*

This massive undertaking, although officially begun in 1993, had its origin some years earlier when Dr Moyal turned her attention to the life and work of the Reverend William Branwhite Clarke (1798–1878), long known in the geological confraternity as 'The Father of Australian Geology'. This title was challenged in more recent times by scholars, such as T.G. Vallance, who maintained that Clarke too slavishly adhered to European concepts and was always concerned to fit his evidence to the European (largely

British) stratigraphical story, rather than considering that the Australian geological story might be different, as the German–born, French-trained Ludwig Leichhardt suggested.

Furthermore, Clarke carried out his geological mapping essentially alone, so in that sense he had no 'geological children'. This volume serves to answer, in part, this criticism, in that it shows Clarke's contacts, albeit at a distance, with numerous younger geologists who worked in various parts of Australasia in the years following Clarke's arrival in the colony of New South Wales in 1839. It also shows that Clarke's influence spread far beyond the subject of geology, and one might in fact suggest that this wide coverage was a more important aspect of Clarke's work in Australia, than his geological work, significant though that was.

A graduate of Cambridge, who had been enthused by the lectures of E.D. Clarke and Adam Sedgwick, Clarke was soon an active geologist in England, while following his avocation as a priest of the Anglican Church. It was probably a combination of health and financial matters which caused him to migrate to Australia, and, while his health improved there, from his arrival day, when he was too ill to leave the ship, to his death at 80, he gained little in the way of monetary wealth. The story of Clarke's life in Australia is well covered by Ann Moyal's 65-page biographical introduction, including footnotes, which lead to other sources. This part of the book has a useful map of relevant localities in New South Wales and portraits of some of the main 'protagonists'. Then follows a selection of 895 letters in date sequence, set in two periods (1836 – 1863, and 1864 – 1878) in the two separate volumes. While the selection consists dominantly of letters to Clarke, Dr. Moyal has been fortunate in obtaining copies of many of Clarke's letters which elicited the replies, so some balance is achieved. Clarke also did keep drafts of some of his own letters.

While interest in this publication will be greatest among Australian historians of science, it has much to offer Northern hemisphere historians, not only informing them of the lively antipodean scientific community, but also of the strong two-way communications which existed between the widely separate groups, and which, in my opinion, has been too strongly labelled by various scholars as a largely one-way contribution of lesser lights on the periphery to the 'great Men' at the centre.

The correspondents include Adam Sedgwick, Roderick Murchison, Andrew Ramsay, J Beete Jukes, Charles Moore, James D. Dana, Jules Marcou, Samuel Stutchbury, Phillip Parker King, Louis Agassiz, Fredric Odernheimer, Vicomte D'Archiac, Achille Delesse, J.W. Salter, W.S. Jevons, Sir George Bowen, Thomas Rupert Jones, Georg von Neumayer, Jules Garnier, Laurent G. de Koninck, William Lonsdale, Thomas Oldham, Alfred Selwyn, Archibald Geikie, W. Boyd Dawkins, Ottakar Feistmantel, Robert Etheridge Jnr, Richard Owen, W.T. Blanford. This is an impressive list in anyone's understanding of influential international geologists. In some ways perhaps the most important are the contacts Clarke, in his later years, maintained with the continental geologists, an area of historical studies which, until now, has been largely neglected by Australian historians of geology.

Although Clarke strongly supported the German Ludwig Leichhardt the latter can hardly be said to have been a protégé of Clarke's, as Dr. Moyal suggests. Leichhardt, was always, I suggest, his own man, and his idea that the geology of Australia was distinctly different from that of Europe, was definitely not in accord with Clarke's thinking.

There are some interesting patterns of thought expressed by Clarke in his letters to Sedgwick and Murchison, particularly respecting the age of the rocks of the 'Sydney Basin'. In 1840 Clarke is convinced they are probably oolitic or Jurassic, although he even tentatively suggests that a Tertiary age is possible. At this time he extends his oolitic story to include even the fossiliferous rocks of the Yass and Wellington regions. It is a very different story by the 1850s. By then he had had the benefit of some good palaeontological work from some of his European colleagues. It is a little disappointing that exigencies of space have precluded the inclusion of several stratigraphic tables written by Clarke in this early period, as they might, indeed, clarify for the reader what he was thinking about the stratigraphic order as he saw it at the different times.

While, as we might expect, the bulk of the correspondence deals with geological matters, there is a wide range of topics, including, particularly botany and meteorology, the latter being a favourite topic of Clarke, and politics is not neglected. These letters will interest a range of historians of science.

Clarke's handwriting is not always the clearest, and one has the impression that the author and her assistants have, in the course of their progress through the letters, improved the accuracy of the transcriptions, and have recognised personal names more accurately than in the earliest stages of the research. However, as Moyal claims, the handwriting of Phillip Parker King, an important colleague and friend of Clarke proved even more enigmatic than did Clarke's, a matter with which I can't agree!

One disappointing aspect of the work is the omission of the numerous sketches, which accompany a great many of the letters. These would have helped to clarify many of the points Clarke is making. Clarke, like all good geologists, realised the importance of the visual in geology, and how a cross-section, for instance, could say more than a few hundred words, a map or short columnar section could explain weeks of fieldwork. In this respect Dr. Moyal and her co-workers have probably suffered by their lack of expertise in geology, compared with their other historical and other editorial skills.

Despite these criticisms this work has much to recommend it. The letters themselves give a fascinating panorama of the colonial life of middle and upper class, rich and not so rich, but the richness of material on many aspects of scientific and technological development lifts this work to another level. It will provide an invaluable mine for years to come for historians of science, both Australian and beyond, hopefully drawing the researcher to go back to the original source, which is the collection of letters held in the State Library of New South Wales. The bibliography of Clarke's manuscripts and published works, based in part on extensive work by Michael Organ, and the reasonably extensive bibliography of later publications of researchers should prove particularly useful for interested overseas scholars. The title *The Web of Science*, I feel, is particularly well chosen; the colonial, and indeed, international geological science of the nineteenth century was indeed a web. The connecting strands are important, but it is also important that one not get too enmeshed! Despite my criticisms and advice to go back to the specific original source material of interest, the only deterrent for the individual scholar is the price (A$200), which is likely to restrict the work to libraries. Hopefully scholars will urge their libraries to get a copy. It will be money well spent.

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INTERESTING PUBLICATIONS

Gerald M. Friedman, CONTRIBUTING 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 Professor Gerald M. Friedman, Northeastern Science Foundation, Rensselaer Center of Applied Geology, P.O. Box 746, Troy, NY 12181-0746, U.S.A.; Fax: 518-273-3249; E-mail: gmfriedman@juno.com

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Annette Vogt studied mathematics at the University in Leipzig, made the Diplom and received her Ph.D. (Dr. rer. nat.) in history of sciences, both at Leipzig. Since 1975 she has been a historian of mathematics and science, first at an Institute of the Academy of Science of the GDR in Berlin (1975–1991), and then in a Forschungsschwerpunkt (Center for History of Science, 1992–1994) in Berlin. Since 1994 she has been a research scholar at the Max Planck Institute for History of Science in Berlin. Her research interests include: mathematics in Germany in the nineteenth and twentieth centuries, scientific relationships between Russia/Soviet-Union and Germany, the history of Jewish scientists, and the com-parative history of women scientists in the nineteenth and twentieth centuries.

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