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Geology at the California Academy of Sciences, 1853-1907

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In this paper, we use the technique of collective biography to document instances of those who used the California Academy of Sciences as the crucible in which to test new ideas developed during the California period of their scientific lives.

Geology at the California Academy of Sciences is a far-reaching topic, one that extends well beyond the confines of the assembling of collections and the organization of a department. It is more the people who associated themselves with the Academy for the purpose of exploring the problems usually thought of as geology or as one of the related disciplines. Thus, although from the early days of its existence, the Academy had a person designated a curator of mineralogy, and had a collection of minerals, said by some to be one of the finest in the state if not in the entire West, nevertheless, during the first 50 years of its existence, the main happenings in geology took place at the Academy's weekly or monthly meetings and in its publications.

To place geology in the proper context, it must be remembered that although incidental obser-

[1] By 1853 the sciences of geology and paleontology were firmly established. In Europe the basic precepts of physical and historical geology had been brilliantly set forth in Charles Lyell's *Principles of Geology*, already in its eighth edition. The preparation of geological maps had become normal procedure. Stratigraphic and areal geology had been actively pursued since William Smith and Georges Cuvier had independently demonstrated the practical use of fossils, and the basic geological time scale had been established. Descriptive paleontology had been an active field for half a century, and Alcide d'Orbigny had established the basic principles and procedures of biostratigraphy, little changed to this day.

The main outlines of the geology and paleontology of the eastern United States had been elucidated by Conrad, Dana, Emmons, Hall, Hitchcock, Morton, Rogers and Rogers, Vanuxem, and others. By contrast, little was known of the geology and paleontology of western North America, and that little from scattered observations and collections made by voyages of discovery or exploring expeditions. (For these early efforts see articles by Addicott 1980, Alden and Ifft 1943, Anderson 1932, Jennings 1966, Natland 2003, and VanderHoof 1951, and bibliographies by Orr and Orr 1984, and Shedd 1932).

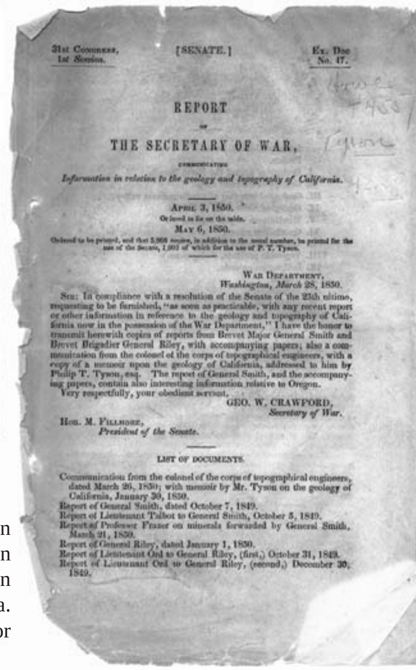
The earliest records are merely sightings of particular rocks or fossils, such as the fossil shells noted at Cape Blanco, Oregon in 1792 by Archibald Menzies during Vancouver's voyage to the northwest coast of North America, or the La Perouse voyage of 1791 that mentions what was probably one of the large fossil pecten shells from southeast Alaska (Addicott 1980).

On later expeditions, naturalists made geological observations and collected specimens of rocks and fossils for later study and possible publication. The Kotzebue voyage of 1816 to Alaska and California included the botanist, Adelbert von Chamisso, who made geological observations in the San Francisco area, and the zoologist, Johann Friedrich Eschscholtz, who collected samples of rocks and minerals later described by Moritz von Englehardt. Eschscholtz returned with Kotzebue's later voyage of 1823–1826, and made further zoological and geological collections which were described in his *Zoologischer Atlas* (1829–1833). On other explorations, the specimens collected were sent to various authorities for study. William Buckland in England received materials collected from California during the voyage of the *Blossom* in1831, and he (1839) prepared the geological section of the zoological report, which included a geologic map of the San Francisco Bay area, prepared by the ship's surveyor, Edward Belcher, and surgeon, Alex Collie, the first of its kind in the West. During his travels in the West, the botanist Thomas Nuttall sent fossils to T.A. Conrad in Philadelphia, who published on them in 1838. Bones found during Ewing Young's travels were sent to Boston and described by Henry C. Perkins (1842). The U.S. Exploring Expedition, and the Fremont expeditions sent geological specimens to James Hall (1845) in New York, and Fremont also sent samples of diatomaceous earth to the German diatomist Christian Gottfried Ehrenberg (1850, 1853).

The discovery of gold and mercury in California led to numerous publications (domestic and foreign) on California minerals and mining; nearly half of the pre-1853 publications cited in Shedd (1932) are on these subjects.

vations were made on the geology of California prior to the 1850s,[1] there was little incentive to do more until after the discovery of gold in 1848 and the resulting population explosion led people to want to know about the economic potential of their new home and the country of its new state.

California was admitted to the Union in 1850. As a prelude to this, in 1849, Philip Tyson (Fig. 1), who traveled to California as a privite citizen (Merrill 1964:290) reported on the peculiarities of the geology and industrial resources of the region to the War Department. His report was transmitted to Congress and published as a Senate Document in 1850. In 1851, two maps of the gold regions of California were printed, one by Charles Gibbes the other by William Jackson. And, in 1853, William Phipps Blake (Fig.2) prepared a geological map of the San Francisco Bay region for his Pacific Railroad report. But a more comprehensive report was that of John Boardman Trask (Fig. 3) who, in 1854, published a paper on the geology of the Sierra Nevada, and two maps, one of the State of California (Fig. 4) and the second, a topographical map of California's mineral districts (Fig. 5), the latter oriented with East on top and which, according to Wheat (1959:160) is not only one of the rarest but also "an outstanding map. . .". Trask published two additional reports on California geology in 1856 (1856a, 1856b).



31st Congress, 1st Session. [SENATE.] Ex. Doc No. 47.

REPORT

OF

THE SECRETARY OF WAR,

COMMUNICATING

Information in relation to the geology and topography of California.

April 3, 1850.
Ordered to lie on the table.
May 6, 1850.
Ordered to be printed, and that 5,000 copies, in addition to the usual number, be printed for the use of the Senate, 1,000 of which for the use of P. T. Tyson.

War Department,
Washington, March 28, 1850.

Sir: In compliance with a resolution of the Senate of the 23th ultimo, requesting to be furnished, "as soon as practicable, with any recent report or other information in reference to the geology and topography of California now in the possession of the War Department," I have the honor to transmit herewith copies of reports from Brevet Major General Smith and Brevet Brigadier General Riley, with accompanying papers; also a communication from the colonel of the corps of topographical engineers, with a copy of a memoir upon the geology of California, addressed to him by Philip T. Tyson, esq. The report of General Smith, and the accompanying papers, contain also interesting information relative to Oregon.

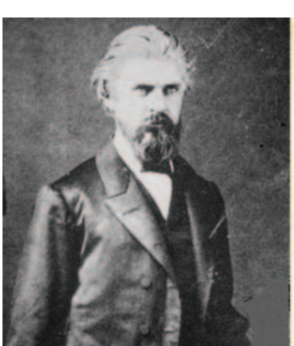
Very respectfully, your obedient servant,
GEO. W. CRAWFORD,
Secretary of War.

Hon. M. Fillmore,
President of the Senate.

LIST OF DOCUMENTS.

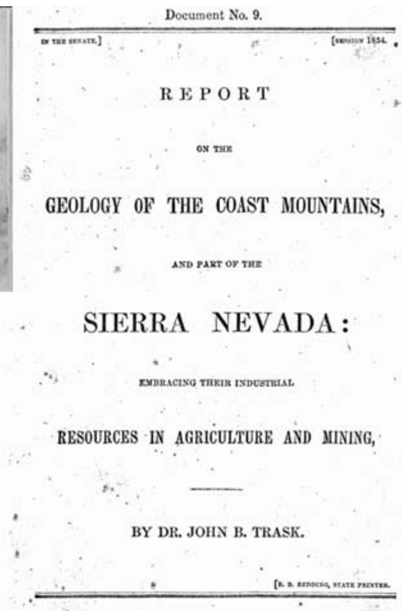
Communication from the colonel of the corps of topographical engineers, dated March 26, 1850; with memoir by Mr. Tyson on the geology of California, January 30, 1850.
Report of General Smith, dated October 7, 1849.
Report of Lieutenant Talbot to General Smith, October 5, 1849.
Report of Professor Frazer on minerals forwarded by General Smith, March 21, 1850.
Report of General Riley, dated January 1, 1850.
Report of Lieutenant Ord to General Riley, (first,) October 31, 1849.
Report of Lieutenant Ord to General Riley, (second,) December 30, 1849.

Figure 1. Philip Tyson and the title/transmission page to his 1849 report on the geology of California. (See Acknowledgments for sources of images.)



Figures 2. William Phipps Blake and his 1853 geological map of the San Francisco Bay area.

At this time we take special note of Trask because he, with six other amateur naturalists, met on April 4, 1853 to found the California Academy of Natural Sciences. Of the seven people, two could claim some knowledge of geology, Trask and Andrew Randall (Fig. 6), the latter having earlier served as a field assistant to David Dale Owen on the Federal Survey of the Wisconsin-Minnesota territories. One month later, Leander Ransom (Fig. 7) joined them, and, not long thereafter, Pacific Railroad Survey geologist William Phipps Blake attended his first meeting the following January. Ransom was the federal surveyor responsible for establishing the Mount Diablo Base & Meridian line, the foundation for nearly all later topographic mapping done in northern California.



Document No. 9.

IN THE SENATE.] [SESSION 1854.

REPORT

ON THE

GEOLOGY OF THE COAST MOUNTAINS,

AND PART OF THE

SIERRA NEVADA:

EMBRACING THEIR INDUSTRIAL

RESOURCES IN AGRICULTURE AND MINING,

BY DR. JOHN B. TRASK.

[B. B. REDDING, STATE PRINTER.

FIGURE 3. John Boardman Trask and the title page of his 1854 Report on the Geology of California's Coast Ranges and Sierra Nevada, the first of three such reports submitted to the California State Legislature in which the economic potential of the State's resources is emphasized.

With the founding of the Academy, which at the time functioned more like a scientific society, members presented their latest observations on local natural history at weekly meetings. Also, local newspapers published verbatim transcripts of the talks. These included the *Daily Alta California* and *The Pacific* (Fig. 8), a Congregationalist weekly published in San Francisco. Somewhat later the *Mining and Scientific Press* and the *Placerville Times* followed suit. Copies of the newsprint columns were sent East, and among the recipients were Spencer Fullerton Baird and Joseph Henry (Fig. 9) of the Smithsonian Institution, which was then only seven years old.

FIGURE 4. Trask's California map of 1853. (Courtesy of the Bancroft Library, University of California, Berkeley.)

Although both Henry and Baird were supportive of the fledgling Academy, it was Baird who advised its members that if they wanted to have their publications taken seriously "by men of science," they should publish the proceedings in journal format (Leviton and Aldrich 1997:33–34). Thus, in September 1854, the Academy issued the first four-page signature of volume 1 of the *Proceedings of the California Academy of Natural Sciences*.

With weekly meetings and an official publication, the Academy attracted new members and

FIGURE 5. Trask's mining district map of 1853. (Courtesy of the Bancroft Library, University of California, Berkeley.)

FIGURE 6. Andrew Randall.

FIGURE 7. Leander Ransom.

provided a place where members could talk about scientific matters and, through the media, inform the public, who were welcome to attend the meetings, about local and regional natural history.

From its founding the Academy began a vigorous, though unsystematic, program to learn about, and acquire specimens of, the minerals, rocks, geology, and fossils of the vast, poorly known western North America, especially of the Pacific slope. Minutes of the early Academy meetings record varied geological observations and specimens brought for discussion and examination and for addition to the growing cabinet. For example, the minutes for 1854 record specimens of ferruginous earth from the San Francisco Bay area, asbestos in serpentine from Fort Point, crystalline limestone from Point Quentin, coal and sandstone from Puget Sound, salt from Isla Carmen (already indicating an Academy interest in Baja California), fossil bone from San Francisco, and a mastodon tooth from Sonora.

All of this reflected the excitement of discovery and the eagerness to share this newly-found knowledge through open meetings and publication of the proceedings. Although this type of small-


The Pacific.

VOLUME III. SAN FRANCISCO, CALIFORNIA, FRIDAY, JUNE 30, 1854. NUMBER 34.

THE PACIFIC:

POETRY

CALIFORNIA SCENES.

FIGURE 8. Front page of *The Pacific*, the Congregationalist weekly newspaper published in San Francisco that regularly carried news about the Califonria Academy of Natural Sciences and its meetings.

scale observations by dedicated amateurs continued as the principal Academy activity for many years, major scientific contributions included John Boardman Trask's pioneering studies of California earthquakes.

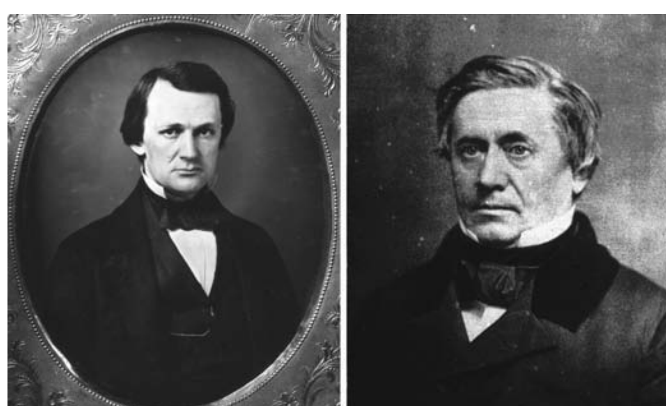


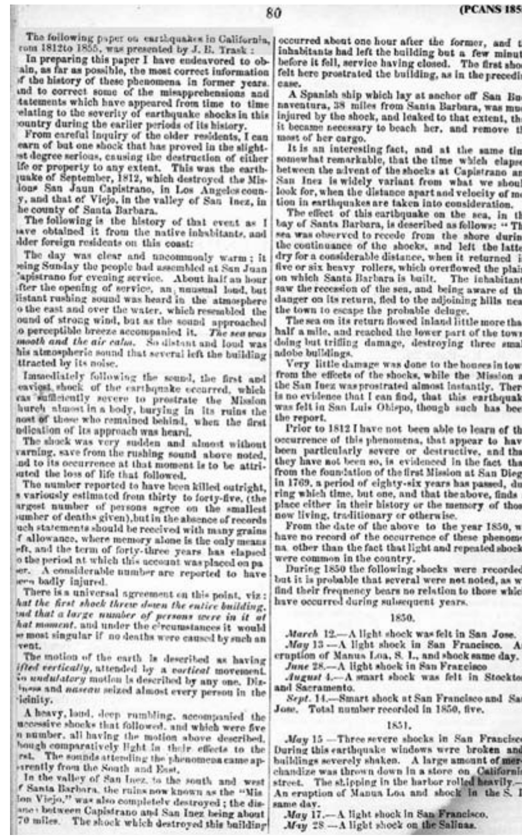
FIGURE 9. (left) Spencer Fullerton Baird; (right) Joseph Henry.

Although the earliest papers on geological topics appeared in 1855, including one by Trask on *Ammonites batesi*, which established the first recognition of Cretaceous rocks in California, Trask's paper in 1856 (Fig. 10) is of particular interest because it is the first of a series in which he chronicled the earthquakes that occurred in California**.** During the next 13 years, Trask issued updates, several of which were then reprinted in the *American Journal of Science*. Trask's data were incorporated into a larger catalogue by Edward Singleton Holden (Fig. 21f), *A Catalogue of Earthquakes on the Pacific Coast, 1769–1897*, which was published in 1898. Thus, Trask, like so many who pioneer interesting branches of study, was overshadowed while credit goes to the encyclopaedists. (Leviton and Aldrich 1982; Rodda and Leviton 1983.)

During the years 1853 to 1860, perhaps best defined as the period of explorers, surveyors, and physician-naturalists, those who dominated in the earth sciences included Trask, William Phipps Blake, Leander Ransom, and Charles Frederick Winslow, the latter interested in the mechanics of earthquakes, tides, and the like as well as cultural anthropology.

In 1860, the California State Legislature authorized a State Geological Survey under the direction of Josiah Dwight Whitney (Fig. 11). Whitney headquartered in San Francisco and quickly assembled the support staff (Fig. 11), William Henry Brewer, William More Gabb, volunteer Clarence King, and others. The Whitney period at the Academy is marked by a dramatic broadening of interest in geology, and by an increase in the number of presentations and geological publications, especially by survey personnel but also by Trask, William P. Blake, and several of Whitney's correspondents, Auguste Rémond and Baron Ferdinand von Richthofen (Fig. 13).

Among the topics addressed by the Whitney survey was the origin of the deep valleys of the Sierra Nevada, notably Yosemite and Hetch Hetchy. At the time, none appreciated the full impact of glacial erosion, a position John Muir (Fig. 12) posited some years later and for which he is given full credit. But it was not John Muir who first promoted the idea of significant glacial action in the Sierras; he was preceded by Joseph LeConte (*Proceedings* for 1873 and 1875) and James Blake (*Proceedings* 1875). Another quirk of history: with strong support from Academy members, Whitney convinced California's congressional delegation to propose legislation to set aside Yosemite as a national park in perpetuity for the benefit of the people, which was done when Abraham Lincoln signed the legislation in 1863, nine years before Yellowstone National Park was established during the Grant administration.


80 (PCANS 1855)

The following paper on earthquakes in California, rom 1812to 1855, was presented by J. B. Trask :

In preparing this paper I have endeavored to obain, as far as possible, the most correct information of the history of these phenomena in former years. and to correct some of the misapprehensions and statements which have appeared from time to time relating to the severity of earthquake shocks in this country during the earlier periods of its history.

From careful inquiry of the older residents, I can earn of but one shock that has proved in the slightest degree serious, causing the destruction of either life or property to any extent. This was the earthquake of September, 1812, which destroyed the Mission San Jaun Capistrano, in Los Angeles county, and that of Viejo, in the valley of San Inez, in the county of Santa Barbara.

The following is the history of that event as I have obtained it from the native inhabitants, and older foreign residents on this coast:

The day was clear and uncommonly warm; it being Sunday the people had assembled at San Juan Capistrano for evening service. About half an hour after the opening of service, an unusual loud, but distant rushing sound was heard in the atmosphere to the east and over the water, which resembled the sound of strong wind, but as the sound approached no perceptible breeze accompanied it. *The sea was smooth and the air calm.* So distant and loud was this atmospheric sound that several left the building attracted by its noise.

Immediately following the sound, the first and heaviest shock of the earthquake occurred, which was sufficiently severe to prostrate the Mission church almost in a body, burying in its ruins the most of those who remained behind, when the first indication of its approach was heard.

The shock was very sudden and almost without warning, save from the rushing sound above noted, and to its occurrence at that moment is to be attributed the loss of life that followed.

The number reported to have been killed outright, is variously estimated from thirty to forty-five, (the largest number of persons agree on the smallest number of deaths given), but in the absence of records such statements should be received with many grains of allowance, where memory alone is the only means left, and the term of forty-three years has elapsed to the period at which this account was placed on paper. A considerable number are reported to have been badly injured.

There is a universal agreement on this point, viz: *that the first shock threw down the entire building, and that a large number of persons were in it at that moment*, and under the circumstances it would be most singular if no deaths were caused by such an event.

The motion of the earth is described as having *lifted vertically*, attended by a *vertical* movement. *No undulatory* motion is described by any one. Dizziness and *nausea* seized almost every person in the vicinity.

A heavy, loud, deep rumbling, accompanied the successive shocks that followed, and which were five in number, all having the motion above described, though comparatively light in their effects to the first. The sounds attending the phenomena came apparently from the South and East.

In the valley of San Inez, to the south and west of Santa Barbara, the ruins now known as the "Mision Viejo," was also completely destroyed; the distance between Capistrano and San Inez being about 70 miles. The shock which destroyed this building occurred about one hour after the former, and the inhabitants had left the building but a few minutes before it fell, service having closed. The first shock felt here prostrated the building, as in the preceding case.

A Spanish ship which lay at anchor off San Buenaventura, 38 miles from Santa Barbara, was much injured by the shock, and leaked to that extent, that it became necessary to beach her, and remove the most of her cargo.

It is an interesting fact, and at the same time somewhat remarkable, that the time which elapsed between the advent of the shocks at Capistrano and San Inez is widely variant from what we should look for, when the distance apart and velocity of motion in earthquakes are taken into consideration.

The effect of this earthquake on the sea, in the bay of Santa Barbara, is described as follows: "The sea was observed to recede from the shore during the continuance of the shocks, and left the latter dry for a considerable distance, when it returned in five or six heavy rollers, which overflowed the plain on which Santa Barbara is built. The inhabitants saw the recession of the sea, and being aware of the danger on its return, fled to the adjoining hills near the town to escape the probable deluge.

The sea on its return flowed inland little more than half a mile, and reached the lower part of the town, doing but trifling damage, destroying three small adobe buildings.

Very little damage was done to the houses in town from the effects of the shocks, while the Mission at the San Inez was prostrated almost instantly. There is no evidence that I can find, that this earthquake was felt in San Luis Obispo, though such has been the report.

Prior to 1812 I have not been able to learn of the occurrence of this phenomena, that appear to have been particularly severe or destructive, and that they have not been so, is evidenced in the fact that from the foundation of the first Mission at San Diego in 1769, a period of eighty-six years has passed, during which time, but one, and that the above, finds a place either in their history or the memory of those now living, traditionary or otherwise.

From the date of the above to the year 1850, we have no record of the occurrence of these phenomena other than the fact that light and repeated shocks were common in the country.

During 1850 the following shocks were recorded, but it is probable that several were not noted, as we find their frequency bears no relation to those which have occurred during subsequent years.

1850.

March 12.—A light shock was felt in San Jose.

May 13.—A light shock in San Francisco. An eruption of Manus Loa, S. I., and shock same day.

June 28.—A light shock in San Francisco

August 4.—A smart shock was felt in Stockton and Sacramento.

Sept. 14.—Smart shock at San Francisco and San Jose. Total number recorded in 1850, five.

1851.

May 15.—Three severe shocks in San Francisco During this earthquake windows were broken and buildings severely shaken. A large amount of merchandize was thrown down in a store on California street. The shipping in the harbor rolled heavily.—An eruption of Manua Loa and shock in the S. I. same day.

May 17.—A light shock in San Francisco.

May 28.—A light shock on the Salinas.

FIGURE 10. Trask's first paper cataloguing earthquakes in California, 1812 to 1855, published in PCANS 1:80-82 (volume for 1855 but published in 1856).

At this point Richthofen (Fig. 13) deserves notice because in 1868 Whitney, as Academy President, launched a new Academy publication series, the *Memoirs*, in which appeared Richthofen's *Principles of the Natural System of Volcanic Rocks*, a 45-page treatise on the classification of volcanic rocks. In 1892, Eduard Suess referred to Richthofen's classification (Fig. 14), also known as Richthofen's Series, as the one "welche Richthofen's scharfer Blick zuerst erkannte, deren Beständigkeit oft geleugnet worden ist. . ." (Suess 1883:220).

Also during the Whitney period, Watson Andrew Goodyear assembled materials for his important publication on coal mining in the state (1877) (Fig. 15); Goodyear was the Academy's first curator of geology (1866). Henry Garber Hanks, who became California's first State mineralogist, was appointed curator of mineralogy and began building one of the West's finest mineralogical collection. Notables such as James Dana and Benjamin Silliman Jr. published several mineralogical papers in the Academy's *Proceedings* (Dana 1864; Silliman Jr. 1867–1868), as did others (e.g., W.P. Blake 1857–1873; Jackson 1885–1886; Lindgren 1887–1890; Whitney 1863–1868).

In the mid-1860s, new people interested in the earth sciences appeared. Among the more

FIGURE 11. Josiah Dwight Whitney (insert upper left) and the members of the California Geological Survey, ca. 1862 (left to right) Chester Averill, William Gabb, William Ashburner, Josiah Whitney, Charles Hoffman, Clarence King, and William Brewer.

notable were William Healey Dall (Fig. 16) who had come West with the Western Union Telegraph's exploration and survey team to locate a route across Alaska to Siberia for a telegraph line; mathematician George Davidson (Fig. 17), who came to California as director of the Pacific Coast branch of the U.S. Coast Survey; Canadian geologist Amos Bowman (Fig. 18), who became interested in Bay area geomorphology, but then returned to the Geological Survey of Canada; and James Blake, M.D. (Fig. 19), previously a member of the Stansbury survey of the Great Salt Lake in 1849–1850, who came to California in 1850 and settled in Sacramento. Blake moved to San Francisco from Sacramento, where, for some time he had kept a low profile after his precipitous departure from Salt Lake City, just ahead of the sheriff, who had been sent by Brigham Young to recover property stolen from the Stansbury team. But that's another story!

FIGURE 12. John Muir, ca. 1863.

An interesting aside, based on the Coast Survey's hydrographic studies, is that both Dall and Davidson argued that the Japanese Warm Current did not enter the Bering Straits, as popularly thought, but that the Arctic circulation was internal and largely depended on tides and shallow water heating (Leviton and Aldrich 1997:144, 233). Because of the interest in opening a Northwest Passage, this was a crucial point and, in fact, it is likely that ignorance of this possibility led to the tragic loss of the U.S. Cutter *Jeannette* (Fig. 20) and its crew. (In all fairness to De Long and the crew of the *Jeannette*, it appears that neither Davidson nor Dall were present at the reception held on 16 June 1879 for the crew of the *Jeannette* [Leviton and Aldrich 1997:222–223, 514–515]).

MEMOIRS

PRESENTED TO THE CALIFORNIA ACADEMY OF SCIENCES.

VOLUME I.

II. *Principles of the Natural System of Volcanic Rocks.*

BY F. BARON RICHTHOFEN, DR. PHIL.

[Presented, May 6th, 1867.]

INTRODUCTORY. Among the features peculiar to modern Geology may be noticed a revival of that speculative tendency which prevailed among the cultivators of this science at the close of the last century. But while in those early times imagination exerted a dominant influence in the framing of hypotheses, and discussions between the adherents of different doctrines were conducted with all the bitterness peculiar to such struggles, when neither party has a firm basis upon which to found its arguments, the constant ascendency of the spirit of the inductive method has imparted to those theories more recently propounded a more logical and scientific form, while, at the same time, the increasing amount of positive knowledge has given to the different doctrines a more varied and more definite character, and enlarged the scope of dissenting views.

This renewed tendency to systematize and theorize, which is especially conspicuous in the records of the last twenty years, must be ascribed, partly, to the vast amount of well-established facts gathered during the previous decades, and which have since been multiplied and intensified in a constantly increasing ratio, as regards depth and distinctness of observation as well as the geographical area over which they extend; partly, and in no less degree, to the rapid progress made by those sciences on which geology has to draw for the general laws which are alone capable of affording a philosophical guide to speculation on the basis of facts gained by observing and comparing. The advance of the chemical and physical sciences, especially, has had a

MEM. CAL. ACAD. SCI. VOL. I. [2x] Jan. 1868. (39)

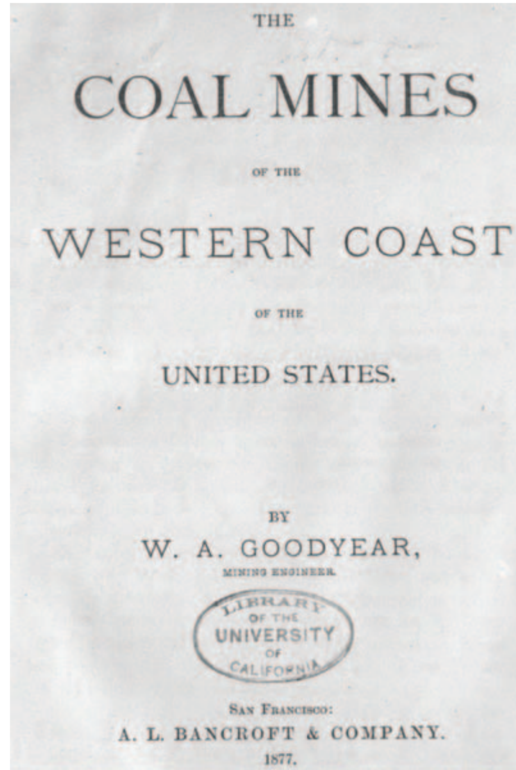
FIGURE 13. Richthofen's introduction to a classification of volcanic rocks published in 1868 in *Memoir* 1 of the California Academy of Sciences.

FIRST CLASS: GRANITIC ROCKS.	SECOND CLASS: PORPHYRITIC ROCKS.	THIRD CLASS: VOLCANIC ROCKS.		ESSENTIAL INGREDIENTS.
Order First—Granite.	*Order First—Felsitic Porphyry.*	*Order First—Rhyolite.*		
Fam. 1st. Granite.				Quartz, Orthoclase, Oligoclase, Biotite, (Hornblende.)
Fam. 2d. Granitite.	Fam. 1st. Quartzose Porphyry.	(Quartziferous Varieties.)	Fam. 1st. Nevadite.	
Fam. 3d. Syenitic Granite.			Fam. 2d. Liparite.	
	Fam. 2d. Varieties without Quartz.	(Varieties without Quartz.)	Fam. 3d. Rhyolite proper.	
Order Second—Syenite.	*Order Second—Porphyrite.*	*Order Second—Trachyte.*	*Order Third—Propylite.*	Oligoclase, Orthoclase, Hornblende, (Biotite), (Quartz.)
		Fam. 1st. Sanidin-Trachyte.	Fam. 1st. Quartzose-Propylite.	
Only Family: Syenite.	Only Family: Porphyrite.	Fam. 2d. Oligoclase-Trachyte.		Oligoclase, Hornblende, (Titaniferous Magnetic Iron-ore.)
Order Third—Diorite.	*Order Third—Melaphyr.*	*Order Fourth—Andesite.*	Fam. 2d. Hornblendic Propylite.	Oligoclase, Hornblende, Titaniferous Magnetic Iron-ore.
Fam. 1st. Diorite.	Fam. 1st. Melaphyr.	Fam. 1st. Hornblendic Andesite.		
Fam. 2d. Rocks intermediate between Diorite and Diabase.	Fam. 2d. Rocks intermediate between Melaphyr and Augitic Porphyry.	Fam. 2d. Augitic Andesite.	Fam. 3d. Augitic Propylite.	Oligoclase, Labrador, Augite, Hornblende, Titaniferous Magnetic Iron-ore.
Order Fourth—Diabase.	*Order Fourth—Augitic Porphyry.*	*Order Fifth—Basalt.*		Labrador, Augite, Titaniferous Magnetic Iron-ore.
Fam. 1st. Gabbro and Hypersthenite.	Only Family: Augitic Porphyry.	Fam. 1st. Dolerite.		
Fam. 2d. Diabase.		Fam. 2d. Basalt.		

RICHTHOFEN — NATURAL SYSTEM

FIGURE 14. Richthofen's classification of volcanic rocks.

George Davidson's Pacific Coast hydrographic survey also led to the discovery of the deep submarine canyons off the central and southern California coast long before their presence was made popular by Francis Shepard (1941, 1948, 1966). As for others employed by Davidson, Thomas Jefferson Lowry deserves mention because of the instruments and mathematical approaches he devised for precise measurements of position at sea. Presented at Academy meetings, his papers were then published in the *Proceedings* (Lowrey 1875a, 1875b, 1875c), as were Davidson's papers on *Submarine Valleys of the Pacific Coast of the United States* (1886, 1897).


THE

COAL MINES

OF THE

WESTERN COAST

OF THE

UNITED STATES.

BY

W. A. GOODYEAR,

MINING ENGINEER.

LIBRARY OF THE UNIVERSITY OF CALIFORNIA

SAN FRANCISCO:

A. L. BANCROFT & COMPANY.

1877.

FIGURE 15. Watson A. Goodyear on coal mines of the West Coast of the United States (1877). (From a copy in the University of California, Berkeley libraries.)

James Blake, who in 1868 followed Whitney as Academy President, took an interest in earthquakes, especially when the Haywards fault broke in 1868 and produced an earthquake some suggest was even more powerful than the 1906 San Francisco event. By analyzing patterns of destruction throughout the Bay region, Blake located the epicenter of the earthquake. In a separate article, he also speculated that there is a strong probability that elevation of land around the Bay Area is related to earthquakes whenever they occur (Blake 1863) (see also Aldrich et al. 1986). And, lastly, Blake would surely feel comfortable with present-day studies in Astrobiology inasmuch as he took great interest in the algae and other organisms that live at extreme temperatures in hot springs near Puebla, Nevada (Blake 1872a, 1872b, 1872c).

With the founding of the University of California in 1867 and Stanford University in 1891, a new breed of scientists appeared on the scene. The age of the amateur naturalist, however, competent, was fast drawing to a close. The age of professionalism, scientists trained in their disciplines, became the order of the day. At the Academy, it is often referred to as the "University period" because the meetings were dominated by university faculty and administration (Fig. 21): David Starr Jordan (Fig. 21a), President of Stanford, James Perrin Smith (Fig. 21b), whose Academy papers on ammonite ontogeny were pioneering efforts, Joseph LeConte (Fig. 21c), Edward Singleton Holden (Fig. 21f), A. Wendall Jackson (Fig. 21g), and Robert Edwards Carter Stearns (Fig. 21h), among others. They were joined by a new breed of professional geologists and engineers employed by the State and city of San Francisco: Waldemar Lindgren, Marsden Manson, whose interest in the glacial period led him to study the evolution of climates (Fig. 22), Harold Fairbanks, and, at the Academy, Frank Marion Anderson. Perhaps the most notable geological studies published in the Academy *Proceedings* in the late 19th century were those that dealt with Baja California, principally by Lindgren and by Academy naturalist and physician Gustav Eisen. But James Perrin Smith, John C. Merriam, and others also produced a steady stream of paleontological papers as did physician-naturalist James Graham Cooper, who had been associated with the Academy since his return to California from the Civil War. Cooper also served for a short time with the Whitney survey.

At this point we must digress and take note of the fact that several Academy members, e.g., Edward Booth, Edward S. Clark, James Graham Cooper, Edward T. Cox, and William Moore Gabb, were appointed to care for the limited paleontological collections that existed at the Academy during the 19th century (see Leviton and Aldrich 1997:62, 242, 252, 266, 283, 334, 414–415, 421). However, in 1903, Frank Marion Anderson (Fig. 23), who had become an Academy member in 1899, and who the year before had donated an important collection of fossils to the Academy, was appointed honorary curator of paleontology. The following year the appointment was [regular] curator of the Department of Paleontology, but again without salary. Anderson had amassed a significant collection of invertebrate fossils while engaged in stratigraphic studies in the Coalinga Oil District in Fresno County, California, and with ongoing field work elsewhere in California and Oregon, he built a large, comprehensive research collection of invertebrate fossils from the Late Mesozoic and Cenozoic rocks of the West Coast (see Leviton and Aldrich 1997:422, 425–426, 431–434, 453, 479). The large collections Anderson had amassed before 1906 were destroyed in the 1906 earthquake and fire, but he entered the gutted building before it was demolished, and was able to salvage a small collection of fire-damaged fossils, including some type specimens of ammonites he had described in 1902. Soon after the fire Anderson, with the help of his assistant, Bruce Martin, began to rebuild the fossil collections, and by 1916 they had re-established a major research collection when the Academy reopened in Golden Gate Park. As a result, since the period of his curatorship (1904–1917) geology at the Academy has been dominated by invertebrate paleontology.

FIGURE 16. Wiliam Healey Dall ca 1865.

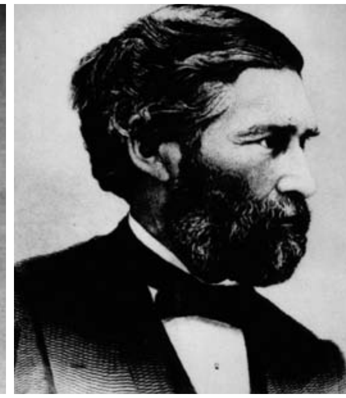


FIGURE 17. George Davidson

FIGURE 18. Amos Bowman.

FIGURE 19. James Blake

In 1891, the Academy moved into its new museum building on Market Street (Fig. 24) that had been made possible by a major gift of James Lick in 1876. The building housed both research programs and public exhibits, among the latter being a large collection of exhibit-grade minerals and a spectacular mammoth reconstruction (Fig. 25) purchased from Henry Augustus Ward of Rochester, New York through the largess of Leland Stanford and Charles Crocker.

In the few pages available, we have sketched out broadly the Academy's participation in the earth sciences during the 53 years from its founding in 1853 to 1906 to give a sense of how it like-

FIGURE 20. 19th century images relating to the U.S.S. *Jeannette* and the Arctic expedition of 1879–1881.

ly influenced the lives and science of individual members. But on 18 April 1906 all that changed, at least for awhile, for on that day San Francisco and so many of its institutions, some holdovers from the heady days of the gold rush, were lost (Fig. 26) in the earthquake and ensuing fire. For the Academy, it was devastating; its collections, the finest natural history library west of the Appalachians, and its nearly new museum building — gone (Fig. 27). But not the people. And in so far as the earth sciences are concerned, several Academy members, for instance, Harold Wellman Fairbanks, John Casper Branner (Fig. 21e), David Starr Jordan, and others, such as Grove Karl Gilbert, wrote reports (Fig. 28) that were to reshape both public and governments' attitudes to earthquake hazards, building codes, and land use.

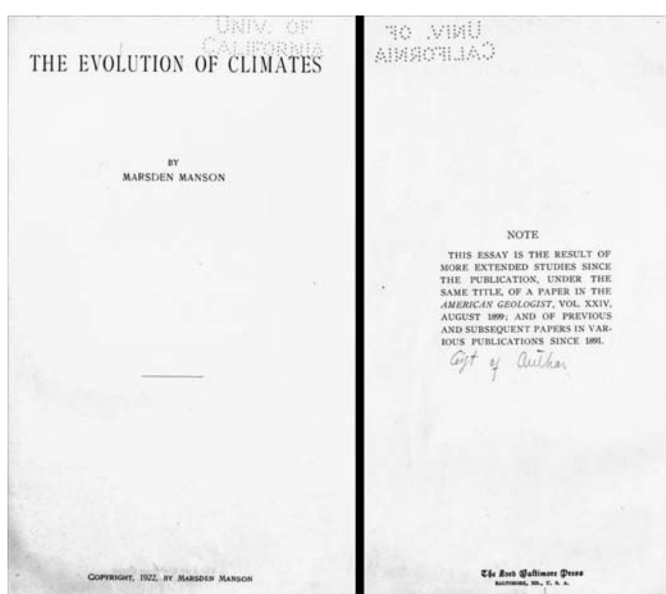
In summary, how does this story relate to the evolution of the Academy as a world-class research museum in the natural sciences? Academy geologists were educated elsewhere and transported their training to a new place that changed their thinking about the earth. James Blake, Whitney, and Richthofen were trained in England and Germany but found their theories reshaped by their Western experience. Trask had to cope with the phenomenon of earthquakes, largely foreign to an Eastern-trained naturalist. In many ways, these geologists affiliated with the Academy experienced the same transformation that the Irish geologists did on encountering India in the 1850s and 60s (Leviton and Aldrich 2000).

The Academy's function in the biographies of California geologists and naturalists in general also changed over time. For the explorer generation, it civilized San Francisco by adding a valuable cultural asset. For the survey generation, it offered a scientific, as opposed to a political, base of operations and an outlet for trying out new ideas and publishing short papers before the appearance of book-length reports. For the university period, the Academy was a place to mix with scientists from different schools and disciplines. In each era, one common thread is that it was not the

FIGURE 21. Dominant members of the Academy with interests in geology during the "University" period (left to right) upper row: (a) David Starr Jordan, (b) James Perrin Smith, (c) Joseph LeConte, (d) John C. Merriam; lower row: (e) John Branner, (f) Edward S. Holden, (g) A. Wendell Jackson, (h) Robert Stearns.

permanent home that academies provided for geologists in more settled districts. For many, it was a transient's place of support and fellowship.

Thus, first, and perhaps foremost, it provided a forum where people could meet, present papers, talk with colleagues and exchange views on topics of mutual interest, to be challenged, or just to socialize. Topics discussed and publications of importance that emerged from the meetings were often printed by the Academy (Fig. 29). The meetings must have been important to the members, even for those who subsequently may have denied its impact (e.g., LeConte quoted in M. Smith, 1987:219, fn. 22). For instance, Joseph LeConte from the University of California at Berkeley and David Starr Jordan from Stanford University in Palo Alto had to travel 40 and 80 miles roundtrip respectively to attend the meet-



THE EVOLUTION OF CLIMATES

BY
MARSDEN MANSON

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NOTE

THIS ESSAY IS THE RESULT OF MORE EXTENDED STUDIES SINCE THE PUBLICATION, UNDER THE SAME TITLE, OF A PAPER IN THE *AMERICAN GEOLOGIST*, VOL. XXIV, AUGUST 1899; AND OF PREVIOUS AND SUBSEQUENT PAPERS IN VARIOUS PUBLICATIONS SINCE 1891.

Gift of Author

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

FIGURE 22. Marsden Manson, 1922, *The Evolution of Climates,* based on papers published during the 1890s on the causes of the glacial epochs and climate change. (From a copy in the University of California, Berkeley libraries.)

ings, which were held in San Francisco. It must be remembered that this was before automobiles and San Francisco Bay bridges; thus, for LeConte it meant horse and buggy from Berkeley to Oakland, then a ferry to cross the bay, and a final three miles by trolley to the old Academy building at California and Dupont Streets or, after 1891, to 4th and Market Street; it was much easier for Jordan, a brief trolley ride from the Stanford campus to the train depot, about one mile, then a one hour 20 minute train trip up the Peninsula, and perhaps a 15 or 20 minute buggy ride to the Academy.

FIGURE 23. Frank Marion Anderson (1940).

To compare with similar activities elsewhere, the California institution most closely resembles the Academy of Natural Sciences in Philadelphia, more so than the Smithsonian Institution, although in time both Academies were to open public museums, as did the Smithsonian. A notable difference between the Philadelphia and San Francisco organizations is that from the beginning the California Academy not only invited the public to participate but it made a special plea for women to get involved. And, well before 1900, it had four women on its salaried staff, three curators and the Academy librarian.

FIGURE 24. 1891. The Market Street building of the California Academy of Sciences. A second building, immediately behind and connected to the Market Street entrance by a bridge housed the museum, library, research collections, and Academy offices.

Second, it is clear from the publications record that during the latter half of the 19th century the Whitney and Davidson eras were peak periods for the presentation of papers in geology and earth sciences in general (Fig. 30).

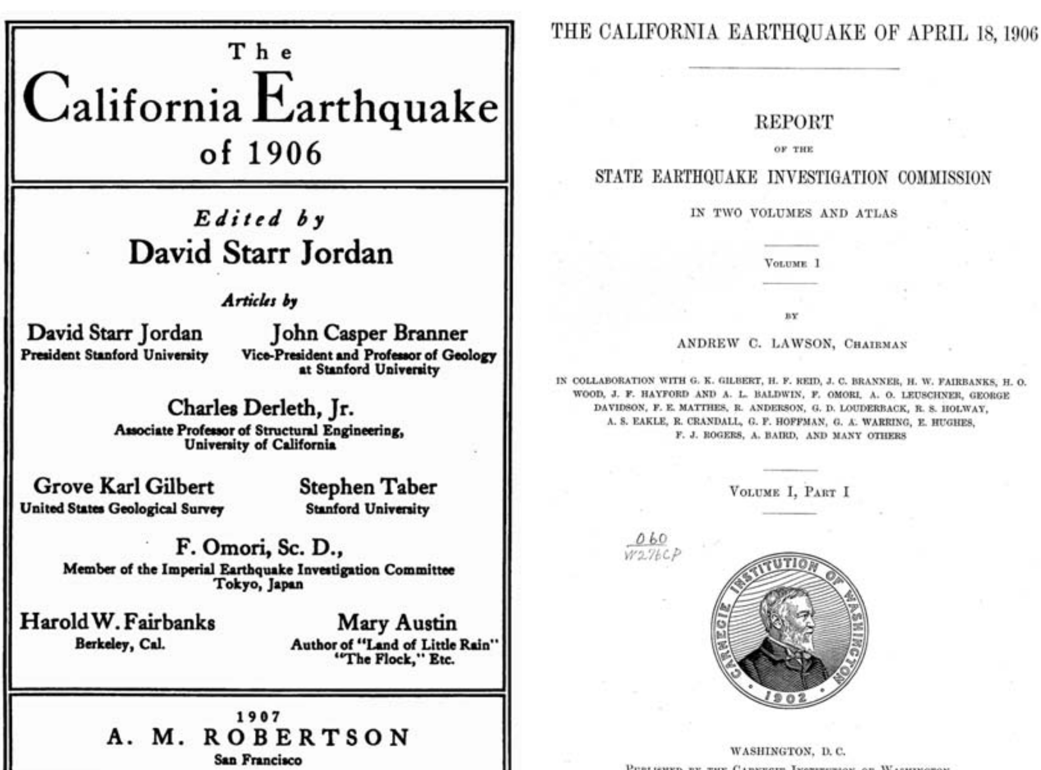
Third, although the Academy did not publish all of the papers of its members, exchanges that took place at its meetings refined the presentations that ultimately were published. However, the Academy did publish some significant contributions in the earth sciences as noted earlier.

Finally, there were controversies not the least of which were Benjamin Silliman, Jr.'s claim on California diamonds, Whitney's negative views on the importance of oil in California and views on the origin of Yosemite Valley, and the fascinating history of the Carson City footprints, which involved both resident Academy members and members who lived elsewhere, such as Edward Drinker Cope, a member from 1888 until his death in 1897, and Othniel Charles Marsh. In all, the Academy proved a focal point for the collective biography of geologists who lived and worked in California, if only for part of their careers.

FIGURE 25. Ground floor of the museum building in 1892 with the Ward Mammoth as the centerpiece. Insert, upper left, Academy member and entrepreneur naturalist Henry Augustus Ward, founder of Wards Natural Science establishment in Rochester, New York.

FIGURE 26. Downtown San Francisco following the earthquake and fire, 18 April 1906. Left, view up Market Street.

FIGURE 27. The California Academy of Sciences following the earthquake and fire, 18 April 1906. (left) Little remains of the front Market Street building; the white building on the left is all that remains of the Academy's museum. (right) The burned out interior of the Academy's museum building.



The
California Earthquake
of 1906

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1907
A. M. ROBERTSON
San Francisco

THE CALIFORNIA EARTHQUAKE OF APRIL 18, 1906

REPORT
OF THE
STATE EARTHQUAKE INVESTIGATION COMMISSION
IN TWO VOLUMES AND ATLAS

VOLUME I

BY
ANDREW C. LAWSON, CHAIRMAN

IN COLLABORATION WITH G. K. GILBERT, H. F. REID, J. C. BRANNER, H. W. FAIRBANKS, H. O. WOOD, J. F. HAYFORD AND A. L. BALDWIN, F. OMORI, A. O. LEUSCHNER, GEORGE DAVIDSON, F. E. MATTHES, R. ANDERSON, G. D. LOUDERBACK, R. S. HOLWAY, A. S. EAKLE, R. CRANDALL, G. F. HOFFMAN, G. A. WARRING, E. HUGHES, F. J. ROGERS, A. BAIRD, AND MANY OTHERS

VOLUME I, PART I

WASHINGTON, D. C.
PUBLISHED BY THE CARNEGIE INSTITUTION OF WASHINGTON
1908

FIGURE 28. (left) *The California Earthquake of 1906*, edited by David Starr Jordan and published in 1907 preceeded the 1908 et. seq. Carnegie reports. (right) Title page of the California Earthquake Commission report.(1908).

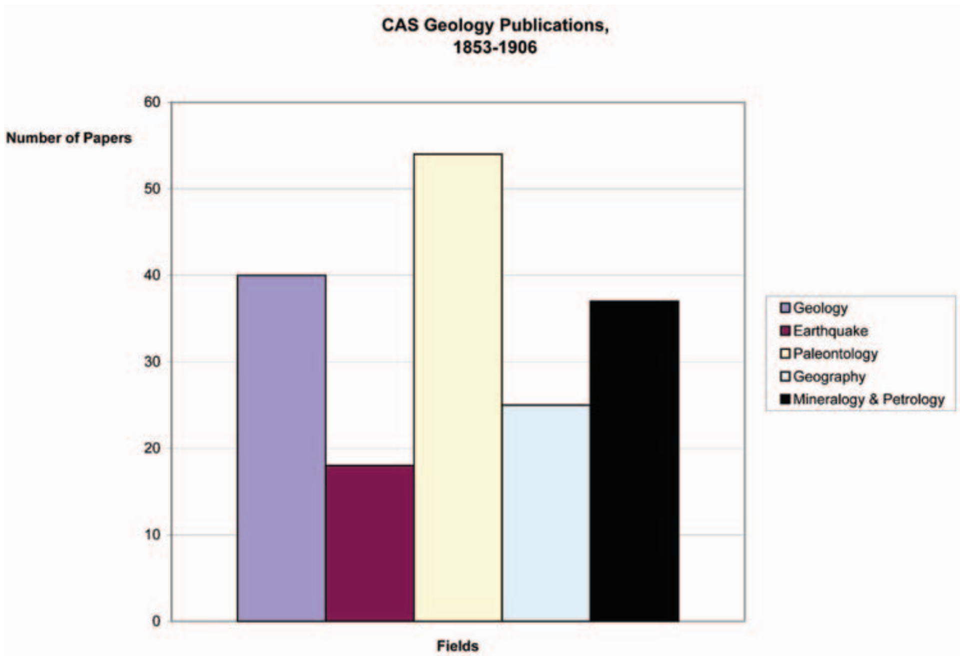

FIGURE 29. Academy publications in the earth sciences, 1854-1906, by discipline.

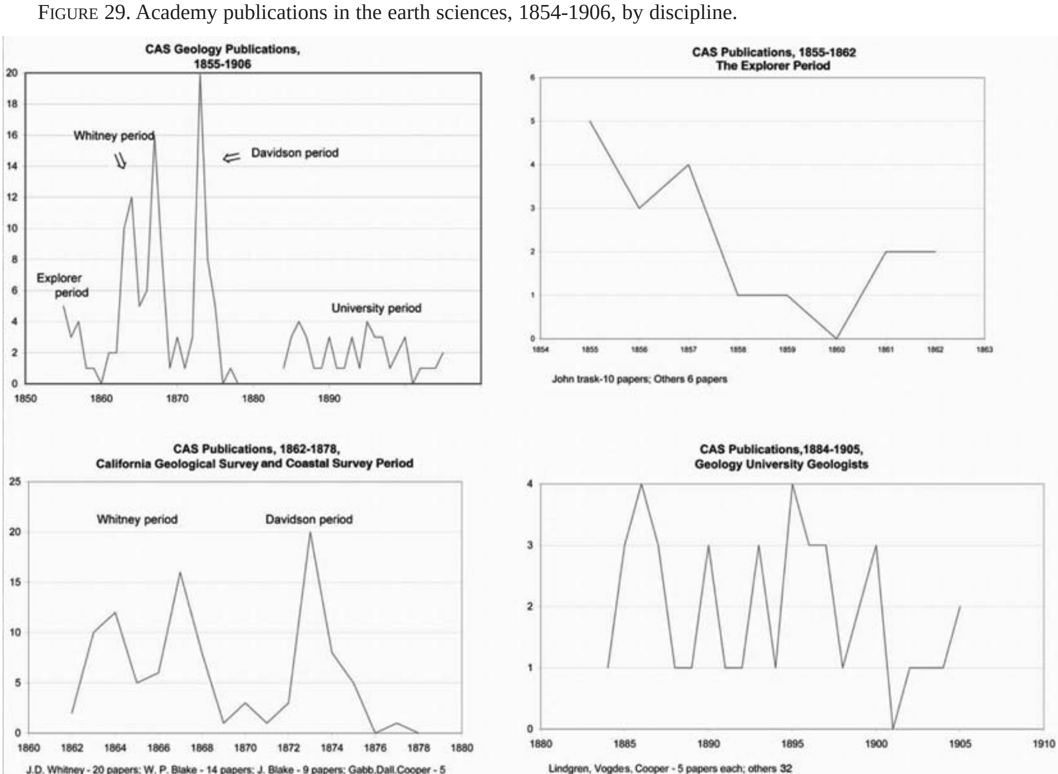

FIGURE 30. Distribution of Academy publications in the earth sciences across the years 1854–1906.

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Institutions: Academy of Natural Sciences, Philadelphia, Archives; Anacortes Museum, Anacortes, Washington; Bancroft Library, University of California, Berkeley; California Academy of Sciences Archives and Library; Harvard University Archives; Hunt Institute for Botanical Documentation, Carnegie-Mellon University; Huntington Library; Library of Congress Newspaper & Periodicals Division; National Archives and Records Service; San Francisco Public Library, History Division; Smith College Library; Smithsonian Institution Archives & Joseph Henry Papers; U.S. Geological Survey Library, Denver; University of San Francisco, Gleeson Library; Yale University Medical Library.

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Unles otherwise noted in image legends or below, portraits are from the Archives, California Academy of Sciences or the GS Myers/AE Leviton Portrait and Biography File in the Natural Sciences. The following additional acknowledgments and thanks are extended to: Smithsonian Institution Archives (Figs. 1 [Philip Tyson], 3 [William Phipps Blake], 10a–b [Spencer Fullerton Baird and Joseph Henry], 12 [California State Geological Survey and insert of Josiah Dwight Whitney]; 15 [Richthofen insert]; 18 [William Healey Dall], 27 [H.A. Ward insert]); Bancroft Library, University of California, Berkeley (Figs. 23g [Wendell Jackson], 23h [Robert Carter Stearns]; Anacortes Museum, Anacortes, Washington (Fig. 20 [Amos Bowman]). Figure 22, a collage of images relating to the ill-fated voyage of the *Jeannette* (1879–1881) was assembled from images available online at the U.S. Navy Historical Center (*www.history.navy.mil/ photos/events/ev-1880s/jean-a.htm* [see also *jean-b.htm, -c, -d,* et seq, *-m*; also *jeannette.htm*]).

† Deceased.

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