BOOK REVIEWS

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ESSAIS SUR L'HISTOIRE DE LA GÉOLOGIE/ EN HOMMAGE À EUGÈNE WEGMANN (1896–1982). *F. Ellenberger and J. Gaudant, for the Comité français d'Histoire de la Géologie (COFRHIGÉO), editors. 1995. Mëmoires de la Société géologique de France (Nouvelle Série No 168), Paris: 152 p., soft cover, 250FF.*

Twenty-two essays on the history of geology by 19 authors—the first issue of a continuing series made possible by a bequest of Eugène Wegmann—are fittingly dedicated *En hommage* to this Alpine peak among geologists; a naturalist whose enthusiasm for the history and epistemology of geology was an integral part of his long career in science. The first four essays are the *hommage* beginning with François Ellenberger's Introduction followed by a candid personal and scientific biographical essay of Wegmann by J.P. Schaer, his student and successor at Neuchâtel, and an article by Wegmann written in his capacity as Editor of the *Geologische Rundschau.* This *Prèmiere partie* concludes with Gabriel Gohau's essay placing Wegmann whose geological *style* (a term he often used) reflected his collaboration with J.J. Sederholm, squarely in the context of the Wernerian-Huttonian heritage.

Essays 5–22 (*Deuxième partie: Essais sur l'histoire de la géologie*) are selected from papers presented at the regular sessions of COFRHIGÉO and previously circulated among its associates only in draft. There are exceptions, the *Postface*—No. 22—is one of two of Wegmann's cartoons dated 1930, "*pour le bureau d'un géologue.*" The other with a third dated 1965, is reprinted in Schaer's essay (pp. 19, 17). They are wonderful specimens of Wegmann's wit and artistry with an underlying epistemological theme. He was after all, the protégé and later the successor of Emile Argand, one of whose field crayons—*Le Cervin*—is reproduced in full color on p. 114.

The history of geology community will recognize familiar names among the contributors, among them Jacques Roger assessing the role of Buffon in the history of the earth sciences, and Martin Rudwick writing of the international community about the Geological Societies of London and Paris in 1835. Scientists of the distinction of Jean Wyart and Eugène Raguin appear here as the witnesses to the histories they made as well as experienced; Wyart writing of the explosion of crystallography at the Sorbonne between the two great wars, Raguin describing the young Wegmann's applying the full force of three-dimensional Alpine tectonics to Sederholm's transformist petrologic-geologic analysis of the great Pre-Cambrian basement peneplains. "It is not exaggerating to say that this way of seeing made a scandal among the petrographic specialists, polarized on the differentiation of magmas (p. 115)." Such papers serve as a guide to the main currents of thought of the century and a salutary reminder that geology did not begin as a science in the 1960's with the introduction of plate tectonics. With Théodore Monod's recollections of his work in the Sahara, Philippe Grandchamp's analysis of the notebooks of Charles-Marie-Joseph Despine (1792–1859), the epistemological essay by Bernard Guy growing out his study of the skarns of Costabonne, Gérard Bignot's recovery of the 18th century "Coquillages Fossiles" of Jacques-Tranquillain Féret, and Ellenberger's essay *Johann Scheuchzer, Pionniere de la Tectonique Alpine,* much of this volume must be considered as very close to primary source material. Ellenberger's profusely illustrated essay traces the intellectual sources of contemporary structural geology by a point to point comparison of Scheuchzer's graphical analyses with our contemporary graphical analyses of the same localities. Such papers can only be written by a geologist with intimate experience of Alpine geology.

They do not by any means complete the collection. Regrettably the pressure of space and time precludes more than a mention of the wealth of resources contained in this important addition to the literature of the history of geology. Geneviève Bouillet continues her search of ancient texts treating geological phenomena. Bernard Gèze has uncovered a major source of public ideas of geology in the works of Jules Verne. The geologist and explorer of the Sahara, Conrad Kilian (1898–1950) is the subject of a biographical study by Maurice Lelubre, and Gabriel Gohau has written a study of Constant Prevost (1787–1856). Jan Houghton Brunn writes of the instructional importance of the history of science in the penultimate item.

Figure 1 of Jean Gaudant's paper on the reception of continental drift in France and the Swiss Romande, displays the well known map of the conjunction of the Atlantic continents by Bullard's group in 1965, side by side with the map of the same conjunction also figured from the bathymetric data and published 30 years earlier by Boris Choubert (*Rev. Géogr. phys. Géol. Dyn. 8,* 5–50, 1935)—a publication, Gaudant writes, not acknowledged by Bullard. Here too is an account by Michel Durand-Delga of *l'Affaire Depart/Plaidoyer pour la Réhabilitation d'un Géologue proscrit*—a case

of an accusation of fraud prosecuted with subsequent ostracism by the geological establishment of France, of a brilliant young geologist, Jacques Deprat, in the years 1917–1921. I had by chance just finished reading an account of the Russian geologist Georgiy Frederiks, shot in 1938 on charges of "willfully misinterpreting' geological relationships." (J.A. Talent, N.W. Archbold and V.Z. Machlin, *Earth Sci. Hist., 14,* 2, 1995)—a disturbing juxtaposition. A fine if all too brief essay by Goulven Laurent refers to the Vatican censure of Teilhard de Chardin who in 1926 was forced to leave his geologic position at the *Institute catholique de Paris* and exiled from France. Laurent concentrates on the paleontology and evolutionism of Teilhard de Chardin's early career—the background of science from which he drew a total system of thought. This 20th Century *reprise* gives us pause. Is the history of the earth and man, then inherently in conflict with the established order, professional, political and religious?

It is a demonstration of the serendipity of association that scholarship of this quality and quantity should have been generated so soon after the organization of the *Comité français*; inspired according to Ellenberger's Introduction by the model of the American Committee (USHIGEO) which was itself set up in order to enable American participation in the International Committee (INHIGEO) set up by the International Union of Geological Sciences.

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THE ORIGIN OF THE SOLAR SYSTEM: SOVIET RESEARCH, 1925–1991. *Alexsey E. Levin and Stephen G. Brush, editors. 1995. American Institute Of Physics, New York. 415 p. Hardcover, $60.00.*

The origin of the solar system has been an important problem for planetary science throughout this century. In attempting to describe in detail how the interlocking complexity of the system as we know it today evolved from its origins, cosmogonists must synthesize a bewildering array of evidence from numerous fields, evidence that has grown and changed dramatically and dynamically during the past several decades. Not only have new earth-based instruments and space probes explored and studied the solar system, but also knowledge and theories about the earth itself have changed considerably. Not surprisingly, the two major poles of this effort, particularly during the space age, were the United States and the Soviet Union. Surprisingly, however, there seems to have been little interaction between the U.S. and Soviet scientists until the 1970s. Certainly the few major U.S. workers in this field during the 1940s and 1950s read some of the publications in Russian, and had some limited direct contacts with their scientific counterparts. During the 1960s as both nations began to explore the solar system directly, there were a few joint meetings and limited exchanges. From the 1970s onward, as the pace and sophistication of solar system exploration increased, U.S. and Soviet scientists took increasing notice of each others' work. At times with, and at times despite the diplomatic and political strictures of their respective governments, planetary scientists on either side of the "iron curtain" exchanged data, coordinated missions, and collaborated. This book, jointly edited by a Russian and a U.S. specialist in the history of cosmogony, reprints English translations of seminal Russian publications concerning the origin of the solar system from the 1920s through the Soviet period, along with introductory essays that set Soviet research in this field in a broad international historical context.

Two introductory historical essays set the context for the selections. Levin discusses "The Otto Schmidt School and the Development of Planetary Cosmogony in the USSR," showing how this field fit within the evolving economy of Russian and Soviet science. Schmidt (1891–1953) came to cosmogony in a sustained way only late in his career (1940s), after a variety of managerial and scientific duties in post-revolutionary Russia. In 1937, he established the Soviet Academy of Sciences' Institute of Theoretical Geophysics and served as its director for ten years. Schmidt himself weathered the stormy political and intellectual environment of Soviet science after the war with limited success, but he left a considerable institutional and intellectual scientific legacy. His students, particularly Victor Sergeyevich Safronov, carried on his program and made Soviet research in cosmogony an active and fruitful scientific endeavor. Brush presents "Planetary Cosmogony in the West and Safronov's Theory," noting especially how the Soviet research influenced Western work in the last several decades. These two essays provide an excellent introduction to the major theories of solar system formation and their numerous variants. Twelve of Schmidt's publications from the second section of the book, and succeeding sections present translations of publications from the 1950s through 1991 under topical headings: The Protoplanetary Cloud: General Theories of Planetary Formation; Rotation of Planets; Formation of the Earth and Other Terrestrial Planets; Origin of the Moon and Other Planetary Satellites; Formation of the Giant Planets; Asteroids, Comets, and Meteorites; Other Planetary Systems. A bibliography of Soviet publications (16 tightly spaced pages) presents a core set of literature on the subject.

The book's tight focus on cosmogony works to advantage. There were many other developments during the period concerning the characteristics and evolution of planetary bodies that bore only slightly on the question of solar system origin and evolution. Treatment of these other issues would have been inappropriately confusing and distracting. With the two excellent his-

torical essays as a reliable guide, and the judicious selection of translated literature providing seminal texts, this book should be valuable to anyone interested in Russian and Soviet earth and planetary sciences. It is especially valuable in that many of the reprinted selections appeared originally in numerous publications difficult to find in U.S. libraries, some are here translated for the first time, and even some hitherto unpublished notes are included.

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HORACE-BENEDICT DE SAUSSURE: FORERUNNER IN GLACIOLOGY. *Albert V. Carozzi and John K. Newman. 1995. Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, Tome 48. 148p. Price not given.*

In comparison to many of the giant figures in early natural science, Horace-Benedict de Saussure (1740–1799) is relatively unknown except amongst a small group of scientific and climbing cognoscenti. His was, of course, the first ascent of Mont Blanc in August 1787, and to him we owe the usage of the terms 'glacier', 'seracs' and 'moraines', and, a good deal of understanding of glaciers. His published writings on the Alps: "*Voyages dans les Alpes*" (four volumes in 1779, 1786, 1796, 1796) however, were subsequently mined by such luminaries as James Hutton (the first two volumes) and John Playfair (who always referred to it as "*Voyage aux Alpes*" [sic]) and for their descriptive insight on Alps relevant to a developing science of the earth. In this volume, it is a great pleasure to have gathered together a collection of relevant manuscripts primarily by de Saussure and related to his epic explorations of the Alps in the second half of the eighteenth century.

There is a wealth of wonderful detail and insightful description, lovingly transcribed, translated, interpreted and annotated. The volume should most certainly be required reading for all graduate students in glacial geology—as a reminder of the very early development (relative to most people's perspectives) of detailed precise description, careful interpretation and methodical fieldwork using repetitive visits in different seasons to try and isolate causative mechanisms (for example, his trip to the *Mer de Glace* in March of 1764 to compare the meltwater outflow with that in full summer). Finally, I should not fail to mention Saussure's powerful theoretical outline developed as early as the summer of 1764, after initial field forays, and which subsequently drove the course of his studies. Saussure was active in the field from 1760 to 1792, and this volume contains the great bulk of those sections of his fieldbooks relevant to his developing understanding of glaciers, and manuscripts he developed based on these findings, including the Oration on Glacières (1764)—the early summary of his understanding. Helpfully we are given a newly discovered manuscript letter by William Windham to Arlaud in 1741 (found in the Saussure library in Geneva), and a review of Martel's subsequent expedition (1744) that set out to augment Windham's account with instrumental measurements.

Even judged against modern understanding, Saussure's work and developing insight are remarkable, and he was judged by his peers as extraordinarily industrious, insightful and unduly modest. He forbore to publish his accumulating work for over fifteen years, in part because he was unable to read the preceding—and in fact unremarkable—work (in German) of Gruner (1760) until he learned the language around 1770 (at about which time a mediocre French translation also appeared), in part because he sought perfection in his understanding of glaciers, and in part because of competing interests he had in rock type and structure, and in alpine botany.

Eventually, he published the first volume of his *Voyages* in 1779 in which was included a masterly thirty-page summary of his general findings on glaciers, and his reputation was made. Although he continued to record substantial notes on glaciers for more than the next decade (and the essence of these observations is supplied in this book), his primary concern turned in these later years to the geological structure of the Alps.

The book proceeds essentially in a chronological manner, presenting in the original and in translation the primary documents such as the new Windham letter and the Oration on Glacières, and in summary the essential field notebooks. Summary assessments of Saussure's progress and thinking are provided at natural breakpoints, together with comments on other relevant issues, such as his relations with Gruner and Haller, and the delay in the publication of his primary, and eventually long-awaited results. There is a healthy number and variety of illustrations, including (de rigeur!) pages from Saussure's notebooks, contemporary illustrations, and modern photographs. The book concludes with perspectives from later generations: Agassiz's in 1841, and ours at the end of the twentieth century. Agassiz's assessment was made entirely on the basis of the "*Voyages . . ..*", and thus he was not aware of the full magnitude and scale of Saussure's investigations as revealed by his fieldbooks, or the chronological development of his thinking. Nevertheless, he did recognize that they represented, even in his day "the most complete set of data available on glaciers" and was perhaps most puzzled by Saussure's failure to interpret correctly the origin of medial moraines.

Perhaps for our generation we should concentrate less on his specific insights (though in no way is this to deny their value), and more on the monumental methodological foundations he laid for field work in the earth sciences in general, the Alpes in particular. In popular potted accounts of the history of the earth sciences, the eighteenth century is all too often labelled as a century of wild speculation and high-flying

theory—certainly in the English language literature this has been true. With this thorough account before us, we shall have good reason to recognize that this was not in fact the case. I think it is fair to say that a comprehensive study of how, and by what routes, eighteen-century investigators laid the foundations of field work in the formative years of the early nineteenth century, still remains to be made.

To conclude, I welcome this volume and recommend it without hesitation. Readers should be warned that it does not flow in quite the same manner as a normal academic treatise, and this is because in large part the authors have chosen to let Saussure speak for himself, and to restrict editorial comments and interspersions to a minimum. Although this is initially a little disconcerting, and at times one might wish for more in the way contextual discussion, if one has to choose I do believe that Horace-Benedict de Saussure speaks well for himself and no author could wish reasonably to do more. I, for one, would use a time machine to spend a summer with Saussure in the eighteenth-century Alps.

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GRAND CANYON, A CENTURY OF CHANGE: REPHOTOGRAPHY OF THE 1889–1890 STANTON EXPEDITION. *Robert H. Webb. 1996. The University of Arizona Press, Tucson, 290 p. Hardcover $60.00 Softcover, $26.95.*

Robert H. Webb, a hydrologist with the U.S. Geological Survey, enrolled the help of six contributing co-authors to tell the tale of Robert Brewster Stanton who between 1889 and 1890 photographed the Grand Canyon at sites one or two miles apart. Brewster's pictures served as documentation for the purpose of planning a water-level railroad route through the canyons of the Colorado River. Webb and his team visited the same identical sites which Stanton had photographed one hundred years earlier and replicated 445 of Stanton's views. Webb examined 2,200 negatives of Stanton's collection and later learned that these were only a small sampling taken during the Stanton expeditions.

Stanton's first trip started in January 1890 and Webb launched his trip in January 1990, to commemorate the centennial of the original voyage. Webb's crews consisted of a photographer, a note taker, river guides, and scientists. This group used "a combination of memory, guessing, and luck to find the old photo positions".

The Colorado River in Grand Canyon had been visited only rarely before 1890. Stanton's supporters felt that a railroad could be built through the canyons—and still be profitable. Stanton was a civil and mining engineer and worked on railroad construction. The year before his first Grand Canyon trip Stanton became a consulting engineer.

Tragedy overtook some of the initial attempts of the nineteenth-century Grand Canyon Survey. The boats were not first-rate and disaster struck. They lost boats, the men became mutinous, and two of the leaders drowned. On a second preliminary trip two other field-trip participants lost their lives.

The excitement of this book is in its repeat photography. As an example, at the head of the 164 Mile Rapid Stanton exposed the negative at 9:00 am on February 20, 1890. Photographer Ralph Hopkins for the Webb expedition made the repeat view on February 20, 1990 at 10:51 am. The camera for the repeat view is in exactly the same spot as the original camera one hundred years earlier. In both views one spots the same formation contacts, bedding planes, scarp slope, river course, and boulder-gravel beds. The boulder-gravel beds have grown slightly, but the rest of the scenery is identical. For a geologist these views are elating. Page after page of repeat views make study of this book an adventure.

The book deals with topics titled floods and dams, streams of mud and rock, water running over boulders, and sand bars. Of historical and geological interest are the debris flows which flash floods generate from the side canyons into the Colorado River. They occur infrequently: the average time between flows seems to be twenty to fifty years. The photographs in this volume, which compare the same sites one hundred years apart, document debris-flow frequency.

The chapter (Chapter 7) "Streams of Mud and Rock" starts out as follows: "Robert Brewster Stanton watched helplessly as three members of his expedition drowned; even that experience did not prepare him for what happened on the morning of July 18." He then described the fury of a debris flow: "the whole sides of the canyon seemed to be moving down upon us with a roar and awful rumbling noise; and as the larger rocks plunged ahead of the streams, they crashed against other rocks, breaking into pieces; and the fragments flew into the air in every direction, hundreds of feet above our heads; . . . it seemed as if we were to be buried in an avalanche of rock and mud." He and his group survived to describe the process of debris flows.

The program of repeat photography of the Grand Canyon lasted three years and four river trips, or a total of a hundred days on the river. As the author states, "This program was decidedly a low-tech, low-budget project with high-knowledge payoffs". I agree and will use some of the material in my academic courses and put the book with its abundance of pictures on my coffee table for friends, family, and colleagues to view. They will enjoy it.

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PUBLIC CULTURE IN THE EARLY REPUBLIC. PEALE'S MUSEUM AND ITS AUDIENCE. *Daniel R. Brigham. 1995. Smithsonian Institution Press, Washington D.C. and London. 218 pp. $39.00*

To the understanding of the origins and development of museums in North America, the story of Peale's Museum is fundamental. It began as a picture gallery in Annapolis, Maryland, in which Charles Willson Peale's own works were exclusively featured, continued thus for the first two years after his removal to Philadelphia in 1784. However, his ideas were expanding and, by 1786, it had become a "Repository for Natural Curiosities." As the author of this excellent work explains (p. 1):

> . . . Peale aspired to exhibit within his museum "a world in miniature," a display that embodied the full range of natural and artificial productions from around the globe. But his museum was more than a static repository of natural history specimens and artifacts. It was a dynamic social site through which Peale helped to define the terms of participation in early national cultural institutions, while his varied audiences wrought to shape the museum to meet their distinctive needs. More specifically, Peale set a standard for the extent to which cultural institutions were accessible to people of different social rank, gender, race, political affiliation, and religion. . . . In promoting the museum to his potential audience, Peale defined it broadly as a public benefit, but he also targeted specific audiences by concentrating on the economic, social, scientific, moral, and religious implications of his exhibitions. In turn, his audience members used the museum to identify with particular social groups, to promote their intellectual accomplishments, to market their products, and to establish the boundaries of their community. In these ways, the world in miniature that Peale fashioned was representative of broad cultural patterns in early national America.

Originally functioning essentially as a family-run business, the collections were at first housed in an outbuilding to Peale's house (p. 13). With growing success came growing pretensions: Peale was coming to view his Museum as an institution for learning. The collections, and with them his family, were moved in 1794 into Philadelphia's Philosophical Hall (p. 15); since this was the home of the 50-year-old American Philosophical Society, it implied an endorsation of the Museum by the cultural élite of the early Republic. The next and final move marked a further enhancement of status. With the relocation of the collections to the Pennsylvania State House (known today as Independence Hall) in 1802 (p. 16), the Museum became a direct expression of national character and pride.

Throughout this time, Charles was given aid and support by the numerous children of his three marriages, over whom he seemed to have reigned as a benevolent despot. Three of his sons, Rubens, Rembrandt and Titian Ramsay Peale II—an earlier son of that name had died young—were artists, contributing portraits and other works to the displays; Rubens and Rembrandt shared an interest in minerals, of which Rubens contributed many specimens to the Museum (p. 114). Titian Peale was a naturalist and aided his father in the excavation of the mastodon skeleton which was to become the Museum's most memorable exhibit, an episode of which brother Rembrandt wrote the official account in 1803. Raphaelle Peale helped to cut the silhouettes which were sold to visitors, while youngest sons Franklin and Charles Linnaeus Peale also worked in the Museum, Franklin becoming its manager after his father's death. Daughters Elizabeth, Sybilla and Sophonisba no doubt helped also, though more concerned with domestic tasks. All in all, the Museum was very much a family enterprise, throughout its successive manifestations.

There were many innovations that presaged the functioning of later museums—evening opening, so that persons working in the daytime could visit the Museum; annual subscriptions permitting unlimited access; special invitations to, and lectures for, women visitors; the presentation of free tickets, to lure distinguished visitors to the museum; vigorous advertisement; the designing of better showcases; the integration of wall paintings with artifacts; and a plethora of publications, from leaflets to formal scientific papers. As noted above, Charles Willson Peale proclaimed his intention that the Museum should be accessible to persons of all social ranks, provided only that they behave properly (p. 7). Author Brigham notes some limitations to this openness (p. 8) and points out that visitors from the lower social classes were few. For this, there was an additional cause which he does not mention; in Peale's time, many men and women worked from dawn to dusk on at least six days out of the seven, quite simply not having the leisure to visit even an "educational establishment" like the Museum.

Geologist readers will be especially interested to note that it was Benjamin Franklin himself who made the first donations of mineral specimens to the Museum—in 1788 of specimens from Derbyshire, England, and in 1791, of specimens from Scotland (p. 107–108). Other early donations included Daniel Buckley's ample gift of metal ores (p. 109) and Talbot Hamilton's, of minerals used in the manufacture of art supplies (p. 112–113). Benjamin Silliman Sr. was another contributor, as were a number of physicians (p. 116). The donations of Adam Seybert were an attempt to promote geological mapping, stressing the geographic and geological sources of the specimens and the uses to which they might be put (p. 118). Immigrant French geologist Sylvain Godon–by now, a forgotten figure, even though he had made pioneer investigations in New England–presented classes on mineralogy at the Museum (p. 119), while several Philadelphia schoolteachers made direct or indirect use of the Museum's displays in their classes (p. 119–120). The influence of Peale's Museum upon the history of earth sciences in the United States was considerable indeed.

Already, in Sellers's *Mr. Peale's Museum* (1980), scientific historians had available to them a good account of its collections, while the work in natural history of Titian Ramsay Peale II through his journals of the Wilkes expedition has been admirably recounted by Poesch (1961). Berta Brigg's biography of Charles Willson Peale (1952), though written for a younger audience, also has value, while the three-volume collection of his letters and papers (Miller, Hart and Appel, 1983–1991; 3 volumes) forms a major lode for mining by historians. This new work supplements and extends the earlier ones, concentrating as it does on the Museum's social status and outreach. It is recommended to all historians interested in the relevance of science to culture in North America.

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HISTORICAL PERSPECTIVE OF EARLY TWENTIETH CENTURY CARBONIFEROUS PALEOBOTANY IN NORTH AMERICA. *Paul C. Lyons, Elsie Darrah Morey, and Robert H. Wagner, eds. 1995. Geological Society of America Memoir 185, Geological Society of America, Boulder, CO. Hardcover, 404 p. $105.00.*

The clue to understanding this compilation is a subtitle and in the first sentence of the Foreword where it referred to as the "... Darrah Memorial Volume." William Culp Darrah (1909–1989) is best known to historians of geology as the author of *Powell of the Colorado,* which was one of sparks toward increasing interest in history of science. It was not, however, Darrah's main preoccupation, for his training and much of his scientific career were in Paleozoic paleobotany.

The 29 chapters are organized into five sections. Not unexpectedly, the first four chapters are devoted mainly to Darrah. They effectively cover his life, which included forays into other fields beside paleobotany, his 1935 experiences in Europe, correspondence—perhaps the single most interesting section in the book—and a summary of the principal collections of Paleozoic plant fossils in America, to better exavuate his contribution to the collections of Harvard University. Darrah had some professional difficulties during this time and his daughter puts them in proper perspective. The second World War and health problems also inhibited his paleontological work, yet despite all, he accomplished enough to be worthy of a volume dedicated to his memory.

The Heerlen (Netherlands) conferences, which first began in 1927, concerned with correlation among the coal-bearing Carboniferous basins, evolved into the Carboniferous Congresses on stratigraphy and paleontology, to which the Permian has recently been added. Although these meetings were outside the mainstream of the International Geological Congresses, in some ways their emphasis on stratigraphy and correlation served as a model for the International Geological Correlation Program. Not all paleobotanists agree on all correlations within the Carboniferous, but this group was far ahead of all other geologists in the subject of intercontinental investigations and nomenclature.

Darrah went to the second Heerlen (Netherlands) conference in 1935 at a time when travel to Europe was by water. A patron, not a grant, made his trip possible. It was an era when one exerted effort to squeeze the maximum out a trip by examining collections and studying outcrops, for no one could foresee the jetset conference-going of the last quarter century.

The Heerlen experience leads to the second part, summaries of the life and career of five European paleobotanists. Four of the five interacted with Darrah either at the Heerlen Conference or at the 1933 International Geological Congress in Washington. For that gathering, David White, the grand old man of American Carboniferous plant studies, gave Darrah an interesting assignment: he was to assist two European delegates in visiting outcrops and collecting, but who had strongly opposing views on correlations; Darrah was able to pull it off and satisfy both men. These chapters also provide a little insight into the immediate post-War community in Europe during the late 1940s.

Twelve chapters, each portraying a paleobotanist in North America, constitute the backbone of this compilation. All are well written sketches of careers, and while emphasis is on Paleozoic contributions, other work is not neglected. The scientific work stretches from the first decade of this century into the lives of two workers who are in their 80s but still going. By no means did Darrah interact with them all, yet many of them influenced his life.

Three amateur collectors who contributed mightily to Paleozoic paleobotany are highlighted. These are precisely the kind of persons basic to science who seldom receive credit deserved for their contributions. Coal ball studies, calcareous concretions which occur in some coal seams and preserve plant material undeformed, would not have advanced so rapidly were it not for F. O. Thompson. The Mazon Creek flora owes a great deal to the one-armed George Langford Sr. J. E. James did not contribute as much as these other two, but he was a significant collector and he was important to coal mining safety and deserves to be remembered.

The final section consists of five papers devoted to topical studies rather than personalities. They provide a firm starting point for those who in the future might wish to review the field of Paleozoic paleobotany during the last half of the 20th century. Many of the names written up earlier appear time after time in these compilations.

I met Bill Darrah only twice, once at a lunch at the Cosmos Club and once at a conference on the late Paleozoic rocks of West Virginia, a non-marine se-

quence that continues to raise arguments among the very few who study it. We exchanged some letters about the early history of the U.S.Geological Survey and he was always helpful. That hardly seems appropriate credentials for a marine invertebrate paleontologist to discuss the efforts of paleobotanists. My excuse is that I am mentioned several places in the book, in part because by accident a colleague and I wrote what is supposed to be a classic paper on coal balls. Later, in travelling with this paleobotanist, whose picture appears four times in the book, I met some of the persons mentioned and intereacted with others at three Carboniferous congresses.

In connection with pictures, it is worthwhile to point out that everyone described is illustrated. Indeed, even those who wrote the articles are pictured on the opening pages. This is a very nice touch for what is basically a study of biographies.

In a broader context, this book is the study of a scientific community. Before the 1960s there were so few persons engaged in Paleozoic paleobotany that in North America, at least, everyone knew everyone else and, for better or worse, everyone had his own agenda to pursue. The sociologists concerned with intergroup dynamics could have a field day expanding on the foundation laid here.

If one wants to know the accomplishments and personalities of a very small group of dedicated paleontologists, off the main stream of the profession—whatever that may be—they should read this book. For the geologist not interested in fossils, it is an interesting insight into stratigraphy concerned with nonmarine rocks. For those interested in coal this is again a worthwhile investment.

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THE CRYSTAL PALACE DINOSAURS. THE STORY OF THE WORLD'S FIRST PRE-HISTORIC SCULPTURES. *Steve McCarthy and Mick Gilbert. 1994. The Crystal Palace Foundation, London. 99 pp. £6.95. [Available from: The Crystal Palace Museum, Anerley Hill, London SE19 2BA, England.]*

The reviewing of some books arouses an almost equal mixture of admiration and exasperation. This work is a classic instance. It presents an assemblage of drawings and photographs (some historic, some contemporary) of what were the world's earliest attempts at full-scale reconstructions of extinct creatures. An array of contemporary accounts of the Crystal Palace's "antediluvian wonders" is presented, which provide a rich vein of information for mining by scientific historians.

Some of Richard Owen's concepts, as represented by Benjamin Waterhouse Hawkins, were wildly inaccurate (e.g. the three dinosaurs *Iguanodon, Megalosaurus* and *Hylaeosaurus* and the mammal-like reptile *Dicynodon*). From a retrospective view, it is ironic that the *Crystal Palace Herald* should have stated that the restorations were made "with a spirit and truth that is perfectly marvellous" (p. 26). In other cases, the inaccuracies are minor; for example, the *Ichthyosaurus's* dorsal fin, and the exact form of its caudal fin, are wrong, but they were features not discernible from the skeleton. In several instances, Owen's reconstructions show close accord with contemporary versions: the marine crocodile *Teleosaurus* and all the mammals. These accuracies and deficiencies are properly pointed out, with reference to the late discoveries that brought confirmation, or otherwise, of Owen's interpretations. The colour photographs are impressive and the discussion of the contemporary condition of the restorations is not only valuable, but should encourage visits to the displays in Sydenham.

All the above are positive features. The negative features all result from the fact that the two authors did not—or so it seems—allow their text to be properly scrutinized by someone expert in the history of vertebrate palaeontology. The consequence of this is a plethora of errors and the quotation of too many outdated opinions.

The authors have trouble throughout with the proper citation of generic and specific names. These are never italicized: the trivial names are improperly given initial capitals, whereas generic names quite often lack them. Scientific and popular names are repeatedly confused, as when (p. 9) it is stated that Cuvier named the first flying reptile Pterodactyl (correctly, *Pterodactylus*) or when the misspelling "ichthyiosaurus" (p. 27) passes unremarked. Other errors include the citation of Joseph Prestwich as "Prestwick" (p. 19)—confusion with the famous Scottish golf course?—and the naming of a great museum in Paris as the "Musee Nationale d'Histoire Naturel" (p. 95). The statement that labyrinthodonts "were almost exclusively amphibians" (p. 50) reads oddly: were there *non*-amphibian labyrinthodonts, then? From the authors' discussion of *Chirotherium* footprints (p. 51), it appears that they are unaware these have long since been demonstrated to be footprints of dinosaurs (as noted by both W. Soergel, 1925; and G. Tresise, 1989). Cuvier was much more than just "a prominent geologist" (p. 9): he was also a leading zoologist and comparative anatomist.

In the recounting of the history of study of fossil vertebrates, errors abound. The story of Mary Ann Mantell's discovery of a dinosaur tooth is uncritically repeated (p. 10); it is, in fact, apocryphal, supported neither by Gideeon Mantell's own writings nor by any other contemporary source. Mantell himself is extolled at length, whereas William Buckland, the true scientific discoverer of the dinosaurs (see Delair & Sarjeant, 1975 in *Isis,* v. 66) gains only the briefest and most cursory of mentions. The story of the cataclysmic death of the *Iguanodon* herd at Bernissart, Belgium,

has been shown by David Norman (1980) to be a total misreading of the available evidence.

Another error is more forgivable; it is only recently that Hugh Torrens (1992 in *New Scientist,* v. 134, p. 40–44) demonstrated that the naming of the Dinosauria occurred, not at the Plymouth meeting of the British Association in 1841, but early in the following year. When the British Post Office was in error by issuing commemorative stamps in the wrong year, McCarthy and Gilbert are scarcely to be blamed for repeating that mistake!

What, then, is my judgement on this book? Yes, the text contains too many inaccuracies and errors; if future editions are forthcoming, I hope these may be eliminated. However, it assembles much documentation not hitherto brought together and, in particular, features excellent (and, at times, witty) illustrations. (I liked especially the back cover, with its "tail-piece"!) The book is quite moderately priced; despite its deficiencies, it well merits purchasing by all persons interested in the history of the study of vertebrate fossils.

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THE DESTRUCTION OF SODOM, GOMORRAH AND JERICHO. GEOLOGICAL, CLIMATOLOGICAL, AND ARCHAEOLOGICAL BACKGROUND. *D. Neev and K. O. Emery. Oxford University Press,* 1995. *175 p. Hardcover, $35.00.*

In this relatively short book, two prominent earth scientists—David Neev of the Israel Geological Survey in Jerusalem, Israel and K. O. Emery of Woods Hole Oceanographic Institution in Massachusetts-join their experience and imagination to try to explain the destruction of Sodom and Gomorrah, and of Jericho, as described in the Old Testament and as suggested by archaeological evidence. The explanations they seek are based on the premise that they must be found in natural causes—local and regional climate change and earthquakes, and not in mystical or mythical origins. Their resulting book is (1) annoyingly speculative; (2) confused and confusing; (3) controversial; and in spite of these criticisms (4) a joy for me to behold.

(1) Speculations. When Neev and Emery invoke an earthquake as the cause for the destruction—around 4350 BP (2350 BCE)—of the twin cities of Sodom and Gomorrah (and the other "*cities of the plain*"), they are unable to show independent evidence that an earthquake actually happened at that time. In reality, no such independent evidence exists. The closest evidential information is the destruction uncovered in several other sites, especially along the Dead Sea fault system (that runs from the Red Sea in the south through the Dead Sea, Sea of Galilee into Lebanon, Syria, and Turkey): destruction that is dated roughly to the same time. Because accurate dating has not been done at these sites (and at present cannot be done), it is not possible to tell whether they all fell in a single M = 7.5 or 8 event from Elat to Tiberias, or whether these were distinct events separated by tens or even a couple of hundred years. Furthermore, some argue that the Sodom and Gomorrah story is only a story—either a fictional oral transmission from the 3rd millennium BCE that somehow made its way into the written Bible in the first half of the 1st millennium BCE, or else a holy script that must not be reinterpreted by man, or worse by scientists. Neev and Emery take the biblical description more or less at face value, and it's anyone's guess as to how accurate this is.

The situation with Jericho is only slightly better: whereas historian and biblical scholars have dated Joshua's conquest to around 1250 BCE, archaeologists tend to agree that Jericho was unoccupied, and in a state of total abandonment since its destruction around 1400 BCE by attackers and invaders, climatic change, or earthquake. Thus the story of Joshua at Jericho may also be pure fiction for scholars, or for orthodox believers a holy factual account, not to be challenged by geological and archaeological facts of hypotheses. Some (secular) biblical scholars have even suggested that Joshua is the combined character of several leaders, and the Jericho story of several battles waged by the Israelite tribes as they gradually invaded Canaan.

Finally, climate change. Although major regional or global climate changes can nowadays be identified and mapped, smaller and more local changes are difficult to identify, and their real magnitude is extremely difficult to determine. Neev and Emery, however, go as far as interchanging, at times, drought with climate change. But how can one tell that a local drought lasted long enough to cause regional abandonment? This is certainly not clarified in this book, and thus invoking these effects is pure speculation.

(2) Confusion. The organization of this book is confused and confusing. It is confused because the authors mix in most chapters, sections and even some paragraphs geological facts, climatological tidbits, archaeological evidence and biblical references. For example, do the authors want to use climate change evidence to explain archaeological findings or use archaeological finding to unravel climate change (e.g., Chapter 3)? I believe that the authors are confused here vis-a-vis what they want to test and prove, and as a result the reader cannot help being confused as well.

In Chapter 5 ("*Coordination of Biblical and Scientific Information*") and 6 ("*Sodom and Gomorrah event*") the authors attempt to put it all together—but the result is utter confusion for the reader. For example, who could possibly understand this sentence: "*Much knowledge of biblical events is from narratives of ancient oral tradition that justify analysis and respect because they may reflect genuine and unique historical information*" (Chapter 5, p. 121)? Or the meaning of "*The rejuvenated early Bronze III tectonic phase continued into the intermediate bronze*" (Chap-

ter 6, p. 144). What is a tectonic phase? And what is a rejuvenated tectonic phase? Do they mean earthquake frequency? maximum magnitude? faulting?

Perhaps in recognition of the confusion, in Chapter 7 "*The Synopsis*", the authors attempt to summarize everything, but instead all is left inconclusive: "*Although the general timetable of climatic and demographic changes sketched here may be correct, detailed biblical reports of some events are not always reliable . . . and there is* confusion *in dating some physical events like earthquakes, climatic changes, and resulting invasions and cultural breaks*" (Chapter 7, p. 150). Confusion indeed.

(3) Controversies. I can think of at least two controversies in this book. One is related to religion, the other to geology. The religious controversy is exemplified by the review of the Neev and Emery book in *Biblical Archaeology Review* (Volume 23(4) p. 70, 1997). "*Is it possible that natural catastrophes were responsible for the destruction of these cities? The Bible tells us only that "The Lord rained on Sodom and Gomorrah sulfur and fire . . . and he overthrew those cities" (Genesis 19:24–25); at Jericho, "The people shouted, and the trumpets were blown . . . and the wall fell down flat" (Joshua 6:20). . . Are the Biblical narratives of Sodom, Gomorrah and Jericho primitive memories of geological events, made by people who had no 'scientific appreciation of cause and effect?' Maybe, but maybe not*". This review, written by SMU Religious Studies Professor Ronald Hendel, typifies and concern, if not the outright disdain, of biblical scholars of the simple-minded way some scientists interpret biblical writings. To Professor Hendel, the Neev and Emery "*book has little of substance to say on this issue, and it says it in execrable prose*".

The geological controversy in this book is the author's avoidance of any meaningful reference to *plate tectonics,* and especially the Dead Sea transform as a *strike-slip fault system.* The "*tectonic movements*" Neev and Emery repeatedly refer to throughout the book as being responsible for both ground and population upheavals are generally related to vertical tectonics—normal faulting, uplifts, etc. This view of regional tectonics has been Neev's personal one for decades and is in disagreement with most earth scientists who work this region. The overwhelming evidence—from earthquake fault plane solutions, offset formations, plate motion reconstructions—favors a crustal deformation model of predominantly strike-slip faulting, with a small component of extension, reflected in the formation of a series of pull apart basins, of which the Dead Sea basin is the largest. The best data to date suggests that whereas typical vertical uplift rates in this region are less than 1mm/yr, the horizontal motion is closer to 1cm/yr.

This issue of faulting type is not just a minor debate about geology. It impacts the estimation of what kind of maximal magnitude of earthquake may have occurred here. If it is assumed that faulting is predominantly of the normal type, then the maximum magnitude is fairly modest ($M < 6$), because the length of coherent normal faults around the Dead Sea is too short to generate larger events. On the other hand the coherent, through-going strike-slip fault system extends hundreds of Km (say from Elat to Banias and beyond) and could in principle generate earthquakes of magnitudes approaching 7.5 or 8. It is this kind of event that must occur to cause destruction on a regional scale. Normal faulting earthquakes cannot, as far as we know, cause widespread devastation in this region. As a result, the authors have been unable fully to explore in detail the probability and nature of earthquakes they suggest as the cause for the destruction of Sodom, Gomorrah and Jericho.

(4) Why do I nevertheless like this book? I like this book because it is the best summary available in print of the interrelation among geology, climate, archaeology, and writings, including biblical writings, for this special geographic region. No one else has ever attempted to put it all together, in spite of the inherently uncertain and incomplete information. Without speculations, and the associated confusion, this material would have never been organized and analyzed and eventually offered to us. Although many may disagree with various interpretations of this data bit or that, I believe that just to have all the information and references in one book is of great value to scholars and non-scholars alike who are interested in understanding how our past was shaped by the interactions between natural processes and phenomena, and human actions and reactions, and how all this got recorded in our ancient writings and archaeological excavation. Anybody who is interested in these must keep this book on his bookshelf.

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LIBYAN SANDS: TRAVEL IN A DEAD WORLD. *R.A. Bagnold. 1935. Reprinted (1993) by Immel Publishing Ltd., London. 288 p. Softcover. £7.95 (North Americans can place credit card orders with the Immel Warehouse by calling 011 44 014 03 710 851)*

During 1941 in wartime London, *The Physics of Blown Sand and Desert Dunes* by Ralph A. Bagnold was published. One half century later, during 1991, scientists, engineers, and others cited this book 36 times, and the data for the decade centered on 1991 suggest that the annual number of citations increases with time (citation data from Science Citation Indexes, Inc.). Over one half century after it appeared, Bagnold's book on blown sand is widely known and used.

The success of his 1941 book depends on Bagnold's intimate personal experience with the phenomena of blown sand. The book under review, *Libyan Sands: Travel in a Dead World,* describes how he got that personal experience. According to his autobiography,

Libyan Sands was written in 1933–34 while serving in Hong Kong, published in 1935, reprinted in 1941, and reprinted again in 1987 with an Epilogue. The 1993 reprint under review seems to be identical to the 1987 reprint. The book primarily concerns Bagnold's exploration of the desert area that includes present Libya, Egypt, Sudan and Chad, an area larger than the Indian subcontinent.

The Bagnold family would make an ideal entry in Galton's *Hereditary Genius.* Bagnold's grandfather (1786–1857) had been a major general in the Honorable East India Company, his grandmother traveled through Egypt on her way to India to marry that man, and his father (1854–1944) traveled up the Nile as an officer of the Royal Engineers in Kitchner's unsuccessful attempt to save Gordon in Khartoum. Bagnold's older sister, Enid (1889–1981), wrote *National Velvet, The Chalk Garden,* and a best-selling *Autobiography,* among other works. Ralph A. Bagnold (1896–1990) was commissioned in the Royal Engineers, serving on the front lines in the Great War and, after two years at Cambridge (1919–1921), throughout the British Empire when the facade of imperial force was still enough to maintain order.

Bagnold arrived in Cairo in 1925 as a captain. While on leave in 1926, he went to Jerusalem in a Model T Ford, much of the way without roads. He enlisted a small group of fellow officers, and they spent their leave during the next two years on increasingly longer travels: to Petra via the Sinai and Aqaba; Amman and beyond; the Dead Sea; southern Sinai. During these trips they perfected desert travel techniques, stripping the Model Ts of all but essentials: no fenders, no hood, no side panels; a simple improved cooling system for the engine; carefully fitted supply cartons. The all-terrain vehicle of the 1920s. They also perfected navigation techniques to accurately traverse large unmapped areas in steel autos where compasses would not work with required accuracy.

After the initial trials, further travels were largely to the deserts west of the Nile. The first long trip was to Siwa, about 400 miles due west of Cairo, where among other things they washed in a spring that the Romans had walled off. He traveled in 1928 to the area southwest of Aswan to investigate reports of a locust invasion. With each trip, the scope and ingenuity of their explorations increased. Model As replaced the Model Ts. The last expedition in *Libyan Sands* is described in Chapters IX and X, both chapters entitled 'Six Thousand Miles', which seems to be the 3700–mile trip described in his autobiography. (The first paragraph of *Libyan Sands* laments that his explorations necessarily had literate eye-witnesses who could check his facts.) This trip extended from Cairo deep into the Sudan and touched northeastern Chad in terms of today's political geography. They got 12 miles per gallon in cross-country travel (p. 220).

Here and there, and particularly in Chapter X, are observations that underlie his *Physics of Blown Sand*:

> "The bulk of the grains flowed as a dense fog, rising no higher than five feet from the ground. Over it we could see each other quite clearly, head and shoulders only, as in a swimming bath. Up above, the great fine–grained crests of the dunes were on the move. Cornices dissolved as we looked, swaying along the curving surfaces in heavy dark folds, as if the mane of some huge animal was being ruffled and reset in a new direction by a gale." (p. 159).

They found many archeological relics, ranging from carvings of giraffes on rocks far out in the desert, to evidence of the Senussi Islamic reform movement in the nineteenth century.

> "We seldom drove fifty miles without finding some human relics, and one never knew what would come next, for they ranged in date over a large period of man's existence on the earth. . . Here in the Libyan Desert the surface is itself the bottom of things, on to which all remains of former men, their tools and pottery, have been lowered through the removal of the old accumulated soil. Everything lies exposed on the top, the bones and weapons of a lost Arab who had lately wandered out and died, alongside the tools of some paleolithic hunter of twenty thousand years ago." (p. 216).

Bagnold arrived home from Hong Kong in May 1934 unable to digest normal food. At the age of 39, he was discharged with the rank of major as a permanent invalid. He lived to be 94. Those in the Darwin industry may read this as an echo: At the age of 40, Leonard Darwin, the fourth son of Charles Darwin, resigned from the Royal Engineers with the rank of major because of poor health. Leonard Darwin lived to be 93.

The 1987 Epilogue in this reprint mentions two outcomes of the *Libyan Sands* explorations: Bagnold's research that led to *Physics of Blown Sand,* and Bagnold's instigation of the Long Range Desert Group (LRDG) during World War II. The LRDG was a direct military extension of Bagnold's desert explorations in the form of lightly armored, highly mobile patrols that, early in the war, kept the Italian military in Libya tied down and hindered it from invading Egypt. Bagnold, who had been recalled to service, initiated this LRDG, but moved on to higher commands. He was promoted to lieutenant colonel, to colonel, and then to brigadier, retiring again in 1944, after the North African campaign had ended.

His work on the *Physics of Blown Sand* was "just exploring in another form" (p. 285). Bagnold does not go into it in the Epilogue, but ultimately this work has had a peculiar effect on sedimentation studies by geologists and engineers in the United States. In 1956, Luna Leopold, then head of the U. S. Geological Survey (USGS) Water Resources Division, proposed collaborative work with Bagnold on sedimentation. Among other things, Bagnold wrote reports for the USGS and collaborated with coastal geologists at Scripps Institution of Oceanography. The title of his most notable USGS report, "An Approach to the Sediment Transport Problem from General Physics" (1966), conveys some of the self-assuredness of the man. It implies (the text makes this more explicit) that

previous workers had ignored physics, an implication that probably did not go over well with some U.S. engineers, those who had spent their lives on the subject and who believed they were more aware of 'general physics' than the brigadier.

In an even more famous paper (1954), Bagnold studied sedimentation in the annular space between two concentric rotating drums. This paper has only two references, to Albert Einstein and Osborne Reynolds. The study of annular flow between concentric rotating drums, done at Cambridge and published in 1923 by G. I. Taylor, had the status of a classic experiment when Bagnold published in 1954.

The Scripps collaboration resulted in a west coast school of bed-load transport enthusiasts who applied Bagnold's insight on air-borne transport of sand to wave-induced water-borne transport where the ruling physics is different.

Libyan Sands records an age that disappeared during the decade of its original publication. It is one monument of an unusual man: the product of heredity, institutions, and times that will not combine again.

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ESSAY REVIEW

JOHN WESLEY POWELL: FOUR PUBLICATIONS CONCERNING HIS TRAVELS AND ATTAINMENTS

Of the four leaders of the major surveys that, during the latter half of the last century, received federal financing to explore the American west, John Wesley Powell (1834–1902) was both the longest-lived and much the most appealing. Clarence King—yes, he had great charm, as so many contemporaries attest: his early career was remarkably distinguished, he was courageous, he was rich (for a time, at least), but he was not altruistic and his latter years were ones of decline into oblivion. George Wheeler's competitive spirit and militaristic preoccupations cause one to view him uneasily, while Ferdinand Hayden's staunch faith in the false doctrine that "rain follows the plow"—so politically appealing in its day—has long since been exploded, to the detriment of his posthumous reputation. In contrast, as the years pass, Powell only grows steadily in stature.

This has several causes. One is Powell's percipience in recognizing the forces that shape landscapes, particularly in arid lands. Another is his courage—that one-armed man, bravely facing the hazards of rock and rapid as his boats traversed the Grand Canyon. A third is his understanding of, and great sympathy with, the native peoples whom he encountered and his subsequent work about and for them. A fourth (and perhaps nowadays the most important) is his formulation and staunch advocacy of a system of development of arid lands that, if adopted, would have led to a much wiser, much less environmentally destructive, settlement of the American west. Finally, one must admire Powell's altruism and honesty, his unwillingness to compromise with the self-seeking requirements of politicians—a quality as rare in his time as it is today, alas!

Powell's memory is perpetuated in many fashions—by the names of several landscape features, most notably Lake Powell; by the formal adoption of his appellations for so many others; by the museum named after him in Green River, Utah; and by the many quotations from and publications concerning his work and ideas.

Though the second *Supplement* to my bibliography of *Geologists and the History of Geology* fills three more volumes (soon to be published), I have never claimed omniscience and am unsurprised that four of those publications on Powell have evaded my attention, even though one of them was published as long ago as 1974. However, since other historians of geology may be equally unaware of them, a brief review seems justified.

Two are reprints of the articles written by Powell himself for *Scribner's Monthly* in 1875. Those recounting the classic first account of his Grand Canyon voyage, later to be incorporated in rewritten form in his two books on that voyage (1875 and 1895), is the later in date. Under the original title, "The Cañons of the Colorado", the articles were reprinted attractively by Outbooks in 1981. The booklet is introduced by editor William R. Jones and incorporates, in addition to original illustrations from Scribners and from the 1875 book, a series of equally classic—and very attractive—illustrations by the great landscape artist Thomas Moran. It is paper bound, cleanly printed and sells for only $5.50.

The second series of articles by Powell reports an episode not often remembered—his "An overland trip to the Grand Canyon". This was undertaken to investigate the mystery of the disappearance of the three members of his crew who, deterred by an especially formidable series of rapids, left the expedition almost at its very end—and died as consequence. Powell did solve that mystery, even identifying the natives who had slain his former colleagues; but, typically, he treated the culprits with compassion and did not seek their punishment. His sympathy with them is further demonstrated by his incorporating, into his articles, a lengthy retelling of a hero myth of their people. His own cool heroism is several times made apparent, as during his account of the descent of the 1200-foot deep Roaring-Water Cañon:

> Between the little river and the foot of the walls was found a dense growth of willows, vines, and wild-rose bushes, and with great difficulty we made our way through this tangled mass. It is not a wide stream—only twenty or thirty feet across, in most places—shallow, but very swift. After spending some hours in breaking our way through the mass of vegetation, and climbing rocks here and there, it was determined to wade along the stream.

> In some places this was an easy task, but here and there we came to deep holes where we had to wade to our arm-pits. We soon reached places so narrow that the river filled the entire channel and compelled us to wade. In many places the bottom was a quicksand, into which we sank, and it was with great difficulty that we made progress. In some places the holes were so deep that we had to swim, and our little bundles of blankets and rations were fixed to a raft made of drift-wood and pushed before us. Now and then there was a little flood-plain, on which we could walk, and we crossed and re-crossed the stream and waded along the channel, where the water was so swift as almost to carry us from our feet; we were in danger every moment of being swept down, until night came on. We estimated we had traveled eight miles that day. (p. 6–8).

The reprint by Filter Press—no. 28 in their *Wild & Woolly West* series—incorporates the original illustrations from *Scribners Monthly,* plus others from a variety of sources: it is both attractive and, at a mere $2.50, surprisingly inexpensive. An earlier item in the series—no. 11, William Rusho's "Powell's Canyon Voyage" (1969)—remains available at the same price in many U.S. bookstores.

The third work meriting mention here is a contribution to the *Western Writers Series* of Boise State University (no. 114, 1994). James M. Aton's assessment of Powell's abilities and influence as writer and visionary is woven around what is surely one of the best and most lucid accounts yet published of Powell's life, scientific attainments and effectiveness as a federal agent. (He served as second Director of the U.S. Geological Survey between 1880 and 1894 and as Director of the Bureau of Ethnology until his death in 1902). Aton's assessment concludes:

> The West that Powell had sought to settle in a rational manner based on the conditions of the environment had, in the Turnerian terms which Powell endorsed, officially closed shortly before his death. His vision, however, did not fully guide that settlement. Much suffering and failure attended whites' settling of the West, in good part because of the myths that Powell had fought against. Nevertheless, Powell bequeathed to the nation a legacy of fearless exploration, brilliant science, and dedicated public service. And with his account of his 1869 voyage down the Colorado, we can say he left us one of the great adventure stories in American literature. (p. 50)

This work is again inexpensive ($3.95) and eminently worth reading. Several others in the series treat with writers who undertook geological studies, most notably no. 48 (Peter Wild's account of Clarence King).

The last book meriting mention here forms part of the Chelsea House *World Explorers* series—moderately large-format works (7.5 × 9 inches), with colour boards and incorporating colour plates, as well as black and white illustrations. This particular work is by Ann Gaines and is entitled *John Wesley Powell and the Great Surveys of the American West* (1991), selling at $9.95. The principal problem is its title. The text and illustrations occupy 119 pages (pp. 12–129) but, apart from a few very incidental mentions, Powell does not appear till page 105, so that less than one-quarter of the book deals with his life and work. The prominence given to his name is surely a sales gimmick!

It is a pity that the publishers strove thus to mislead potential readers, for this work is in fact an admirably balanced and succinct account of all four of the geological-cum-topographical surveys which, during the latter half of the nineteenth century, jostled so vigorously for public funding. Successive chapters treat with King's meteoric career, Wheeler's attempt to develop a new mapping approach and Hayden's solid achievements and unwise agrarian philosophies. Powell's own attainments are then assessed, adequately though perhaps in a less clear-headed fashion than by Aton. The problem is, perhaps, that the introductory paragraph of page 105 is already so valedictory, before the assessment even begins:

> John Wesley Powell was the most important of the leaders of the four surveys not simply because his two river journeys down the Colorado River constituted the single greatest feat of post-Civil War western exploration but because he possessed the most insightful and far-reaching scientific mind of the quartet. He combined King's skill as the theoretical geologist and his flair as an outdoors-man and a man of action with Wheeler's drive and ambition and Hayden's love of the West and dedication to its settlement, but Powell stood alone in the degree to which he questioned the already apparent pattern of settlement and economic development of the western lands. Powell was perhaps the only one of the four to fully realize that conflicts unresolved east of the Mississippi—how public land was to be distributed, the proper role of federal and local government in regulating settlement and development and allocating resources—were to be played out in the West, with potentially disastrous consequences. Like King, Wheeler, and Hayden, he harbored an immense appreciation for the uniqueness and beauty of the West, but he outdid them in the extent to which he recognized that the region's singularity demanded a new set of concepts and ideas to regulate its settlement. Powell also differed from the others in the immensity of his appreciation for the native peoples of the West and their culture and in his devotion to understanding their past and present way of like so as to help them build a meaningful future. (p. 105–106)

Gaines's final words are:

> Clarence King, George Wheeler, Ferdinand Hayden, and John Wesley Powell were thus the last significant individual explorers of the American West. No doubt they would today lament some of the consequences of the West's continued development—the elimination of the magnificent, fearsome grizzly bear from its natural dominion, perhaps, or the acid rain and pollution that imperils Yosemite and other national parks, or, for Powell, the continuing tragedy of the American Indian—but all four believed that in working to facilitate the settlement of the western lands they were on the side of progress. And Powell, at least, would have been optimistic about the ability of science and government, working together, to apply their resources to solve these new problems. "The revelation of science is this," he said in 1882. "Every generation in life is a step in progress to a higher and fuller life; science has discovered hope." (p. 129)

Is that truly so? Those words, as Gaines notes, were penned in 1882: Powell was to live twenty years longer after that and to realize that the policies he had advocated were not being implemented. I suspect that, by the end of his life, Powell must have lost much of

his earlier faith, when he saw how randomly and destructively the settlement of the west was proceeding. Neither, I suspect, would he find any comfort today. Development is still determined only by the quest for quick dollars. Cities like Denver and Albuquerque are sprawling shapelessly across ever-wider acres, while burgeoning clots of houses are spoiling more and more of the once-beautiful hill-slopes and deserts of Wyoming, Colorado, Utah and New Mexico—those lands about which Powell cared so passionately.

Has science lost hope, then, since Powell's time? No; but it has somehow forfeited too much public trust. As these books make sadly clear, the lessons that he tried to teach us have still to be learned.

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ESSAY REVIEW

THE ABERDEEN GRANITE INDUSTRY. *Tom Donnelly. 1994. Centre for Scottish Studies, University of Aberdeen, Scotland. 186 p. Softcover, £9.50.*

The search for economic mineral deposits—especially those yielding gemstones and the noble metals—afford a glamour that has stimulated a prolific popular literature. In contrast, the documentation of the less glamorous extractive industries—stone quarrying, the working of economically valuable deposits of clays, sand and gravels—is sparse, at best.

It is in Great Britain that this topic has received fullest examination. Quarries in general, in England and Wales, have been surveyed in two works by Stanier.[1] The working of fuller's earth—the clay used for washing sheep-fleeces—has been very amply documented by Robertson[2] and of alum by Turton.[3] The history of extraction of Portland stone and Purbeck "marble" has been recounted by Benfield.[4] Bath stone, called "the fashionable stone", has had the story of its working amply recounted in three books[5] and a personal history.[6] The history of Norfolk Carstone extraction was reported by Messent[7] and of Derbyshire "black marble" by Ford[8] and Tomlinson.[9] The working of various building stones round Cambridge was recounted by Purcell[10] and around Leckhampton, Gloucestershire, by Bick,[11] while the history of Dartmoor's granite industry was lavishly portrayed by Woods.[12]

Other extractive industries have also attracted the attention of British historians. Flint mining in Sussex in historic times was documented by Pull.[13] Ironstone mining in Cleveland, North Yorkshire, was discussed by Chapman[14] while, in a magnificent series of eight volumes, Eric Tonks meticulously recounted its history in the Midlands (Tonks;[15] and Tonks and Scholes[16]).

The working of materials for brickmaking in England has featured less well. It was briefly surveyed by Hammond,[17] while the Firmans[18] discussed the geology of mediaeval bricks; but only one detailed regional study[19]—on brick clay working at Fletton, Northamptonshire—has come to my attention. In contrast, the much more minor industry of digging ball-clays for pottery-making has attracted three studies—by Legg[20] on Dorset and by Rolt[21] and Messenger,[22] respectively on workings in south and north Devonshire. The history of the (essentially) Cornish china-clay industry has been recounted by Barton[23] and Hudson[24] and features in a reminiscence by Best.[25] Shorter papers on the extractive industries are to be found in such journals as *British Mining* and the *Bulletin of the Peak District Mines Historical Society.*

Now that tiles roof most modern houses, the once-important British slate industry has almost faded away. A brief general account has been given by Williams[26] and an account of a Cumberland slate "mine" by Cameron.[27] However, that industry was centred in Wales and has recently attracted much reminiscent attention. Richards[28] produced a gazeteer of the industry, while particular slate quarries and quarrying districts have been examined by Carrington,[29] Isherwood,[30] Lewis,[31] Lewis and Denton[32] and Richards.[33]

In contrast, the historical study of the extractive industries in Scotland has scarcely begun. Before the publication of the volume, the only extended treatment was of the Scottish shale-oil industry.[34] The book here reviewed thus has a particular significance. It is also important in that it is only the second to treat with the history of granite working in Britain (for the first see endnote #12). It is thus recommended to the attention of all persons interested in the economic aspects of the earth sciences.

As happened much later in North America, the first

stone structures were built using field stones (called, in Scotland, "land gatherings"). It was not until 1602 that the first quarry was opened in Aberdeen and not until the 18th century that granite-quarrying truly began to gain momentum. Though Donnelly does not discuss this, it seems to me quite probable that, in many such quarries, the working was seasonal rather than year-round, being undertaken by farm workers, at times when their agricultural or pastoral duties allowed. Some quarries in continental Europe are worked in this fashion, even today. Since granite is a difficult stone to work, its extraction was soon being facilitated by blasting. Gunpowder was preferred for this, since "it heaved or sprung the rock from the quarry face without shattering it into small pieces".[35] Rocks tipped with bronze, copper or even wood were used to ram the powder into the holes made by drilling: steel caused dangerous sparks. The drill-hole was then "filled with clay or stones to direct the blast inward".[36] Even so, the blocks obtained for building purposes were not large; the smaller pieces were used for granite setts for cobbled roads or else broken by labourers called 'knappers'[37] into still smaller pieces, to make the roadstone for 'gravelled' roads.

Because granite is heavy and costly to transport, the earlier quarries were centred in the immediate neighbourhood of Aberdeenshire's two principal ports—Aberdeen itself and Peterhead. These early quarries had names that were often strange: Loanhead, Pitmuxton, Greyhope, Nigg, Dancing Cairns, Sclattie, Dyce, Tyrebagger. With the advent of turnpike roads, transport to the harbours became easier and quarries were opened at progressively greater distances. With the advent of railways, working was extended to Corrennie and Tillyfourie in the Alford Valley, while opening of the Deeside line allowed the first exploitation of the pink granites of the Hill O'Fare. Progressive exhaustion of surface deposits increasingly necessitated 'tirring', the removal of such superficial deposits as rotted granite and boulder clay. This necessarily increased the cost of working. Fortunately, the market was improving, from a variety of causes; among them, a disastrous fire in Aberdeen that caused that city's officials to require stone construction; the growing Victorian urban pride, requiring more impressive civic and commercial buildings and fad for granite statues; even the use of granite in the erection of urinals!

Unexpectedly, the British market for granite tombstones was slow. Instead, between about 1850 and 1880, the principal market for these was in New England! The cause for this may have been the immigration of Scottish stone-masons to work in New England's own granite quarries. These loyal Scots may well have expressed their preference for the stone of their homeland so strongly that the Yankees were persuaded of its greater virtues! Certainly several of the Scottish masons, having accumulated funds enough, promptly returned to Scotland and became quarry-owners in Aberdeenshire.

Indeed, Aberdeen granite has acquired a world significance. It has been used to face important buildings, and to commemorate important persons (during their lifetimes or posthumously) throughout the British Commonwealth and in many parts of the United States. We geologists have benefitted from what the quarries have revealed to us, such exposures helping to fuel the long controversy concerning granite's plutonic or metamorphic origins. However, we have not much aided the industry for, as Mr. Donnelly remarks:

> Though coal mining has benefited from subsequent studies in geological science, granite quarrying has not benefited to the same degree. Even now geologists cannot estimate accurately the value of granite deposits below the earth's surface.[38]

All in all, we can learn much from such historical studies as this—if only that, after all, we geologists are not quite so crucial to society as we sometimes believe! It is also time that historians began to examine the history of our own North American extractive industries, a story that has barely begun to be told.

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ESSAY REVIEW

GEOLOGY 'TALKS': COMMERCIAL CASSETTES RECORDING THE HISTORY OF GEOLOGY

The tape recorder has long since proved itself to be a valuable tool for historians. In particular, it has permitted the preservation of reminiscences and interviews with persons who, through disinclination or disability, have not written down the story and the incidents of their lives. It has been utilized with this aim by a number of historians of geology, myself included, to put on record the stories and the thoughts of senior colleagues.

However, such tapes have hitherto been unique productions—or, at best, copied only a few times upon special request. The production of such tapes for commercial sale is a relatively new venture and merits being brought to the attention of the readers of this journal.

The earliest I have obtained is one produced in 1990—*John Wesley Powell River Journal—The Grand Canyon of the Colorado.* This consists of carefully selected readings from Powell's record of his epic voyage, with occasional interludes of river sounds. The J-card within the plastic tape container is attractively printed in colour, but on one side only. Frustratingly, it does not give either the name of the reader,

the source (was it taken from a radio broadcast?), or the address of the company—Teaberry—producing and distributing the tape. This is a pity, for the reader did too good a job to merit such anonymity and the cassette is well worth purchasing. If you wish to obtain it, I can only suggest that you write to the John Wesley Powell River History Museum in Green River, Utah, where I purchased my copy.

In contrast, the two other cassettes here reviewed provide much ampler information. Both were released in 1994 by Fossil Records of 2805 N. Keystone St., Burbank, California 91504, as part of a series entitled *Dinosaur Talks.* The J-cards feature portraits and brief biographies of the two vertebrate palaeontologists whose reminiscences are presented—respectively, Edwin H. Colbert and Elmer S. Riggs—and the second J-card illustrates, on the obverse side, two dinosaurs collected or reconstructed by Riggs.

Of the two tapes, the interview with Ned Colbert (FR 003) is the better-recorded—in November 19th, 1993, at the Museum of Northern Arizona in Flagstaff. Moreover, Ned's pleasant voice and easy style of discourse make for relaxed, as well as interesting, listening. We are fortunate also to have available to us his two autobiographical works (1980, 1989); the tape inevitably overlaps these very broadly, but there are enough new stories to make it a worthwhile purchase.

Historically much more important is the tape of Elmer Riggs (FR 005), since he died without leaving behind any written account of his life. It has been carefully edited from a tape made by Mr. Pat Miller of the National Park Service—according to the J-card, during March 1990, but this is surely an error, since Elmer Riggs died in 1963. (Was the true date 1960? That seems likeliest.) The J-card states that

> . . . the original recordings . . . were made under non-professional conditions. Although they have been filtered and enhanced, back ground noises remain.

True enough; one has the impression that Riggs must have been moving about the museum, picking up specimens and displaying them to Pat Miller as they conversed. (Miller's own voice, if present on the tape, has been excised). It is not easy listening, this tape, but one *is* hearing the voice of a distinguished collector and preparator of vertebrate fossils, lost to us more than thirty years ago, and much information is presented that was not available hitherto.

Both these tapes, then, well merit purchase: Donald Glut and Pete Von Scholly, who produced them, merit sincere congratulation. It is somewhat paradoxical, in view of the series title, that both Colbert and Riggs talk more about their work on fossil mammals than about dinosaurs; but no doubt that name *Dinosaur Talks* will help generate tales. I trust the series will be continued, so that the voices of other great palaeontologists may likewise continue to be heard by future generations of geologists.

In the meantime, we historians of the earth sciences had better decide how we're going to treat with such cassettes in reference lists and bibliographies! For my part, I'm also wondering what was on Fossil Records tapes FR 001 and FR 002 and FR 004, which I've not found—talking *dinosaurs,* perchance?

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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 members are requested to send them to Gerald M. Friedman, Brooklyn College and Graduate School of the City University of New York, % Northeastern Science Foundation, Inc., Rensselaer Center of Applied Geology, P.O. Box 746, Troy, NY 12181-0746 U.S.A.

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TREASURER'S REPORT FOR 1996

$22,848.30	**Carried forward from 1995**		
–$17,670.27	**Expenditures in 1996**		
		$15,115.92	to Allen Press for ESH v. 14(2) and 15(1)
		$ 2,554.35	operating expenses (office, computing, and mailing supplies; postage)
		$17,670.27	total expenditures in 1996
+$20,214.05	**Income in 1996**		
		$17,708.36	membership dues and institutional subscriptions
		$ 697.79	interest on checking account
		$ 1,807.90	page charges, monetary gifts, sale of back issues, etc.
		$20,214.05	total income in 1996
$25,392.08	**Balance forward into 1997**		

Explanation:

Please keep in mind that the balance forward into 1997 does not represent long-term savings. It is instead the temporary storage of annual dues and subscription payments which are earmarked for upcoming issues of the journal. The above balance includes a large portion of the institutional subscriptions for the 1997 issues of the journal, v. 16, as well as some pre-paid 1997 individual dues. In addition, the bill from Allen Press for the second issue of 1996, v. 15(2), which appeared in spring of 1997, was not paid until 1997. Nevertheless, when projecting 1997 expenses and income, it is believed that this balance forward from 1996 is approximately on target, perhaps modestly above. The society should try to maintain at least a slight cushion of funds in case of sudden future increases in printing or mailing costs.

Much of the credit for achieving an approximately balanced financial situation goes to Mott Greene, who has saved the society considerable funds by keeping a close eye on journal production costs and by obtaining electronic submission discounts from Allen Press. Individual HESS members have also helped by responding in a timely fashion to dues notices. In addition, the society benefits greatly from the service of the assistant treasurers, Stuart Baldwin (U.K.), Barry Cooper (Australia), Jordi Martinell (Spain), and Keith Tinkler (Canada), whose time and effort make HESS membership affordable to many individuals living outside of the U.S. Page charges were received during this past year from Sandra Herbert, Paul Pearson, Martin Rudwick, Cecil Schneer, the University of New Hampshire, and Macquarie University. Finally, the society is very grateful to Kennard Bork, Aart Brouwer, Albert and Marguerite Carozzi, David Donnenfield, Robert Dott, Jr., Andres Duarte Vivas, W. Dean Grafton, Peter Guth, Gretchen Luepke, and Wilfried Schröder for voluntary monetary contributions that they made to HESS in 1996.

Respectfully submitted,
Dorothy Sack, HESS treasurer

HISTORY OF EARTH SCIENCES SOCIETY OFFICERS—1997

(Election results tabulated and transmitted by Secretary Rainger)

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ANNOUNCEMENTS

Announcing a **Historical Symposium** at the Annual Meeting of the South-Central Section of the Geological Society of America **March 22–24, 1998,** on the campus of the University of Oklahoma, Norman, Oklahoma. The symposium theme is:

GEOLOGY AND TRAVEL: HISTORICAL PERSPECTIVES

"We must preach up traveling, as Demosthenes did 'delivery,' as the first second, and third requisites for a modern geologist . . . "Charles Lyell

The practice of geological science has always had strong links with travel. From the science's early phases to the present day, geologists have often emphasized the need to see the world—as Lyell proclaimed in 1829. The travel imperative underscores one of geology's most interesting features: its peculiarly strong commitment to a *geographically specific* understanding of the Earth. By focussing on this dimension of the priorities and the experiences of geologists, it is possible to shed light on the processes by which the earth sciences have grown and changed. In this symposium we aim to explore aspects of this linkage between geology and travel, throughout all periods of geology's development.

Proposals for contributed papers on any topic related to this theme are encouraged. The deadline for abstracts will be 28 November 1998. *Inquiries:*

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Web page for the meeting: http://hoth.gcn.ou.edu/~jahern/scgsa/

THE BERNARD L. MAJEWSKI RESEARCH FELLOWSHIP

The American Heritage Center announces the second annual offering of the Bernard L. Majewski Fellowship and invites applications from interested scholars. The Fellowship is named in honor of the late petroleum industry pioneer, Bernard L. Majewski, and provides a stipend of $2,500 in support of research conducted in the archival collections at the American Heritage Center on the campus of UW. Acceptable areas of research include history, oral history and historical archaeology pertaining to economic and petroleum geology, or, environment and natural resources, business or economic history pertaining to economic and petroleum geology. The deadline for applications for the 1998 Fellowship is December 15, 1997 and research should be conducted by the Fellow within one year of appointment. For application information or a comprehensive listing of available research collections, contact:

Manager
International Archive of Economic Geology
American Heritage Center
P.O. Box 3924
University of Wyoming
Laramie, WY 82071
Phone: (307) 766-6506 or fax (307) 766-5511
E-mail: mgrafel@uwyo.edu

For updated information on this subject, check our web page:http://www.uwyo.edu/ahc/iaeg/majewann.htm

PALAEONTOGRAPHICAL SESQUICENTENNIAL

In celebration of the 150th anniversary of the founding of the PALAEONTOGRAPHICAL SOCIETY, a one-day Symposium is being organised on **THE HISTORY OF PALAEONTOLOGY IN GREAT BRITAIN** at the Dept. of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ on **Wednesday 24th September 1997** by The Palaeontographical Society and the History of Geology Group of the Geological Society of London. If you would like to attend offer a paper or would like further details contact the convenor:

Stuart A. Baldwin,
Fossil Hall, Boars Tye Road,
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KUDOS

Founding Editor of *Earth Sciences History*, Gerald M. Friedman, Distinguished Professor of Geology at Brooklyn College and Graduate School of the City University of New York, received the James Hall Medal of the New York State Geological Survey/State Museum. This medal is presented to those prominent, living, senior geologists who have made significant contributions to the earth sciences in New York, as decided by a consensus of the current members of the New York State Geological Survey permanent, senior staff with the conditions that the recipient is alive at the time of nomination and has never been a member of the NYSGS permanent staff.